Camel Abscesses in the Red Sea State of the Sudan

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Dedication

To the soul of my father
Which guided me
Through the path of success.
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Abstract

The study was carried out in the Red Sea State to investigate incidence of camels’ abscesses using clinical and pathological investigations. The animals were surveyed between June 2005 to September, 2006. During this period, 6,677 live and 287 slaughtered camels of both sexes and different age groups were examined in seven localities in the Red Sea State. These municipalities were Port Sudan, Elgonoub and Elaolib, Suakin, Gabeat Madden, Sinkat, Dourdeab and Haya.

It was found that 630 (9.05 %) of the examined camels had abscesses. Superficial abscesses constituted 444 (6.64%) out of 6677. The highest number of abscesses 83.33% was found in camels brought to the clinic followed by 4.96% camels examined at the veterinary quarantine. The most frequently affected sites were ventral superficial cervical nodes, fore limbs and hind limbs.

Port Sudan slaughterhouse was regularly visited for inspection of external and internal abscesses. A total of 275 lesions were encountered in 186 camel carcasses. Fifteen (5.22%) abscesses were located in superficial parts in live animals. Internal abscesses constituted about 186 (64.8%) out of 287 and were seen in 44 (16.29%) in the lungs, 24 (8.88%) in the liver parenchyma and 202 (73.45%) in the lymph nodes.

Statistical analysis of the incidence of abscesses indicated that the overall mean was 26.4±0.041. The mean incidence in the Veterinary clinic and slaughterhouse was 46.3±0.08 and 43.2±0.08 and were significantly higher from those in the veterinary quarantine (3.5 %±0.08) and Port Sudan (12.4 ± 0.08). The mean number of female camels affected with abscesses
was (18.9±0.07) and the mean number of affected males was (17.3±0.07). There was no significant difference between the two sexes.

The condemnations records of Port Sudan slaughterhouse showed that out of 2527 slaughtered camels during the period of records, 14 (0.55%) were totally condemned and 1628 (64.2%) were partially condemned. The mean percent of partial condemnations due to other lesions (37.2±8.05) was significantly higher from the mean condemnation due to abscesses (7.55±8.05).

From 459 samples collected in Red Sea State (both field and slaughterhouse), 365 (79.5%) samples were positive for bacterial growth and 94 (20.5%) samples were negative. Gram-positive bacteria isolates were 351 (62.9%) identified as 140 (25.08%) *Staphylococcus* spp, 75 (\(\times\)\(\frac{31}{44}\)) % *Streptococcus* spp, 54 (9.67%) *Bacillus* spp, 39 (6.98%) *Micrococcus* spp, 22 (3.94%) *Corynebacterium* spp, 12 (2.15%) *Enterococcus* spp, 7 (1.25%) *Kurthia* spp and 2 (0.35%) *Actinomyces* spp.

The Gram-negative bacteria isolates were 207 (37.1%) identified as 92 (16.48%) *Escherichia* spp, 30 (5.37%) *Proteus* spp, 19 (3.4%) *Klebsiella* spp, 18 (3.22%) *Enterobacter* spp, 15 (2.68%) *Moraxella* spp, 11 (1.97%) *Vibrio* spp, 7 (1.25%) *Acinetobacter* spp, 7 (1.25%) *Citrobacter* spp, 5 (0.89%) *Shewenella* spp, 2 (0.35%) *Pasteurella* spp, and 1 (0.17%) *Pseudomonas* spp.

Abscesses were observed mainly in lymph nodes, lungs and livers. Necrosis, fibrosis and calcification can be seen in association with chronic abscesses which were confirmed histopathologically.
النتائج

اجريت هذه الدراسة في ولاية البحر الأحمر بغض استقصاء حدوث خراجات الأبل بالمسح السريري والإمراضي على حد سواء وذلك من الحقل والسلخانة، إذ تم خلال فترة المسح من يونيو 2005 حتى سبتمبر 2006. خلال هذه الفترة تم تسجيل 6,677 نموذجًا و287 نموذج ذيحي من الجنسين وأعمار مختلفة في فصول مختلف في ولاية البحر الأحمر وهي بورتسودان، القنب والأوليب، سواء، جبيت المعادن، سنكات، دربيب وهبيا. وقد وجد أن (30% (9.05% من النتائج مصاب بالخراجات، شكلت الخراجات الخارجية حوالي 44% (6.64%) من 277 وجدته أعلى معدل للإصابة في 33% من النتائج التي جلبها إلى العيادة البيطرية بليما معدل الإصابة في المحجر البيطرى 4.96%. أكثر الأجزاء المنافرة كانت الغدة العنقية البطنية الخارجية والقوائم الأمامية والخلفية. تم تسجيل خراجات بورتسودان بصورة دورية وذلك بهدف الكشف عن الخراجات الداخلية والخارجية، وجد 27% في ذبى 182 ذبى نموذج ذيحي (15% (0.22%) من الخراجات وجدت في الأجزاء الخارجية من الحيوانات الحية، مثلت الخراجات الداخلية 18% من 87 (64.8%) ووجدت في الرئة بنسبة 16.29% في نسب الكبد بنسبة 8.88% وفي الغدد المفاوية بنسبة 73.45%. كما وجدت النتائج أن متوسط الإصابة هو 26.4%، متوسط الإصابة في العيادة البيطرية والسلخانة هو 46.3% و43.2% على التوالي، حيث من توزيع الإصابة في المحجر البيطرى (3.5% ومدينة بورتسودان (12.4%) ولا يوجد اختلاف بين حدوث الخراجات بين الجنسين إذ أن متوسط إصابة الإناث بالمرض كان 18.9 و30% متوسط إصابة الذكور 17.3.

وقد من سجلات الإعدادات بسلخانة مدينة بورتسودان أنه تم اعداد 2527 ذبيح أبل خلال الفترة مابين 2005 – 2008 (70% (0.55%) لقبلي و (30% (20.5%) اعدم جزئي، كان هناك إصابة بالخراجات، ووجدت ان المتوسط بالخراجات (7.55). من 459 عينة جمعت من ولاية البحر الأحمر (من الحقل والسلخانة) كانت هناك 365 عينة (79.5%) موجبة للنمو البكتيري و 94 (20.5%) عينة كانت سالبة. 351 (62.9%) صنفت بكتريا موجبة للجرام وهي 140 (25.08%) نوع العنقودية، 75 (13.44%) نوع العقدية,
٥٤ (9.67%) نوع العصوية، ٣٩ (6.98%) نوع المكورة الدقيقة، ٢٢ (3.94%) نوع الوريدية،
١٢ (2.15%) نوع المكورة المعوية، ٧ (1.25%) نوع كيرثيا، ٣ (0.35%) نوع الشعية.
صنفت البكتريا سالبة الجرام في ٢٠٧ (37.1%) وهي ٨٢ (16.48%) نوع الدبنريكي،
١٩ (3.4%) نوع الالبكتيل، ٨ (2.22%) نوع البكتيريا، ١٥ (3.22%) نوع المستروباكتير،
١١ (1.97%) نوع موراكسيلاء، ٧ (1.25%) نوع المستروباكتير، ٦ (0.89%) نوع المستروباكتير،
٢ (0.35%) نوع شيونلا، ١ (0.17%) نوع الذكور.

الآفات العيانية لأنواع الخراجات لوحظت بصورة أساسية في الغدد المفاوية، الرئة والكبد. التنخر،
التليف، التكلس وجد مرتبطا بالخراج المزمن. وأكدت هذه النتائج بالفحص المجهر للمIONS
المرضي. ٩٣ ٩٣ ٩٣

XXII
Introduction

The camel population in the world is estimated as 18 millions, (Wilson, 1984). There are two types of camels in the world: the one – humped camel (*Camelus dromedarius*) and the two – humped camel (*Camelus bactrianus*). The one humped camel populates the semiarid, arid, tropical and subtropical regions of Africa and Asia. The two – humped camels inhibit the cold regions of Asia (knoess, 1979).

The camel in the Sudan is concentrated in two main regions; the Eastern States where the camels are found in Butana and Red Sea Area and secondly in Western States. The camel population in Red Sea State has been estimated as 202,106 camels (Anon, 2002).

The camel is primarily a browser although grass and other ground vegetations are grazed; camels can be fed on fodder and grain. Some deficiency conditions have been identified but knowledge, generally, on this subject is sparse. Because of their capability of working and producing milk in arid and often waterless zones, camel makes life possible for very large number of people in such areas in Sudan. The camels are hardy animals which have adapted well physiologically and anatomically to surviving in harsh condition. Water is essential to life and the camel has often to survive on limited quantities for long period of time, developed not only a very low rate of water use, but mechanisms for restricting water loss as soon as its intake is reduced (Wilson,1984).

The dromedary is an economic feeder which can uniquely survive in the desert as a net producer of milk, meat and other by-products from natural resources which might otherwise be unusable.
The camel is a triple-purpose animal providing milk, meat and transport; it also provides hair and hide and traditional management system for milling oil from sesame seeds. Camels are employed to carry loads, amount as a draught animal.

In Sudan, livestock generally has contributed considerably to the national economy through exportation. At present, camel exportation constitutes a very important sector to the gross national income. Camels are exported to Arab countries for meat and for racing (the Gulf countries). The exported camels to Egypt are basically brought from Port Sudan to Shalateen, according to the recent data obtained from the Port Sudan Veterinary Quarantine. The average numbers of camels exported to Egypt via Shalateen amounted to 3000 heads per month. The total numbers of camel exported to Egypt and Saudi Arabia during the years 2003 -2008 were 224,021 and 42,520 heads respectively. The highest camel number exported were 57238 at 2005 (Anon, 2008) (Table 1).

Sudan possesses a huge wealth of camels. In the past, research workers paid only little attention to camel research. Although numerous viral, bacterial and parasitic diseases were recorded, yet only few diseases received attention and extensive studies need to be conducted.

Camel abscesses has received little attention with the bulk of research directed towards historic disease of camel. Also in abscesses there are both economic and public health hazard, generally recognized economic losses result from the condemnation of infected carcasses or part of it leading to nutritional problems.
The objectives of this study were:
1- To determine the incidence of the superficial abscesses by field investigation and clinical examination of camels at different ages in different parts of Red Sea Area.
2- The incidence rate of abscesses among slaughtered camel which were examined in Port Sudan slaughterhouse and the picture of the disease in camel will be studied.
3- To correlate the post mortem and ante mortem finding with the number of abscesses and their distribution.
4- Determine the prevalence of microorganisms, the morphological, cultural and biochemical characters of isolates from abscesses will be studied and to identify the bacterial agents isolated from samples by using different cultural and biochemical properties.
5- To determine the gross and histopathological changes produced by the different species of bacteria that cause camel abscesses.
Literature Review

1.1 The camel:

The dromedary is an important domesticated animal of the tropics and its wider distribution and larger total population demand that it should receive more attention (Wilson, 1984). The camel was among the most recent animal to be domesticated, few morphological change are apparent in domestic camel and there has been little differentiation into breeds. Sudan and Somalia contain about 50% of all world camelidae and 55% of all dromedary (FAO, 1986).

Females are sexually mature at three years of age but are not generally bred until they are four years old. They may continue to breed until they are over 20 years. The average length of gestation is 370 days. Normally only one calf is produced every two years but occasionally the female may breed twice in two and half years. A good dam should yield 20 pound (9.1 liter) of milk daily at the peak of her lactation. The dam goes dry after about 9 months in dessert fed and up to 18 months on richer farm (William and Payne, 1978).

1.1.1 The skeleton of the camel:

The skull of the camel is more nearly to any other domestic animal (Leese, 1927). The occipital crest is prominent and is responsible for the peak - shaped poll of the camel; the bone is very massive, up to 75 mm thick between the apex of the crest and the cranial cavity. The vertebral anatomy is similar to that most of other domestic animals. The forelegs, the upper edge of the shoulder blade, the scapula, is very convex with constriction just above the shoulder joint (Wilson, 1984).
1.1.2 The muscular system:

The active locomotors system of the camel is strongly supported by elastic connective tissue over flexion surface of the joint of the limbs. In general, the muscular system depicts economy and conservation of energy. Most of the fatty tissue of camels is stored in the hump rather than diffused throughout the body. This is an adaptation to heat transmission. (Wilson, 1984). The camels long, thin legs have powerful muscles which allow the animal to carry heavy loads over long distances.

1.2 Occurrence in the world:

In general terms, the camel is considered as an animal of the tropics in the 18 African countries in which it forms an important part of the domestic livestock population. The camel population in the world is estimated to be 18 millions camels, (Wilson, 1984). About fifteen million heads were found in the Arab countries (AOAD, 1990).

Camels are considered as animals of tropics, but much of its present day normal range is extra tropical. It has always been difficult to make reasonable estimates of camel number in the world mainly because camel exist in desert areas with difficult accessibility (El Amin, 1979).

1.3 Classification of camel:

The extant camelidae are classed in two genera the old world genus of camel as is generally accepted to comprise two species: *Camelus dromedarius*, the dromedary, one–humped or Arabian camel; and *Camelus bactrianus*, the bactrianus or two–humped camel (Wilson, 1984). Dromedary camels were closely related to modern two humped or Bactrian camels from which one–humped camels were apparently involved (William and Payne, 1978). The one humped camel populates the semiarid and arid tropical and subtropical region of Africa and Asia and has also been
successfully introduced to other regions such as Australia; the *Bactrian camels* are bred in the cold regions of Asia (Knoess, 1979).

1.4 Camels in Sudan:

Sudan holds about three millions and this represent 32% of camel population in Africa and 20% of the total world camel. That mean Sudan is considered one of the richest countries of camel. Camel herds grow slowly due in part to the long calving interval rather than late age at first calving (FAO, 1986).

Babiker (1984) surveyed camel populations in and around all the towns and larger village in the camel areas. This survey indicated a much larger population than the two - five millions. In the west of Sudan the number of camel was estimated at nearly three million. In the Eastern Sudan camels are more abundant around the agricultural schemes along the main permanent rivers of the region. Consequently relatively high estimates are quoted for the provinces through which these rivers flow. More than 80% of camel population in Sudan is found in the states of Kordofan (37%), Darfur (17%) and the eastern states (27%) of the Sudan (Idris, 2003).

In the Sudan, camels are owned by tribes that inhabit the dry semi-Desert areas. Because of its limited distributions and numbers, the camel has undergone very little variation and there has been no development into individual differentiated breed as is the case with other types of farm animals (El Amin, 1979).

1.4.1 Types of camel in the Sudan:

Camels in the Sudan are classified as either the riding (light) or pack (heavy) type according to the function which they perform. These are further classified into the riding camel which refer only to the Bishari and Anafi and pack camel to the Arab and Rashaida camel (El Amin, 1979).
Camels are concentrated in two main regions; the Eastern States where camels are found in Butana and Red Sea Area and secondly in Western States (Darfur and Kordofan) where camels are found in the northern parts.

Since the domestication of the dromedary has played an important role for personnel transport. The light riding camels the Anafi and Bishari strains of eastern Sudan are justly famous for their speed and endurance (Wilson, 1984).

The Sudan is home to some of the most well-known camel nomads, the Kababish, Shukria, Hadendowa and others. Most tribal groups breed distinctive types of camels. Well known among these are the Anafi and Bishari, prized for their racing and riding capacities, the Rashaida, a study transport camel with superior drought resistance and the large whitish Lahaween, which gives high meat yields (Rollefson, Musa and Fadl, 1990).

1.4.2 Types of camel in the Red Sea Area:

The Red Sea Area is inhibited by different types of camels such as Bishari, Rashaida and Anafi. The Bishari type is owned by the Beja tribes of the Eastern Sudan. It is active, small sized but hardy; cannot carry much weight, but is fast and has more stamina.

The Red Sea hills breeds were performed as riding camel’s. They are strongly and muscular and rather leggy. The pack camels are big often weighing well usually sandy grey (Wilson, 1984).

El Amin (1979) reported that Beja or Bishari type is a general purpose mount with better conformation and well-developed neck. Many crosses exist between Anafi and Bishari or heavy camels. Some of the Rashaida, however, spend most of the dry season on the Red Sea coast around the Sawakin and Toker areas. These groups arrange their migration
to coincide with the availability of good-quality rain, which develops as a result of the Red Sea coastal winter rains (Agab and Abbas, 1998).

The Bishari have two types of riding camels, the Albai are heavy much at home in the Red Sea Hills west of Sawakin. The Amrat, Aliab and Hamadorab section of the Bishari have the best northern types while the Eriat and Naafab have the best southern strains (Wilson, 1984).

1.5 General physiology of camel in the desert environment:

Animals produce heat continuously and they are to maintain a constant body temperature, must lose it to their surroundings. The routes by which they may lose heat are by radiation, conduction and convection from their body surface and by the evaporation of water from both their body surface and their lung. The rate at which heat is lost depends in the first instance on the difference in temperature between the animal and its surrounding (McDonald, Edwards and Greenhalgh, 1981).

The *Camelus dromedarius*, was the only animal species that survived the drought (Wilson, 1984). The camel is hard and tough animal, well adapted to living in a harsh desert environment under nomadic or semi-nomadic husbandry system. Ecologically, the camel is very well adapted and suited to life in arid lands. It can tolerate extreme dry and hot weather and can move to much longer distances under extreme scarcity of water and fodder as compared to other domestic livestock (Khanna and Rai, 1995).

The camel loses body heat by sweating more efficiently, fat is concentrated in the hump which enables sweat to be evaporated easily over the rest of the body surface. The camel can lose 25% of its body weight, without losing its amount in 10 minutes by drinking. The body of camel temperature can vary over a wide range under condition of dehydration. The ability of the camel to rise its temperature also has the advantage of reducing
heat gain (Wilson, 1984). In addition, the camel is able to concentrate its urine to considerable extent.

Physiologically the camel is peculiar among domestic animals. Its ability to allow its body temperature to rise and fall is quite exceptional. Temperature, therefore, used as an indication of the state of health of camel. It must be used with caution (Wilson, 1984).

The animals must achieve homoeothermic in the face of potential variation in both heat production and rate of heat loss and it has only partial control over these variation. In general, the animals primary response to a change in its environment is to maintain the rate of heat loss (Mc Donald, et al., 1981).

1.6 Adaptation of feeding and water balance of the camel:

The animal obtains energy from its food, the quantity of chemical energy present in a food is measured by converting it into heat energy and determining the heat produced. This conversion is carried out by oxidizing the food by burning it. The quantity of heat resulting from the complete oxidation of unit weight of a food is known as the gross energy or heat of combustion of that food (Mc Donald, et al., 1981).

Camels are able to live on browse to a greater extent. Anatomical adaptation in lip and long tongue mean that a browsing rather than a grazing diet is most suitable for the camel (Wilson, 1984). Camels on natural range will browse and graze at any time of the day or night. During very hot weather they tend to avoid feeding during the heat of the day and to adopt positions which reduce heat gain and thus conserve energy. Even when not under extreme climatic stress of the day than at others, for example just before and after sunset (Acland, 1932).
The remarkable ability of the camel to conserve water should not obscure. On occasions it can go for weeks without access to free water, it is essential to life and the camel has often to survive on limited quantities for long period of time. To do this it has developed not only a very low rate of water use but mechanisms for working. Camels generally need to be watered every day if possible or at least once in every two days, working camels generally need to be watered every day if possible or at least once in every two days (Wilson, 1984).

Under the drought and desertification most of the traditional livestock died or suffered from shortage of food and water. However, camels were the survival through the period of crisis with minimum losses when compared to other species of animals (Mohmed, Abu-Samra and Musa, 1990). The camel was the only animal species that survived the drought and increased in number as a consequence of this survival (Higgins, 1983).

1.7 Economical importance of the camel:

The ability of the camels to withstand and survive the hot and harsh environmental condition is not matched by any other animals. For centuries the camel used to be versatile animal that provides its nomad owner with food (milk and meat), transportation and a social prestige.

With increasing human population and declining precipitate production of food there is an urgent need to develop the previously marginal resources to optimize their utilization through appropriate production of which the camel in certainly the most suitable one (Fahmy, 1990).

Domestic camels function mainly as a means of transport, a source of traction power and as producers of meat and milk, they are used in arid regions because of their ability to flourish on the fibrous vegetation found
there, which cannot be utilized to some extent by any other species of domestic animal (William and Payne, 1978).

1.7.1 Milk and meat production:

Camels domestication and the reasons for its use primarily as a pack animal rather than producer of meat, milk or clothing (Wilson, 1984). The camel meat and milk constitute an important source of animal protein, especially for the majority of lower income groups (Leese, 1927).

Camel milk has been a source of nutrient for millions of people in African countries. Several types of camels have been identified as potential dairy breeds and could be used as a source of protein for these populations in drought-stricken areas and the milk production in camels is not affected by water restriction (Tibary and Anouassi, 2000). Camel milk is important at the subsistence level but is rarely marketed (Rolefson, et al., 1990).

The average annual camel meat production ranged between 72-81 thousand tons, this production is characterized by seasonality of supply because of the productivity characteristics and environmental factors which determine the pattern of market supply. The consumption of camel meat in the Sudan is very low due to the lack of awareness of the nutritive value of camel meat which is not less than that of other red meat and there is no marketing strategy to promote camel meat to penetrate the red meat market (Idris, 2003).

Camels annually produce about 3218, 538, 95 and 14 thousand tons of consumable milk, meat, hides and fiber, respectively and make up 19% of the total milk unit of the Arab countries (Wardeh, 1992).

Camel are better milking animals than the foreign breeds of cattle which have been imported in considerable number in recent years and camel milking is being strongly encouraged. The milking camel are less susceptible
than cattle to endemic diseases and are more tolerant to heat and the spares, rough pastures of the desert and rangelands (Mustafa, 1987). Camel milk is an important component of nomad's diet in Sudan. It is consumed by the owners and herders and not exploited commercially (El Amin, 1979).

Female camel in good condition produced 8-10 lbs per day or 3600 lbs per lactation period 15 month. Camels are able of producing 6 liter of good quality milk per day even when water is restricted during summer (Mohmed, Abu-Samra and Musa, 1990).

Rollefson, et al. (1990) reported that to some extent the Rashaida alleviate these discrepancies by processing milk that is not need by the calf or for immediate human consumption into storable products. Unprocessed camel milk remains fit for consumption for 4-5 days.

There is often some resistance to the consumption of camel meat, particularly in developing area, in which camel meat might contribute an important fraction of total protein availability.

1.7.2 Work power:

In Sudan camels are used as draught animals, baggage carrier and for riding (El Amin, 1979). Camels in Sudan are capable of transporting weight of 150 - 300 kg average 250 kg over 25 - 40 km per day. Sudanese riding camel can over 8 km per hour trotting and up to 32 km per hours when running (Lesse, 1927 and Mohmed, et al., 1990). Egypt imports camels mainly from the Sudan, about 70% are slaughtered and 30% brought by farmer for work on the farms and to fatten them to sell them for a profit (Idris, 2003).

1.7.3 Camel by-product:

Camel hair is important for nomads as they use it for making robes, tents, saddles...etc. (El Amin, 1979 and Mohmed, et al., 1990). Hides of
locally slaughtered camels also find markets in Egypt and recently in some European countries. Apart from limited local manufacture of glue from other by-products are not utilized, it can be processed into different types of product with practically unlimited by simple procedures (Babiker, 1984).

1.7.4 Marketing and export potential:

Not surprising the volume of camel trade in local markets varied. The camel as game animal for races in the gulf countries is gaining much popularity, where very remunerative prices are paid for the race camel; there is also very good export potential. Moreover, racing camels in Saudi Arabia and North Africa are highly priced. In other countries, such as Tunisia, a large portion of the agricultural work is dependent on camels (Wardeh, 1992).

The volume of camel trade in local market varies seasonally depending on annual migration; and relative importance of market in towns is also correlated with animal movement. Omdurman has always been the main camel market in the country (Babiker, 1984). The export of camels for slaughter – mostly Egypt, but also to the Libyan Arab Jamahiriya and other countries, is an important source of foreign currency (Rollefson, et al., 1990)

The greater part of the local camel trade only involves a change of ownership, the purchased camel simply returned back to the grazing stocks. The volume of the export trade varies seasonally from year to year. It is conceivable that at least part of the trade did not pass through the normal customs procedures and actual trade volume might have been higher than that officially recorded (Babiker, 1984).

The recent expansion of asphalt roads into most of the camel rearing areas of the Butana and the west of the Sudan could enable export of live
camels and processed product. It is now time to export camel’s meat, frozen or chilled (El-badawi, Eisa, Slepnev and Saad, 1979 and Babiker, 1984).

The Sudan is the major source for camel export to Egypt. Camels are mainly produced in Western and Eastern Sudan. A great number of camels imported each year for slaughter and available data indicate that more than 70000 Sudanese camels reach the market of Ambaba near Cairo (Shalabi and Sallouma, 2003) (Table 1).
Table (1): The number of camel exported to Egypt and Saudi Arabia from Port Sudan Veterinary Quarantine during the period of 2003 - 2008 (Annual Report, 2008).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of camels exported to Saudi Arabia</th>
<th>Number of camels exported to Egypt</th>
<th>Total and percentage</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Number</td>
<td>%</td>
<td>Number</td>
</tr>
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<tr>
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<tr>
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<td>-</td>
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</tr>
</tbody>
</table>

Note: During year 2008 no camels was exported to Saudi Arabia.
1.8 Infection:

Infection is the invasion of the tissue of the body by microorganisms. The animal body is continually exposed to contact with numerous organisms of many different species. Pathogenic microbes are specially adapted and endowed with mechanisms for overcoming the normal body defenses (Cruickshank, 1965).

For bacterial pathogen to be successful in growth and reproduction (colonization), it must find on appropriate environment such as nutrient, pH and temperature within the host (Klein, 2000). The superficial infection may be acquired through contact with infected materials. Pathogenic bacteria derived from respiratory tract are important cause of skin infection wound (Cruickshank, 1965).

Bacteria that infect the animal body must have the means of overcoming there. Defense mechanisms of protecting themselves against the bacterial substances in the body fluids and of avoiding ingestion or intracellular destruction by phagocytes (Cruickshank, 1965).

The various organisms that can cause disease have natural habitat to which they are well adapted. Most organisms that have been the associated with those animals, some organisms will usually only grow and multiply in certain host species. Some disease causing organisms are transmissible from animals to humans and vice versa (Carter, 1986). Infecting agent is most frequently transmitted to new host by direct or indirect contact. By the direct process is means spread by contact with infecting organisms on the infected host (Carter, 1986).

1.9 Camel diseases:

The literature is not abundant with information about the camel diseases. This is because camel husbandry and management system vary
greatly from the nomadic pastoralist of Arabian Peninsula or Sahara to productive farming of milk and meat (McGrane and Higgins, 1985).

Disease is the most important factor in limiting camel production. Parasitism is dominant, generally occurring in a chronic from entailing a drop in milk and meat yields and adversely affecting the calving rate (Richard, 1979).

Despite the importance of camels, information about their diseases is scant. The latest textbooks are those of leese (1927) and Curasson (1936). This review covered literature publisher since these books appeared, and also earlier items cited without bibliographical details in books. It demonstrates the lack of reliable information on many important diseases, their incidence and control.

With growing role for the camel to play in the animal owner’s life; increasing attention is being focused on improving its productivity and health status. Unfortunately veterinary literature in this respect is sparse and the standard work on camel diseases remains very few (Haroun, 1989).

The diseases of African camel have not been very extensively researched in comparison with those of other domesticated species, probably owing partly to the non sedentary nature of herds; constantly moving in search of grazing and water. It is only in few places, where the animals are found in favorable environments often alongside other species.

There are no diseases that are specific to the dromedary. All infection that have been reported are known to exist in other domestic animal. Symptoms of the disease are often missing or obscured (Leese, 1927). The long intervals between watering mean that the close or frequent contact is necessary for the transmission of infection and avoided.
Physiology and diseases of the udder are an important facet of reproduction and production of camel milk. Camel milk has been a source of nutrient for people in Africa and Asia countries. Mammary gland function is also very important for the health and growth of newborns since udder diseases are known to have a negative affected on both of these factors and can pose public health hazards for population consuming camel milk. Udder skin abscess, are lesions usually due to severe infection with ticks and fly larvae (Tibary and Anouassi, 2000).

Woldemeskel and Gumi (2001) conducted a study on the diseases of camels slaughtered in Ethiopia. Results revealed that a number of diseases affecting camel production in arid areas of Eastern Ethiopia. A detailed epidemiological study on camel pathology and determination of the true impact of the major diseases on camel productivity is recommended.

The pathology of myiasis in Saudi Arabian camels examined at slaughterhouses, larvae were found. The formation of lymphoid nodules with central abscesses, at the sites of larval attachment and a combination of inflammatory (Hussein, El amin, El -taib, Basmaeil and Taib, 1982).

A retrospective study of diseases diagnosed in camel calves in Mauritania between 1977 and 1998 was performed by Kane and Diallo (2000). The main bacterial diseases were supportive lymphadenitis, pyodermatitis, diarrhea and bronchopneumonia. The bacteria isolated included *Actinomyces spp, Klebsiella spp, Ecoli, Staphylococcus spp, Streptococcus spp*. The main parasitic disease were mange, mycoses and tick infestation. The various diseases result in unthriftiness, poor growth Performance sometimes death of the camel calf.

AL-Rawashdeh, AL-Ani, Sharrif, AL-Qudah, AL-Hami and Frank (2000) conducted a survey of camel disease in Jordan. Information on
incidences among 369 live and 156 slaughtered camels were examined and the proportion of diseased camels was calculated. Further investigation into the relationship between parasite burden and health in camels is required to assess the significance of the high prevalence of parasites.

One hundred camel lungs having gross pathology changes were collected from abattoirs of Pakistan. The microorganisms were isolated *Corynebacterium* *spp*, *Staphylococcus* *spp*, *Streptococcus* *spp*, *Ecoli*, *Proteus* *spp*, *Bacillus* *spp*. Pathological condition of lungs particularly pneumonia in farm animals may result in sever reduction in production and even terminate in death, thus causing economic losses to the farmers. Pneumonia in farm animals has been recognized as a major malady in all parts of the world (Zubair, Khan and Sabri, 2004). Literature revealed only sparse reports about pathological changes and associated bacterial isolation from camel lung (Nabiha, Rawhia, Doghim, Al-Zeftawi and Sondons, 1981).

Kane, Diop, Isselmou, Kaboret, Mekhalle and Diallo (2003) conducted study to determine the major constraints affecting camel breeding in Muritania. A complete examination of diseased animals in each herd and bacteriological and serological analysis were also performed. It was shown that diseases, food, drug supplies and veterinary care were the major constraints limiting camel breeding in this country. The main diseases observed were camel pox, scab, abscesses in young camel, tick infection and mastitis.

There is truth statement that a sick dromedary moves about and lies down and dies. The low density of camel population in its traditional habitat areas and the long interval between watering mean that the close or frequent contact necessary for transmission of infection and avoided. In general the most diseases affecting camels are mentioned (Hegazy, 1992)
A survey was conducted to record ethnoveterinary practices of traditional healers in Qassim region in Saudi Arabia, ethnoveterinarians and extensive knowledge on camel husbandry, physiology and diseases which was reflected in the wealth of terminology on the camel, both in health and disease. Surgical procedures were practiced to correct fractures or treat wounds and abscesses or to help in cases of dystocia (Abbas, AL-Qarawi, and AL-Hawas, 2002).

Bacteriological analysis of camel milk, fecal and pus samples collected by Kane, et al. (2003) during the study of major constraints of camel breeding in Mauritania, yielded *Ecoli, Klebsiella spp, Streptococcus spp, Pseudomonas spp* and *Staphylococcus spp*, showed some resistance to several antibiotics.

**1.9.1 Camel Abscesses:**

**1.9.1.1 Definition:**

An abscesses is a localized collection of pus in any part of the body, produced by a pyogenic irritant, the inflammation being limited to one area producing a pus filled cavity with damaged but still living wall. In the process of abscess formation two chief changes occur side by side in the tissues, a progressive emigration of polymorphonuclear leucocytes, which come to the tissue or gradual destination and disappearance of the tissue elements. The special cells of the part become necrosis, break down into granular material and melt away, while the supporting connective tissue fibrils, capillaries… etc, are digested and disappear. The accumulation of leucocytes still goes on and the tissue gradually becomes replaced by pus, in which remains of the dead tissue are present (Chaudhary, 1978).

Some diseases are spread by agent that can penetrate apparently undamaged skin or mucous membranes. In animals, spread in this manner is
most often by means of fomites such as effected litter and bedding rather than by direct contact. Included among the diseases that may be spread by these direct and indirect means are skin abscesses (Carter, 1986).

Abscesses involving the skin and adnexia are frequently seen in camel. The lesions may incorporate the skin and subcutaneous tissue and commonly the lymph nodes and other organs. The invasion of this structure by pyogenic bacteria may be due to wounds. On the other hand, camel grazing pastures are thorny shrubs and thorny trees and bites of animals or secondary infections following diseases may be responsible for a great deal of skin infection. The presence of abscesses usually leads to emaciation and increase susceptibility of such animal to secondary infections.

The abscess may grow to a huge size to accommodate the increase in pressure as more content accumulates inside. This process involves formation of more connective tissue in the middle and outer areas of the pyogenic membrane and lyses of the inner layer (Thomson, 1978).

Wounds and abscesses were the third most common disease problem affecting the surveyed camels, with peak incidence during the rainy seasons. Heavy tick infestation during the summer, as well as complete reliance on thorny bushes for this seasonality. Abscesses of lymph nodes and traumatic injuries of the footpad, were commonly during this study (Agab and Abbas, 1998).

The diseases and causes of mortality in intensively kept dromedary camels studied by Agab (2006) in a dairy farm in Al -Qassim region ,central Saudi Arabia .Camels were affected with one or more disease and the skin wounds and abscesses found of the ten most common diseases encountered among the camel of the farm .
Forty-nine cases of peri-articular abscesses were examined in camel calves in Kenya aged 16 days to 9 months, the lesions located around the elbow, tarsus, carpus, knee and fetlock joint. There was antibiotic treatment, but healing was protracted over several months in untreated cases. Chronic abscesses were fatal in 5 of the 49 camel calves seen (10% mortality) (Younan, Bornstein and Gluecks, 2007).

Evans and Powys (1979) reported that the leg abscesses at the base of the neck and the hump cause considerable distress. Abscesses in the gland can become large and require to be removed surgically. Ali, Murad and Thabet (2001) examined 450 camels clinically during the training of veterinary student in Assiut Governorate in Egypt. The clinical examination of these camels showed that twenty camels were infected with cutaneous abscesses in the lower part of the mandible and dorsal surface thigh of the hind legs.

Most subcutaneous abscesses are the result of traumatic skin penetration with infection (Blood, Radositis and Henderson, 1983). Batey (1986) stated that among Australian feral goats most lesions were found occur in the head or body. Carne (1939) reported that spread of infection from infected skin wounds lead to involvement of local lymph nodes and development of abscesses.

From Toloa cases in racing camels in United Emirates, Afzal, Sakir and Majid-Hussain (1996) collected pus samples from cases of lymphadenitis from unruptured abscesses. In cases of freshly ruptured abscesses, swabs were also taken. Some abscesses in camels have sinus tracts draining purulent materials to the outside. In few affected camels the peripheral lymph nodes were slightly enlarged but without abscesses formation (Hawari, 2008).
In Ethiopia a chronic supportive disease known as Mala leading to the formation of internal as well as external abscesses is apparently more important than contagious skin necrosis and usually found on the lower neck or on the hump (Domenech, Gliidot and Richard, 1977).

Radwan, El-Magawry, Hawari, Al-Bekair and Rebleza (1989) described outbreaks of *Corynebacterium pseudotuberculosis* infection in two herds of camels for the first time in Saudi Arabia. Over period of four months about 15% developed numerous muscular and subcutaneous abscesses partially on the hind quarters, shoulder, neck and tail. Both herds were heavily infested with ticks. Postmortem examination reveals emaciation and presence of multiple abscesses in lungs and liver. The body lymph nodes were enlarged and congested but without abscesses formation. The abscesses contained odorless, non-granular and non-calcified thin creamy yellowish white pus. This was also observed in an investigation on Ethiopian camels by Domenech, *et al.* (1977) . In an investigation in Iran on camels natural infection resulted in caseous lymphadenitis or cheesy gland disease (Esterabadi, Entessar, Hedayati, Narimani and Sadri, 1975).

In Saudi Arabia, Mustafa (1987) reported that minor bacterial lesions in the camel are represented by localized Actinomycotic granulomas and cold abscesses, mostly at the base of the neck. This condition is referred to locally in both Saudi Arabia and the Sudan as "anaba.

In Egypt, Caprano (1932) described a condition in camels characterized by enlargement and caseation of external and internal lymph glands. In some cases, lymphangitis, skin necrosis and ulceration were also observed. A *Corynebacterium spp* was isolated. A similar condition has been described in Kenya, the size of an orange or larger; abscesses contain non-granular yellowish pus (Schwartz, Schwartz and Wilson, 1982).
Didier (1975) in his study of the pathology of the camel puts considerable emphasis on the importance of *Corynebacterium pseudotuberculosis* in camel and considers *Corynebacterium spp* to be the main cause of Mala. Domenech, *et al.* (1977) examined 59 cases of this condition and recovered sinus which might resolve or continue discharging pus intermittently for months.

Bengoumi, Gandege, El-Abrak, Berrada and Faye (2000) studied camel calf mortality in south Morocco. A retrospective survey was conducted and 252 camels herd were included. Calf prenatal mortality was found to be a major constrains to development of camel husbandry with an average 2-20 % death rate. The main causes of mortality reported by breeders were diarrhea (72%), stillbirth (6%) and abscesses (5%). Strong correlations between camel calf mortality and some adult camel diseases. Because management practices were very similar, correlations between mortality and breeding practices, which probably played a major role, could not be highlighted.

In Ethiopia, Bekele (2008) reported that during a study of respiratory lesions, 104 adult camels at the Dire Dawa abattoir examined and the result showed that 3.85% were infected by pulmonary abscess.

1.9.1.2 Clinical manifestation:

Postmortem examination of eight camels revealed emaciation, and presence of multiple external and internal abscesses particularly in the lungs and livers. The body of lymph nodes were slightly enlarged and congested but without abscesses formation. The abscesses contained odorless, non-granular and non-calcified thin creamy yellowish white pus (Radwan, *et al.*, 1989).
1.9.2 Lung abscesses:

The causes of lung abscesses are divided into four group’s inhalations, embolic, pneumonic and miscellaneous group. Inhalation group of the abscesses of the lung is common complication it may follow a local or general anesthetic. Embolic group is caused of a septic thrombus being carried to the lung. Pneumonic group, it is usually cause by bacterial group such as *Streptococcus spp*. Mycotic abscesses is caused by variety of fungus (Chaudhary, 1978).

1.9.2.1 Appearances:

Abscesses associated with aspiration are usually solitary, occur more so on the vertical right main branches and involve predominantly the posterior segment of the upper lobe, pyaemic abscesses tend to be scattered, they are filled with pus, some time air and tissue debris and when chronic have fibrous walls (Cotton, 1992).

The development of single or multiple abscesses in the lung causes a syndrome of chronic toxemia; cough and emaciation supportive bronchopneumonia may follow Pulmonary abscesses may be part of a primary disease or arise secondary to disease in other parts of the body (Blood, Radositis and Henderson, 1983).

Abscesses happen after the attack of pneumonia if it is not treated or partially treated and the owner start taking work from the camel. The inflammation of lung may turn into an abscess. At the beginning, the camel may not show any symptoms of the disease except that he gets tired soon at the time of working. Localized area of pulmonary parenchyma supportive necrosis due to infection by pyogenic organisms (Cotton, 1992).
1.9.2.2 Lesions:

The lesions is at first a solid mass of yellow, inflammatory tissue, but liquefy occurs, a pus filled cavity is formed. The wall of the cavity is ragged and necrotic in chronic forms; a wall of fibrous tissue is built up and the lining becomes smooth. The abscess is usually single at first but secondary abscess may develop at any time due to aspiration of infected material into other segments, the inhalation abscess is likely to communicate with bronchus. Chronic abscess may show epithelial of its wall from the bronchus (Chaudhary, 1978).

1.9.2.3 Pathogenesis:

Pulmonary abscesses may be present in many cases of pneumonia and are not recognizable clinically. In the absence of the pneumonia, pulmonary abscess is usually a chronic disease, clinical signs being produced by toxemia rather than by interference with respiration. Polypnea appears, caused probably by simulation of stretch receptors in the alveolar walls or by the sudden development of extensive embolic endarteritis. In chronic cases the abscesses may reach a tremendous size and cause respiratory difficulty by obliteration of large areas of lung tissue. In many cases there is a period of chronic illness of varying degree when neurotic focus is walled off by connective tissue (Blood, Radositis and Henderson, 1983).

During the year 1988-1989 in central and northern Sudan a total of 622 lungs were condemned in slaughterhouses (Annul report, Ministry of Animal Resources, 1988/89). The reasons of such condemnations included pneumonia, congestion and abscessation (Mohamed, 1992). Pneumonia was also reported in Saudi Arabia and the lung abscesses were found to be caused by Corynebacterium spp (Mustafa, 1987).
Al-Tigani (2003) carried out study in Tamboul and Nyala abattoir to investigate the condemnation cause of camel's lung. 206 camel lungs were inspected at post-mortem. The survey revealed different causes of lung condemnation. Lung abscess were found to be 2.9% at Tamboul and 8.5% in Nyala abattoir.

Mustafa (1992) stated that during collection of specimens from the abattoir he revealed pathological factors, Apart from lung abscesses due to Corynebacterium spp, the lesions consist of swelling, congestion and discoloration and firmness of lobules.

In Sudan, Agab and Abbas, (1998) carried out an epidemiological survey in eastern region camel's population (AL Butana area). Through their investigation they illustrated that pneumonia was considered as a one of the major diseases that faced and confined camels breeding in that areas with other diseases. In Sudan slaughterhouses records the occurrence of pneumonia are increasing high with evidence of the condemned lungs in the slaughterhouses. Mustafa (1992) reported that the occurrence of pneumonia in 96 lungs out of 125 examined camels at antimortem and postmortem inspection. Also Nasr (2003) investigated the aerobic bacteria associated with respiratory tract infection of camel brought to Tamboul market; he observed pulmonary abscesses with pleura.

Bekele (2008) conducted study in of respiratory lesion in 104 adult camels of unknown age and health status brought to slaughter to abattoir at Ethiopia. The study showed 98% of the examined lungs had one or more lesions included the pulmonary abscesses in 3.85%.

In a bacteriological and pathological study on pneumonia in camels in Jordan, out of 284 lungs examined 3(10.34%) lungs had lung abscesses these lesions were found in lungs of various camel age groups (1-2 years).
Lung abscesses were characterized by the presence of several abscesses (1-2 cm in diameter) close to each other and filled with cheese – like viscid pus (AL -Tarazi, 2001).

During study of are aerobic bacteria associated with respiratory tract infection of camel in Sudan, Suliman (2003) reported that the camels were examined for obvious respiratory signs in antimortem and for lungs lesions at postmortem inspection. The observed were pulmonary lesions were different stages of consolidation, red hepatization, pulmonary abscesses and adhesion with pleura. A number of 144 bacteria isolated during this study included Staphylococcus spp, Bacillus spp and Ecoli.

1 .9 .3 Camel liver:

1 .9 .3 .1 Histology of the camel liver:

The histology of the camel liver correspond to that of other domestics animals. But some variations have been reported, the colour of the dromedary liver is dark brown .The average weight is 5-7 kg. Microscopically the liver is characterized by well – developed connective tissue, so that, distinct lobules are evident grossly and histologically (Rasha, 2002).

The liver is highly lobulated, particularly on the rear lower part. There is considerable amount of interlobular tissue; this has appearance of cirrhosis (Wilson, 1984).The liver lobule for long time consider to be the basic functional unit of the liver. Liver sinus is defined as the area of parenchyma supplied by a single terminal hepatic artery (Cotton, 1992).

1 .9 .3 .2 Diseases of the liver:

The liver has a very large reserve of function and approximately three- quarters of its parenchyma must be rendered inactive before clinical signs of hepatic dysfunction appear. Diffuse diseases of the liver are more
commonly accompanied by sign of insufficiency either by the toxins formed in the lesions or by pressure on other organs, including the biliary system. Diffuse diseases of the liver can be classified according to the pathological changes and the types of causative agent (Blood, Radositis and Henderson, 1983).

Many disease processes affecting the liver have a zonal distribution which can be explained on the basis of functional differences occurring with the anatomical units of the liver (Cotton, 1992).

1.9.3.3 Hepatic abscesses:

Great variation in the size of the liver is often seen at necropsy but clinical detection is not easy unless the liver is grossly enlarged. This is most likely to occur in congestion heart failure, in some plant poisonings and multiple abscesses. (Blood, Radositis and Henderson, 1983).

The term liver abscess is used by most authorities to denote any encapsulated lesions, which contain necrotic matter or pus, regardless of the agent, which is responsible for these changes (Thoronton, 1968).

Local supportive infection of the liver does not cause clinical signs of hepatic dysfunction unless they are particularly massive or extensively metastatic. They may cause signs of toxemia because of the destruction of hepatic tissue or the liberation of the potent toxin. Toxemia of traumatic hepatitis is usually due to toxins of bacteria (Blood, Radositis and Henderson, 1983).

Obeid (1994) reported that during the period of study in cause of cattle liver condemnation in Khartoum state abattoirs, he found that 6.04% of condemned liver were due to abscesses. It was noticed that there was no distinct variation in the seasonal occurrence of these abscesses. Good animal management and husbandry were suggested to minimize their incidence.
Itman, Farrag, Arab and Makhareta (1989) were the first in Egypt to study liver abscesses in the camel. From 100 camel livers showing necrosis and abscesses, they could isolate *Clostridium* spp. The same bacteria were also isolated from apparently healthy livers. Also in Egypt Refai (1992) reported that the camel slaughtered at Cairo abattoirs are routinely examined for bacterial disease. He mentioned that the organisms isolated from the affected carcasses with liver abscesses were pathogenic ones.

Pathological and bacteriological studies on abscesses in ovine and bovine livers was carried out, they were found to be 15% in ovine and 1.2% in bovine (Hind, 1996).

Besides occasionally ending in total illness, the condition known to meat inspectors as liver abscess, has long necessitated the condemnation at a large number of livers, with a consequent economic loss of substantial proportion (Smith, 1944).

The pathogenesis of pyogenic liver abscesses due to *Staphylococcus aureus* infection was studied in mice experimentally infected with *Schistosoma mansoni*. The result showed that development of liver abscesses occurred during both the acute and chronic phases of schistosomiasis. Wild strain of *Staphylococcus aureus* produced more liver abscesses than strains maintained in laboratory (Teixeira, 1997).

Post-mortem examination of goats, showed that 17 (2.5%) had hepatic abscesses. *Corynebacterium* spp (61.9%), *Ecoli* (11.8%), *Pasteurella* spp (5%) , *Proteus* spp (5.9%) and *Staphylococcus* spp (5.9%) were isolated. (Rosa, Johnson, Alves and Santos, 1989). In Sudan Khalid (1971) isolated *Corynebacterium pyogenes* from sheep liver abscesses and Abusalama (1995) isolated a number of bacterial strains from different livers, identified
as *Micrococcus spp*, *Streptococcus spp*, *Staphylococcus spp*, *Bacillus spp*, *Corynebacterium spp*, *Ecoli* and *Proteus spp*.

Bacteriological survey of bovine liver abscesses done by Madin (1949) showed that 85% of the abscesses contained *F.necrophorum* and additional 10% contained the same organisms plus other bacteria.

Macroscopic and histopathological study showed multiple liver abscesses around granulomas of *Schistosoma mansoni* in the acute and chronic phases of the disease. The study finding indicates that granulomas around *S.mansoni* eggs and worms lodged in the liver provide a focus and substrate for pyogenic abscesses caused by *Staphylococcus aureus* (Teixeira, 1997 and Mahmoud and Awad, 2000).

### 1.9.4 Lymph nodes:

#### 1.9.4.1 Structures and function:

The lymph nodes were surrounded by a capsule of dense irregular connective tissue consisting mainly of large bundles of collagen fibers and few elastic and reticular fibers. In the cortex of the lobule, the lymphocytes were organized into lymph nodules and diffuse lymphoid tissue. The medulla, it contained medullar sinuses surrounded by cortex (Lemiaa , 2004). Lymph nodes vary in size from less than 1 mm to over 2 cm. They contain a mixed population of cells including B and T cells (Cotton, 1992). The lymphatic system in camels characterized by few ganglia with conglomeration in the usual area (Wilson, 1984).

The parotid, mandibular and lateral retropharyngeal lymph nodes of the dromedary camel were examined by Abdel-Magied, Taha, Al-Qarawi and Elfaki (2001) . They were lobulated and characteristic medulla, cortex and par cortex of typical lymph nodes . Instead, they contained lymphatic nodules, dense a nodular lymphoid tissue and diffuse lymphoid tissue
dispersed throughout the lymph nodes. Morphometric analysis has shown that the percentage volume densities of the stoma and the various parenchymal components were similar in the three lymph nodes.

The lymphatic system consists of a branching series of closed vessels and a collection of lymphatic organs. Lymph as defined by Thoronton (1968), is a fluid similar to plasma, even though more watery and contains less proteins. The lymph is responsible for conveying oxygen and nutritive substances from blood to the tissues and for removing waste products from tissues back to the blood circulation. It is also functioning in the production of lymphocytes, which were active agents of defense against foreign practices and microorganisms.

1.9.4.2 The lymph circulation:

The lymphatic system of the camel is similarity to that of other domestic animals. The circulation of the lymph through a lymph node involved afferent lymphatic vessels, a system of lymph sinuses within the node and different lymphatic vessels (Lemiaa, 2004).

1.9.4.3 Classifications of lymph nodes:

In a study by Osman (1988) classified lymph nodes of the dromedary camel. The primary mixed lymph nodes (PMLN) are the key mixed nodes of the dromedary camel and include the parotid, mandibular, dorsal and ventral superficial cervical, axillary, tuberal, popliteal, mammary, scrotal, hepatic and renal lymph nodes. The secondary mixed lymph nodes (SMLN) include the retropharyngeal, pterygoideus, deep cervical, intercostals, thoracic, mediastinal, bronchial, lumbar aortic, ruminal, reticular, osmasal, abomasal, pancreatic duodenal, jejunal, caccal and colic lymph nodes.

Blood and different lymphatic vessels are seen at the helium. The different lymphatic vessels divided several times before entering at multiple
points on the surface on the node. Both size and weight are seen to increase with age (Lemiaa, 2004).

1.9.4.4 Pathogenesis:

Spread of infection along the lymphatic vessels causes chronic inflammation of the vessel walls. Abscesses often develop and discharge to the skin rough sinuses. Enlargement of the lymph nodes may occur as results of infection or of neoplastic invasion metastases may develop as a result of spread from neoplasm in surrounding tissue, primary neoplasm involving lymph nodes include lymphadenitis (Blood, Radositis and Henderson, 1983).

1.9.4.5 Clinical finding:

An indolent ulcer usually exists at the original site of infection. The lymph vessels leaving this ulcer are enlarged, thick end and tortuous often have secondary ulcer. Local edema may result from lymph obstructions (Blood, Radositis and Henderson, 1983).

1.9.4.6 Abscesses in lymph nodes:

The abscesses are most frequently located in the lymph node of the mandibular region (mandibular, parotid, and lateral retropharyngeal) followed by the superficial cervical, subiliac, popliteal, supermammary and scrotal lymph nodes respectively (Fuente and Suarez, 1985). Thoronton (1968) reported that in the majority of cases lesions are confined to the lymph nodes, chiefly those which are situated externally. The carcass nodes were being affected in the following order of frequency, prescapular, perfemoral, superficial inguinal and popliteal. Shirlaw and Ashford (1962) reported that histological sections prepared from lymph nodes close to abscesses showed slight hyperemia of lymphoid tissue, edema of lymph channels and hyperplasia of lymphoid cords.
Lymphadenitis:

The term lymphadenitis denotes inflammation and enlargement of the lymph nodes and is usually associated with lymphadenitis. Lymphadenitis as due in most cases to local skin infection with subsequent spread to the lymphatic system. The inflammatory reactions of the lymphatic and lymph nodes can always be traced from the different pathological condition of the camels as well as other animal species (Blood, Radositis and Henderson, 1983).

Lymphadenitis in camels has been reported in many countries. In Ethiopia, Domenech, et al. (1977) studied lymphadenitis in camels clinically and microbiology, the microorganisms isolated from effected camel. The condition, locally called "Mala" which resembled caseous lymphadenitis in small ruminant. This is chronic condition, which develop slowly and is characterized by external and internal abscess formation and usually affecting adult camels. A similar condition has been described in Kenya by Schwartz, et al. (1982). The size of the lesions varies and abscesses contain a non-granular yellowish pus.

In Jordan, AL-Rawashdeh, AL-Ani, Sharrif, AL-Qudah, AL-Hami and Frank (2000) reported that the information on incidence of camel disease is scarce, caseous lymphadenitis has been reported. Isolation of *Corynebacterium pseudotuberculosis* from pus abscesses, lymph nodes, milk, ticks and blood proved to be due to endemic infection with these organisms. However, the role of imported camels from neighboring countries in transmitting or spreading of such disease should be investigated.

In Libya, Moustafa (1994) reported that the clinical signs of lymphadenitis in camels were investigated. Four animals 6 to 8 years old were emaciated and slightly anemic. The disease was characterized by
swelling and abscess formation in the inferior cervical lymph nodes at the base of the neck.

Batey (1986) described the lesions of the disease. In contrast to sheep and goat, *Corynebacterium pseudotuberculosis* might not be the only cause of lymphadenitis in camels. Also Tejedor, Martin, Lupiala and Gutierrez (2000) reported that caseous lymphadenitis that affect dorsal and ventral superficial lymph node of young camel was *Corynebacterium ulcerans*.

Hawari (2008) conducted study to describe and report for the first time outbreaks of natural *Corynebacterium pseudotuberculosis* infection in adult camel herds in Jordan, an infectious disease syndrome was reported. Postmortem examination of carcasses revealed emaciation and presence of external and internal multiple abscesses were encapsulated by fibrous tissue and contained pus. The lymph nodes were slightly congested and swollen.

Ashfag and Campbell (1979) concluded, taking into consideration the anatomy of the lymphatic drainage to the submandibular and parotid lymph nodes peculiar to goats, could result from infection through the buccal mucosa or skin to the head and upper neck.

Tejedor, et al. (2000) reported the caseous lymphadenitis that affected the dorsal and ventral superficial lymph nodes of a young camel. The agent isolated was *Corynebacterium ulcerans*, This was the first description of purulent lymphadenitis caused by *Corynebacterium ulcerans* in species belonging to the camelidae. Smith (1984) has succeeded to isolates *Salmonella spp* from mesenteric lymph nodes of animals.

A case of Rhodococcus equi associated with necrotizing lymphadenitis in a two-year old male llama was described. Caseous necrosis, resembling macroscopically that seen in ovine caseous lymphadenitis, was observed diffusely in the tracheobronchial and
mediastinal lymph nodes and in an extensive lesion in the lungs. Necrosis was present to lesser extent in the spleen and hepatic and gastric lymph nodes. Numerous bacteria were present around the necrotic areas (Hong and Donalue, 1995).

1.9.4.7.1 Acute lymphadenitis:

Nodes draining sites inflammation such as abscess may show varying degree, change range from mild with sinus dilatation by macrophages, to florid supportive with neutrophil polymorphs present in peripheral sinuses and node parenchyma (Cotton, 1992).

Lymphadenitis accompanies other signs in much specific disease. In acute lymphadenitis there may be pain and heat on palpation but the nodes are for the most part painless. As well as the other lesions, there is a variety of bacterial cause including *Streptococcus spp, Staphylococcus spp* and *Mycobacterium spp* (Blood, Radositis and Henderson, 1983).

1.9.4.7.2 Chronic lymphadenitis:

The lymph node show variable changes including reactive hyperplasia, macrophage accumulation, collection of plasma cells and fibrosis (Blood, Radositis and Henderson, 1983).

1.9.4.7.3 Granulomatus lymphadenitis:

The granuloma can range from small collection of histocytes to necrotizing granuloma. Mustafa (1987) reviewed the bacterial diseases of the dromedary. The inflammation of the lymph nodes was reported with in the inflammatory process of the diseases.

1.10 Transmissions of the abscesses:

Blood, Radositis and Henderson (1983) reported that the source of infection is the discharge from ruptured lymph nodes. Contamination of the soil on bedding ground or shelter may result in persistence of organism in
the environment for very long periods. As camels are often infested with ticks, that produce multiple wounds at different sites of the body, microorganisms may enter the blood circulation via such wounds and consequently cause abscesses in the internal organs. The connective tissue wall of abscesses may rapture and discharge pus and bacteria contaminated the environment in case of external abscess or into blood system in case of internal abscess.

March (1965) stated that contamination of superficial skin wounds caused by shearing, docking and castration, with discharging from ruptured lymph nodes is considered the usual mode of transmission. Wooddruff and Oxer (1929) considered contamination of skin especially shearing cuts as the most common mode of transmission. The invasion of these structures by pyogenic bacteria may be the result of tick or fly bites, but in some instance, the cause is difficult to determine. Saddle and baggage are frequently encountered in working camel (leese, 1927).

It was clear that the respiratory tract of apparently normal animals acted as a reservoir of many species and type organisms. Those microorganisms reached the nasal cavity either through inhalation or during drinking. Stress factors such as changes in the hygiene, environmental and climatic condition play an important role in the onset of pneumonia. Such factors would lower the resistance of the lung tissue (Zubair, et al., 2004).

The isolation of *Corynebacterium pseudotuberculosis* from milk of camels with multiple abscesses indicated a possible role of milk in transmission of the disease and the economic losses of the malady (Hawari, 2008).
10.1 Tick infestation:

Ticks are known to cause problems to their host through biting, irritation, sucking of blood and causing a break on the skin which exposes the host body to a variety of penetrating microbes. Like all other livestock species, the Camelidae are parasitized by smaller organisms amongst which are the ectoparasites. The most common ectoparasites of camels are mange and ticks (Higgins, 1983). In relation to camels, there is little information on tick investigation or the role of ticks as potential carriers of diseases of camels or their effect on camel (Garba and Alabi, 1995). Reports exist in literature on the presence and activities of these parasites in camels in many parts of the world (Richard, 1979 and Mustafa, 1987).

Unlike that obtained in most domesticated animals fewer ticks were found on the neck, head and ear. This may not be disconnected with feeding habit of the camels, as well as the characteristics of its long neck. The absence of tick in this region may not affect transmission of parasites but may greatly reduce the degree of irritation as a result of biting (Garba and Alabi, 1995).

Survey of villages in Eastern Province of Saudi Arabia was carried out by EL-Amrousi, Hafez, Ashour, Razig and Ramadan (1986). Multiple abscesses were seen in dromedaries with tick pyaemia.

Radwan, et al., (1989) reported that in Saudi Arabia over a period of months about 15% of camels under investigation developed numerous muscular and subcutaneous abscesses particularly on the hind – quarters, shoulders, neck and tail. Both herds were heavily infested with ticks of Haylomma species.

Blood, Radositis and Henderson (1983) stated that transmission between sheep and deer is possible by tick bite. Also Carter (1986) reported
that various arthropods such as ticks, mites, lice act as vectors for infectious diseases. In Egypt Soliman (1992) reported that tick infection will have a direct pathogenic action on the camel. The lesions describes were those of cachexia. Bacterial secondary complications must also be noted, they can appear after the tick has disappeared. The tick were observed on the head and genital areas, the rest of the body (neck, rib, legs) being hardly infested.

Ticks are considered as a major veterinary problem, especially where animals aggregate for watering, marketing or slaughter. The species of ticks involved are mainly Amblyoma and Hyalomma (Mustafa, 1987).

Blood, Radositis and Henderson (1983) stated that the Corynebacterium pseudotuberculosis has been isolated from deer and from engorged female tick feeding on deer. Also Hawari (2008) during study of caseous lymphadenitis in camels in Jordan, reported that the entire body of most of the camels was heavily infected with ticks of Hyalomma species. The infected camel did not respond favorably to repeated inoculation with several broad spectrum antibiotics and anthelmintics.

1.11 Contagious skin necrosis:

This is perhaps the most important bacterial disease of camels and is very widespread, most common site is on the back or hump with the base of the neck has being affected fairly frequently (Gatt Rutter and Mack, 1963). The disease was also reported by Curasson (1936) in Sudan by Peck (1939) in Somalia and by Domenech, et al. (1977) in Ethiopia. In Kenya McGrane and Higgins (1985) found the disease to be characterized by necrosis of the skin, abscessation, sinus formation and enlargement of local lymph nodes.

Curasson (1936) and Peck (1939) claimed that a relationship existed between the level of salt intake and the disease. They reported that the daily
intake of 5 ounces of salt has cured and prevented the disease in Somalian camels.

**1.11.1 Symptoms:**

Symptoms and lesions are described by Leese (1927) and Curasson (1936). Prognosis was usually good, with quick recovery following isolation of the animal and early treatment of lesions. It was more serious when local lymph nodes were involved and septicemia was fatal.

Edelsten and Pegram (1974) found lesion situated mostly on the center of the genital region with a single sinus on either leg in Somalian camels. In Ethiopian camels, lesions were mostly localized on the shoulder and neck region (Domench, *et al.*, 1977). The most common sites were found to be on the back or hump with the base of neck (Wilson, 1984). However, the lesion may be found on any part of the body (Peck, 1939).

Fazil (1977) stated that the lump appears on the skin surface that gradually becomes hot and sore. Eventually the hair falls off from the sore area which was hard and appears black in the centre. The lesions which are about two cm in diameter from when the lump breaks open and pus runs out, then the skin sloughs off. The disease, characterized by necrotic lesions of the skin and abscesses in various part of the body was widespread in Sudan and Egypt (during the rainy season). It appeared to be less common in west Africa.

The disease started as a painful swelling, then the skin becomes hard and dry over the center of the swollen area, the dead center then separated from the surrounding healthy skin and pus exudates and the center sloughs off leaving an ulcer which takes a long time to heal (Leese, 1927).

Contagious skin necrosis was found to affect mostly young animals, while adults seemed to be relatively resistant this is perhaps to exposure
infection. In some herds, this disease took the form of an outbreak, while in all other herds it was sporadic (Agab and Abbas, 1998). Edelsten and Pegram (1974) reported a sporadic of the disease in camel at Somalia, which affected mainly adult camels.

1.11.2 Causative agents:

Different causative agent was isolated from the lesions in infected animals. Among these organisms, a fungus from pus samples. Known as Actinomyces cameli was isolated by Curasson (1936). A Streptococcus spp was however, recovered earlier by Cross (1917) and later Edelsten and Pegram (1974) have isolated gram positive cocci predominantly in chains from the exudates, of which Lancefield group β Streptococcus agalactiae and Staphylococcus aureus.

Domenech, et al. (1977) examined 23 cases of disease and 40 % of isolated were found to be of the group β Streptococcus alone or in association with Staphylococcus spp, Corynebacterium spp and Lactobacilli spp.

Higgins (1983) pointed out that this condition to be less common than in the past when military expedition employed the famous "Camel Crop". Long numbers of camels were then closely accommodated without extensive grazing. However, Peck (1939) considered this condition to be related to faulty diet and pointed out that the condition could be prevented if the dietary salt intake was increased.

AL-Ani (1989) emphasized the non-specificity of the causative agents of the disease in camels. However, they isolated Staphylococcus spp and Actinomyces spp.
1.11.3 Treatments:

To prevent the occurrence of the diseases, Peck (1939) recommended discontinuous use of sponges for wound dressing as well as the rounding of the bite. He also advised increasing the salt intake of camel. On the other hand; Higgins (1983) recommended separation of healthy camels from sick ones. Treatment so far described has been based on the application of antiseptic dressing to the lesions. There is no record of the efficacy of intravenous sodium iodide therapy. Hygienic measures to prevent the spread of the disease are described by Leese (1927).

Peck (1939) considered that salt deficiency was an important contributory factor, and that daily administration of 150g crude salt prevent and cured the disease. He concluded that cauterization with phenol, followed by the application of saline packs was most effective. He also considered the condition to be related to faulty diet and in feed trials able to prevent the occurrence of contagious skin necrosis by increasing the dietary intake of salt-free, ranging desert camels with ready access to salt. Bush and allied browsing are unlikely to become deficient in salt under normal circumstances.

1.12 Traditional methods for treatment abscesses:

Cauterization deserves special handling as it is commonly employed healing practice. The use of fire brands is an ancient in the pastoral system in the Sudan. Pastoralists believe that every infections condition can be relieved by fire (Abbas, 1997). However, in the pastoral system cauterization is often employed on experimental basis for new or undiagnosed condition. Such condition include broken or injured horns and in the treatment of abscesses. Camel herders usually treat affected animal on the spot on the basis of an initial diagnosis. The herder will treat only his own animals.
Hilba is used externally, as a paste, to ripen abscesses and to release the pain of swollen lymph nodes. Also sesame oil is used externally for treatment weakness and eventual abscessation in the shoulder of camels (Abbas, 1997).

1.13 Economical losses due to abscesses:

Abscesses were explained financial losses due to condemnation of meat such animals when disseminated efficiency production losses when abscesses nodes interfere with necessary function such as milking and devaluation and down grading of the quality of skins. In addition it might constitute a public health hazed specially in rural areas where raw camel meat is consumed. Food poisoning associated with consumption of raw camel livers is known in Sudan. Therefore camel liver is potentially hazardous. Abattoirs are established only in the urban areas consume meat that is not inspected and may potentially unsafe.

The occurrence of abscesses in the superficial lymph nodes which results in great economical losses due to partial and total condemnation of carcasses during postmortem of subcutaneous abscesses, makes the dressed carcasses unappealing to consumers and also marks down camel for exportation. Moreover, it lowers qualities of skins of such animal.

1.14 Bacteria associated with camel abscesses:

Identification of bacteria depend upon the knowledge of the animal species, clinical sign of disease, type of pathological lesions, examination of stained smears and characteristics and demonstrate some biochemical reaction of the bacteria (Quinn, Carter, Markey and Carter, 2002).

Qureshi, Kataria and Gahlot (2002) conducted a study to isolation bacterial microflora from wounds and abscesses on camel. The percentage frequency of various bacterial was recorded; the most abundant bacterial
species was *Staphylococcus aureus* (23.39%), present either as pure isolate or mixed with other bacteria.

Results of the bacteriological examination supported with biochemical tests and laboratory animal inoculation revealed that the bacteriological causes of skin abscesses were *Corynebacterium pygoenes* (66.67%) and associated with *Staphylococcus aureus* and *Streptococcus spp* (Thabet, 1993).

Isolation and growth of bacteria are required before many diagnostic can be used to confirm the identification of the pathogen. The presence of bacteria growth usually can be recognized by the development of colonies on solid media or turbidity in liquid media (Klein, 2000).

Ismail, Ezzat, EL-Jakee, El-Sayed and Abd El-Rahman (1990) isolated bacteria from closed abscesses on the thoracic regions, shoulder, abdomen, head and limbs of camels. Bacteria isolated were *Staphylococcus spp*, *Corynebacterium spp*, *Streptococcus spp*, *Ecoli*, *Klebsiella spp*, *Proteus spp*. Also Itman, *et al.* (1989) were the first in Egypt to study liver abscesses in the camel. From 100 camel liver showing necrosis and abscesses they could isolate *Clostridium novyi* from 6 cases and *Clostridium perfringens* from 9 cases. However, such bacteria were also isolated from apparently healthy livers.

Some workers revealed the presence of the many aerobic and anaerobic bacteria pathogens among skin abscesses of infected camels and showed high bacterial isolation rate. The most predominant aerobic and facultative anaerobic organisms are *Streptococcus pyogenes* and *Staphylococcus aureus*. Other obligatory anaerobic organisms are *Clostridium perfringens* (Shaton, 1955 and Khamiev and Kubentaeva, 1984).
Camel in Jordan was found to be affected with pneumonia. Their prevalence rate was 10.2%, lung abscesses were caused by pyogenic organisms. The majority of bacterial pneumonia cases had multifactor causes (AL-Tarazi, 2001).

Kataria and Sharma (2001) reported that the non-immune binding activity with *Staphylococcus aureus* and *Ecoli* antigen was present in normal camel serum for both the organisms. The titer was higher for *Staphylococcus aureus* in serum of camel suffering from multiple skin abscesses.

**1.14.1 Staphylococcus:**

Staphylococci occur as a worldwide in mammals, although the spread of Staphylococcus strains occurs between different animal species. Many infection are endogenous but prolonged survival of Staphylococci in the environment permits indirect transmission (Quinn, *et al*., 2002).

Several *Staphylococcus species* are notorious pathogen. They are also associated with a large number of animal species and cause several infections of major economic importance. In addition, the zoonotic transmission of Staphylococci to animal, especially those which are antibiotic–resistant is a growing threat to public health (Fitzgerald and Penades, 2008).

Demenech, *et al.* (1997) and Al-Tarazi (2001) isolated *Staphylococcus species* from camel abscesses. The lesions occurred as an abscesses of the lymph nodes at the base of the neck and the croup, the external pyogenic infection was considered as local condition due to various trauma. Colonies usually appear in 24 hours. After 48 hours inculcation, well isolated colonies can reach four diameters. They are round, smooth and glistening in blood agar tend to appear substantial (Quinn, *et al*., 2002).
1.14.1.1 Pathogenicity of Staphylococcus:

The Staphylococcus are pyogenic, they are associated with abscesses formation and suppuration. Pus is composed of the debris of dead leukocyte and living and dead bacteria can be surrounded by intact phagocytic cells and fibrin stands. A fibrous capsule will eventually be formed around an abscess (Quinn, et al., 2002).

The pathogenic strains of *Staphylococcus species* are producing extracellular enzymes and toxins and ability to produce coagulase has been considered as the primary criterion to differentiate pathogenic and relatively non pathogenic strains (Ashok Dubey, Ghorui and Kashyap, 2009).

Abscesses supportive condition, the main diseases caused by pathogenic Staphylococcus. Infection can be systemic notorious for infections following surgery in many animal species (Quinn, et al., 2002).

Mohmed, et al. (1990) during a study of camel diseases in the Sudan, reported that abscesses are sporadic incidence that cause loss of weight. The causative various bacteria include *Staphylococcus species*. Carter (1986) stated that various infections of the skin of many animals, subcutaneous abscesses are caused by *Staphylococcus species*.

1.14.1.2 Staphylococcus aureus:

*Staphylococcus aureus* is an important pathogen associated with several pyogenic conditions in animals. It is the main pathogen causing disease leading to great economic losses. The pathogenic strains of *Staphylococcus aureus* varies greatly owing to colonization to different tissues and host species or adaptation to varying microenvironment (Ashok Dubey, et al., 2009).

*Staphylococcus species* can cause many forms of infection, *Staphylococcus aureus* causes superficial skin lesion and localized abscesses.
and it was the main bacteria isolated from wounds, abscesses, pus and blood (Qureshi et al., 2002). Salih (1971) and Mohamed (1992) isolated *Staphylococcus aureus* from livers and lymph nodes of slaughtered camels.

Raga (2008) studied the pathogenesis and pathogenicity of *Staphylococcus aureus subsp anaerobius* on sheep abscesses causation. She discussed the role of fatty acid modifying enzyme (FAME) and lipase on abscesses production by non-abscess producer Staphylococci.

1.14.1.3 *Staphylococcus hominis:*

*Staphylococcus hominis* is one of the major *Staphylococcus* species living on human skin, it may cause some infection like wound infections (Kloos, 1980).

1.14.1.4 *Staphylococcus xylosus:*

*Staphylococcus xylosus* is found occasionally on the skin of human and other higher primates (Kloos, 1980).

1.14.1.5 *Staphylococcus sciuri:*

*Staphylococcus sciuri* is commonly isolated from skin of rodents and carnivore. It causes skin lesions in cattle (Kloos, 1980).

1.14.1.6 *Staphylococcus epidermidis:*

Over the last two decades, coagulase–negative staphylococci is the most important species, *Staphylococcus epidermidis* has been recognized as an important opportunistic pathogen. These are abundant commensally organisms (Queck and Otto, 2008).

1.14.2 Streptococcus:*

Quinn, *et al.* (2002) reported that the Streptococcus is worldwide in distribution. Most of the species of veterinary interest live as commensal in mucosa of the upper respiratory tract. They are susceptible to desiccation and do not usually survive for long away from the animal host.
Demenc, et al. (1977) and Evans and Powys (1979) reported that foot abscesses and abscesses in the gland can become large and require to be removed surgically. Pus from abscesses revealed β haemolytica Streptococci. Most Streptococci produce small colonies (about 1mm after 48 hours incubation) and in case of the β haemolytica Streptococci the colonies appear translucent, colonial variation in the type of haemolytic activity is a useful diagnostic characteristic.

In Kenya, Younan, Ali, Muller and Bronstein (2000) studied subclinical mastitis in camels in a different management system, they isolated Streptococcus agalactiae from camel with septic arthritis, skin abscesses and secondary respiratory infection. A presumed correlation between the Streptococcus agalactiae carrier status of the mother and performance of the calf was examined in ranch-camels.

Al-Tarazi (2001) reported that the haemolytic Streptococci were the most frequent isolates from lung abscesses. Streptococcus agalactiae was isolated from camels in Kenya with skin abscesses and from all fatal cases. A mixed infection of Streptococcus species was isolated. There was antibiotic treatment in fresh cases, but healing was protracted over several months in untreated cases. Chronic abscesses were fatal in camel calves (Younan, et al., 2007).

1.14.2.1 Pathogenicity of Streptococcus:

Streptococcus is pyogenic bacteria that are commonly associated with suppuration and abscesses formation (Quinn, et al., 2002). Also in case abscesses always a severe bronchopneumonia becoming confluent early (Cotton, 1992).

An ulcerative lymphadenitis caused in many instances by Streptococcus has been observed in foals. Laboratory examination is largely
a matter of the bacteriological examination of the discharge for the presence of the pyogenic bacteria or fungus which cause the diseases (Blood, Radositis and Henderson, 1983).

Quinn, et al. (2002) reported that Streptococcus dysgalactiae as a cause abscesses and endometritis in skin and vagina of horse and Streptococcus porcinus as a cause of jowl abscesses and lymphadenitis in pigs.

1.14.3 Corynebacterium:

Demench, et al. (1977), Evans and Powys (1979) and Tejedor, et al. (2000) observed that lymphadenitis in camels affect frequently most lymph nodes leading to developing abscesses. The main cause of the disease is considered to be Corynebacterium species. Also Mohamed (1992) and Moustafa (1994) isolated this species from lymph nodes of camels.

Corynebacterium species are ubiquitous organisms and occur in many animal diseases either as a primary cause or as a secondary infection. There is palpate enlargement of one or more of the superficial lymph nodes. The abscesses commonly rupture (Blood, Radositis and Henderson, 1983).

1.14.3.1 Pathogenicity of Corynebacterium:

In Bahrain sporadic cases of subcutaneous localized and internal abscesses due to this species were recorded in adult and young camels, single or multiple abscesses of various sizes were found. Internal abscesses were found in lungs, kidney, lymph nodes and spleen (Abubakr, Nayel and Fadlalla, 1999).

Little known about the manner in which these organisms produce disease. Corynebacterium pygoenes produce relatively weak exotoxins. Abscesses are frequently resulted from Corynebacterium pygoenes and
Corynebacterium equi infections; they are usually confined to one organ (Carter, 1986).

Corynebacterium pseudotuberculosis type I strain (the known cause of caseous lymphadenitis in sheep) was isolated from pus, lymph nodes, tick, milk, blood and liver samples. The clinical symptoms, nature and distribution of lesions of caseous lymphadenitis in camels are not as typical as in sheep (Hawari, 2008). On the other hand, some reports on Corynebacterium pseudotuberculosis infection in camels were recorded in Saudi Arabia by Radwan, et al. (1989). They isolated organisms from camels with caseous lymphadenitis. Postmortem revealed emaciation and presence of multiple external and internal abscesses particularly in the lungs and liver. The body lymph nodes were enlarged and congested but without abscesses formation.

In Ethiopia, Domenech, et al. (1977) reported a chronic condition in camel which resembled caseous lymphadenitis in small ruminants. It produced poly arthritis and numerous muscle and subcutaneous abscesses.

In United Arab Emirates, Afzal, et al. (1996) reported that lymphadenitis (known locally as toloa or mala) is common in the camel and may affect more than 10% of camels in a herd. It is particularly important in racing camels since the development of abscesses results in loss of half of the racing season. In Egypt Caprano (1932) described a condition in camels characterized by enlargement of external and internal lymph glands. In some cases lymphangitis were also observed in Egypt by Mohamed, El-Saied and Attia (1997) investigated bacterial lesions in liver. In Corynebacterium infections, there were multiple abscesses and granulomatous reactions with the involvement of Staphylococcus species.
1.14.4 Bacillus:

Most of the numerous *Bacillus species* are saprophytes, widely distributed in air, soil and water. The majority of this species have little pathogenic potential but can occur commonly on laboratory media (Quinn, *et al.*, 2002). Salih (1971) isolated the organisms in 100% of 34 samples of camel liver collected from camels slaughtered at Omdurman abattoir.

1.14.5 Enterobacteriaceae:

Some strains are important pathogens for man and animals and cause intestinal and other infectious as well as food poisoning. The group has considerable epidemiological importance. They have been divided into a large number of genera and species (Barrow and Feltham, 1993).

The Enterobacteriaceae can be divided into three groups based on their pathogenicity for animals. In certain significance for animals, some of them may be isolated from clinical specimens as range of their biochemical reaction. Opportunistic pathogens that are known occasionally to cause infections in animals. These include species within the genera Klebsiella, Enterobacter, major pathogens of animals such as *Salmonella species, Ecoli* and *Yersinia species* (Quinn, *et al.*, 2002).

With the advent of antibiotics, the organisms belonging to the family Enterobacteriaceae are developing drug resistance. The use of antibiotics in the treatment of infection caused by microorganisms usually respond to the treatment with a particular antibiotic (Cruickshank, 1965).

1.14.5.1 *Escherichia coli*:

*Escherichia coli* is a natural inhabitant of the large and small intestine in animals and are geographical spread and may widely distributed out the environment and of animal. *Escherichia coli* strains, normally regarded as
non-pathogenic, can cause opportunistic infection in sites of the body such as mammary gland and uterus (Quinn, et al., 2002).

1.14.5.1 Pathogenicity of *Escherichia coli*:

*Escherichia coli* has been isolated from livers of camel slaughtered at Omdurman abattoir (Salih, 1971). The organisms had also been isolated from different lymph nodes of camel (Mohamed, 1992). This finding indicates that camels are vulnerable to *Escherichia coli* infection in gastrointestinal organs including the liver and lymph nodes.

Ambwani and Jatkar (1969) studied sensitivity of *Escherichia coli* and Salmonella isolated from camel (*Camelus dromedarius*) to various antibiotics, from the results of the in vitro test, it appears, that majority of strains of *Ecoli* and Salmonella are sensitive to chlortetracycline, oxytetracycline and chloramphenicol.

1.14.5.2 Klebsiella:

Usually communally equived with chronic extensive fibrous scarring, abscesses formation and necrosis (Cotton, 1992). It was isolated by Mohamed (1992) from different lymph nodes of camels in the Sudan. Arora and Kalra (1973) isolated *Klebsiella species* from broncopneumonia in camels.

The first isolation of Klebsiella organisms in the Sudan was made by Gameel, El Sanousi, Al-Nawawi and Al-Shazly (1991) from sheep suffering from pneumonia.

1.14.5.3 Moraxella:

This species are commensally on the mucous membrane of animals. They are susceptible to desiccation and do not survive well away from the animal host (Quinn, et al., 2002).
Moraxella bovis was first isolated by El Sanousi, Ibrahim and Babiker (1971) from outbreak of infectious bovine keratoconjunctivitis. Adifferrential mechanisms fascilitates the isolation of Moraxella was prepared by the use of tween 80 agar (El Sanousi, Laylay and Abdel Magid, 1984).

1.14.5.4 Proteus:

Mohamed (1992) isolated Proteus as well as Klebsiella, Citrobacter and Erwinia from prescabular, supramammary, submaxillary, bronchial and mesenteric lymph nodes of camel in the Sudan.

1.13.5.5 Pseudomonas:

This species are found worldwide and mainly in tropical regions. Pseudomonas aeruginosa can be found on skin and can produce a number of protein exotoxins and endotoxin that may play a role in pathogenesis. (Quinn, et al., 2002) also this species cause skin infections and abscesses in cattle, lung abscesses and eye infections in horses (Quinn, et al., 2002). This species is a frequent contaminant in disease processes and isolation alone is not necessarily significant. Its significance in mixed infections, particularly with Streptococcus and Staphylococcus may be questionable. Isolation in pure culture strongly indicates pathogeneity (Carter, 1986).

1.14.5.6 Actionbacillus:

The Actionbacilli are commensally on the mucous membrane of their hosts. The actual pathogenic mechanisms of action bacilli are unknown. (Quinn, et al., 2002).

1.14.6 Pasteurella:

Natural habitats of this species are worldwide in distribution with wide spectrum of hosts. Most are commensally on the mucous membrane of animals; the carrier rate for different species varies greatly (Quinn, et al.,
Fayed (1973) isolated *Pasteurella multocida* from 6 out of 100 nasopharyngeal swabs collected from apparently healthy camels.

*Pasteurella spp* are distributed worldwide. Occur as commensally in the upper respiratory and digestive system of animals. Infection may be acquired by contact, inhalation or ingestion; rarely it is transmitted by biting arthropods (Carter, 1986).

In Egypt, Seleim, Amal, Mohamed, Nada and Gobran (2003) reported that the bacteriological examination of internal organs of dead camel had severe respiratory symptoms revealed the isolation of *Pasteurella multocida* from 86.6% of the collected organs. Microscopically examination of smear slides from dead camels as well as clinical and apparently healthy cases revealed the typical morphological content of this species. The wide range of isolation explained that camels in close association with the smaller ruminants and other farm animals that naturally harbor the organisms in their respiratory system.

**1.14.7 Kurthia:**

Is not usually regarded as a pathogenic bacteria, but we include it as strains that have been isolated from meat and dairy products and occasionally from clinical material.
Materials and Methods

2.1 Study area:

The study was conducted in Red Sea State situated well within arid zone of the Sudan. It lies between 23 - 38 degrees east and latitude 17-22 north. It is an area of approximately 212,410 sq km and the advantage of the diversity in the nature of this image vitiated climate coastal mountains from the north to the south, features a series of volcanic mountains separating the coastal plains of the Red Sea from desert land. The mean annual temperature in Red Sea State ranges from 22 - 42°C and the mean relative humidity range from 52 - 71%. The average annual rainfall varies from 25mm to 400mm in the south area and the total area average rainfall less than 100 mm/annum. The winter rainfall and summer (November to February- July to October) beside the seasonal rains (April -July) that made the Red Sea State of climate distinct from the rest of Sudan (Source: Animal Resources Administration - Port Sudan - Red Sea State).

Desert covers about one third of the total area of the mandate is as natural resources (forests and grasslands) and the high slopes of the mountains and the outskirts of lagoons and valleys, while traditional agriculture is part of the lagoons and valleys.

Animal population in the state is as follows: cattle (46,868), goats (549,029), sheep (209,898) and camels (109,401) (Anon, 2002). The activity of the population and animal resources at Red Sea State in terms of intensity and type, depending on the year include the north and south of that we find that the northern region are based activity, population and livestock in the valleys and slopes of the mountains and the Lagoons of the presence of
vegetation while in the plains to the southern regions, where the rural population of maize cultivation areas of the summer rains and winter rainfall areas of millet.

The camel owning tribes (except in Port Sudan city) are on continuous movement in search of pasture and water leading a pastoralist nomadic system in the Red Sea State. The most common types of camels in this area are of the Bishary, Rashaida and Anafi ecotypes.

The observation reported in this study were conducted in seven localities of the Red Sea State (Port Sudan, Elgonoub and Elaolib, Suakin, Sinkat, Gabeat Madden, Dordeab and Hayia). However, most of the work was concerns in Port Sudan city.

2.2 Field investigation:

Field investigations were carried out in Red Sea State to determine the prevalence and etiology of camel abscesses in different part of Red Sea State. The areas surveyed comprised Port Sudan city (275 camels), veterinary hospital (18 camels), slaughterhouse (287 camels), veterinary quarantine (2879), livestock market (Malaga) (10 camels) and Alzareab (150 camels), Alshahinat (30 camels). Elgonoub and Elaolib localities including: Arbat (670 camels), Aroos (396 camels), Sloum (622 camels), Hoshiry (44 camels), Klaneab (45 camels) and in Gabeat Madden (46 camels), Suakin (812 camels), Sinkat (270 camels), Dordeab (380 camels), and Hayia (30 camels).

2.3 Clinical examinations:

Live camels were examined for the presence of superficial abscesses, sinus formation and enlargement of superficial lymph nodes. The examination was made visually and by palpation especially superficial
lymph nodes (parotid, mandibular, dorsal superficial cervical, ventral superficial cervical, precural and superficial inguinal).

Ticks infested a considerable number of camel examined. Most of the ticks were on the external eye lids and udder. Some time infestation was heavy and caused slight bleeding or pus at the site of biting.

2.4 Collections of pus samples from field:

The surface was disinfected with 70% ethyl alcohol, allowed to dry. Then the needle were used to insert deep in the abscesses until pus flew out. About five ml pus was collected aseptically from each lesion in a labeled sterile bijou bottle or in the needle which was then submitted to the laboratory for bacteriological examination as quick as possible. Pus sample were also collected from clinical cases brought to Port Sudan Animal hospital. In some cases the abscesses was hard, the incision was made and the samples was collected in sterile plain swaps.

2.4.1 Requirements for samples collections:
- Sterile plain swaps.
- Sterile, screw - capped, disposable containers.
- Postmortem knife, scalpel, forceps, scissors.
- Plastic bags and water proof marker pens.

2.5 Collections of samples from slaughterhouse:

At Port Sudan slaughterhouse, antemortem and postmortem inspections were carried out. Camels were slaughtered according to the Islamic method, throat were cut with a sharp knife drawn across the neck horizontally.

2.5.1 Antemortem inspections:

Port Sudan slaughterhouse was visited periodically for inspection of camel’s antimortem for the presence of external abscess and enlarged lymph
nodes over a period of fifteen months. Camels were inspected within 24 hours of delivery to slaughterhouse.

Camels slaughtered at Port Sudan slaughterhouse were mostly a local breed of the Red Sea State (Bishari, Rashaida and Anafi). A total number of 287 camels were examined; age and sex of camels was estimated. The distribution of lesions and their number were recorded. The general condition and health of camels was judged by the clinical signs. Superficial lymph nodes were examined for enlargement. Camels having supportive lesions at the sites of the lesions were recorded. Pus samples were then taken from all affected camels.

2.5.2 Postmortem inspections:

The camels carcasses were inspected for the presence of abscesses, every organ and its related lymph nodes were grossly examined by naked eye with regard to the size, colour and consistency. The organs that showed gross pathological changes in the form of enlargement were selected for sampling, palpation and incision were made. The samples were taken as soon as possible using clean sterile instrument and protected from contamination. Samples were collected in sterile plastic bags which were kept in an ice box and transported to the Customs Laboratory in Port Sudan where they were immediately subcultured. A more detailed postmortem examination of the slaughtered camel with such abscesses, site and position of the abscesses were determined.

2.5.2.1 Collections of samples from lymph nodes:

Both apparently normal and abnormal lymph nodes were taken during this study. Abscesses together with surrounding tissue were carefully removed from affected organs and put in sterile plastic bags. Distribution of lesions and their number were recorded. A total number of 202 samples
consisting of 40 pulmonary lymph node, 33 ventral superficial cervical lymph node, 21 submandibular lymph node, 8 inguinal lymph node, 20 hepatic lymph node, 19 parotid lymph node, 19 supramammary lymph node, 18 retropharyngeal lymph node, 16 popliteal lymph node, 6 dorsal superficial cervical lymph node and 2 tuberal lymph node were obtained.

2.5.2.1.1 Parotid lymph nodes:

Parotid lymph node was located in the head, consisted of pair of superficial lymph nodes one on each side and embedded of the parotid salivary gland.

2.5.2.1.2 Mandibular lymph nodes:

The mandibular lymph nodes were two in numbers, one on each side. They were situated in a depression at angle of the mandible.

2.5.2.1.3 Retropharyngeal lymph nodes:

The retropharyngeal lymph nodes consists of two lymph nodes one at each side of the pharynx. Each node locates in the neck ventromedial to the wing of the atlas.

2.5.2.1.4 The ventral superficial cervical lymph nodes:

Ventral superficial cervical lymph nodes are represented on both sides of the neck; each node situate in the caudal and ventral part of the neck.

2.5.2.1.5 The dorsal superficial cervical lymph nodes:

Dorsal superficial cervical nodes are found on both sides of the neck, each node situate craniodorsal to the shoulder joint.

2.5.2.1.6 The mammary lymph nodes:

The mammary lymph nodes the largest lymph nodes in the camel. They are paired on each side. Each was embedded in a considerable amount of the fat of superficial ring of the inguinal canal.
2.5.2.1.7 Popliteal lymph nodes:
Popliteal lymph nodes Situated between the biceps femoris and the semitendinosus muscles on the gastrocnemices muscle.

2.5.2.1.8 Tuberal lymph nodes:
Tuberal lymph nodes consists of two superficial lymph nodes, one on the either side at the pelvic outlet and is covered by the skin.

2.5.2.1.9 Bronchial lymph nodes:
Bronchial lymph nodes are placed around the trachea and bronchi.

2.5.2.1.10 Hepatic lymph nodes:
Hepatic lymph node is placed on the liver.

2.5.2.2 Collections of samples from lungs:
After removal of the pluck from the carcasses, the lungs were carefully examined for the presence of macroscopic abscesses lesions. Lung was carefully palpated for detection of abscesses. Small pieces, approximately two cm in length, were cut from the lesions with sterile scissors and forceps. A total number of 44 abscesses were collected from lung affected during this study showing gross pathological change.

2.5.2.3 Collections of samples from livers:
The liver was examined for the purpose of detecting only abnormal condition whether localized superficially or deeply in the organ, either single or multiple. It were examined visually on both parietal and visceral surfaces, then palpated and incised on the visceral surfaces in such a way that the incision comes across most of the bile ducts. A visual examination with palpation was made for abscesses which consisted of control mass of necrotic liver tissue surrounded by pus and a wall of connective tissue. A total number of 287 livers were examined and 24 abscesses were collected.
2.6 Transportation of samples:

Samples were kept in a sterile plastic bags, labeled and placed in an ice box, transported to laboratory and culture within two hours after collection. The remaining ones were labeled, stored frozen and cultured later.

2.7 Preparations of samples for bacteriological examination:

Treatment of the samples was done in the laboratory. The lymph nodes were prepared by removing the surrounding fat by sterile scissors and forceps. The remaining fat achieving to the node capsule was removed by searing of the surface of the node with a large red hot spatula. The examined lymph nodes, lungs and livers are speared by a hot spatula and opened under sterile condition. Loops full of the content of lesions were obtained for direct smears and cultured for bacteriological examination.

2.8 Preparations of samples for histopathological examination:

Samples from abscesses organs showing in gross lesions were preserved in 10% formal saline for histopathological examination. After preparing the smear and culturing, pieces of 1 cm length fixed in neutral formalin and studied grossly and histopatholoically.

2.9 Microscopic examinations:

Direct smear preparation were made from all pus samples. The smears were fixed by heating, stained by Gram’s Method and examined microscopically for presence of pyogenic organisms.

The Gram-stain is helpful for distinguishing different bacterial types in a sample. The morphology of the organisms was defined by Gram’s Method of staining. Size, shape and grouping of the bacteria were recorded.
2.10 Cultures of samples:

In the laboratory, the samples were cultured on sheep blood agar and MacConkey agar and incubated aerobically.

2.10.1 Inoculations of culture media:

Onto solid media, plates were inoculated by streaking with platinum loop. In liquid media by transferring growth from solid media with a loop or by using Pasteur pipette in case of liquid media.

2.10.2 Incubation of culture media:

Inoculated media were incubated aerobically at 37°C from 24 hours or otherwise indicated. Then solid media plates were examined microscopically for growth colonial morphology, liquid media similarly examined for turbidity.

2-10-3 Purification of culture:

Pure culture of bacteria was obtained by subculturing from a typical and well isolated colony on solid media till pure bacterial growth was obtained. Gram-positive organisms were purified by subculturing on blood agar media while Gram-negative bacteria were subcultring on a macConkey's agar.

Culture plates and pathological materials that may pose a human health hazard were disposed properly. Method of destroying to place the materials in an autoclavable bag and autoclaving.

2.10.4 Colony characteristics:

Examination of plate culture for colonial morphology was recorded. Size of colonies, their outline, elevation, translucency and colour, other characteristics such as causing haemolysis on blood agar or fermentation were recorded. Colonies are described as:
- Shape: circular, regular, radiating.
- Surface: smooth, rough, fine, shiny, granular.
- Size: usually colonies are two - three mm.
- Consistency: mucoid and dry.
- Media change: colonial growth my bring colour changes.

2-10-5 Isolation and preservation techniques:

Isolation attempts were made on all samples on the same day of collection. A loopfull of samples was inoculated by streaking on 10% defibrinated sheep blood agar, one plate incubated aerobically, the second aerobically under increased CO$_2$ tensions (candle jar system) . All plates incubate at 37°C and examined daily by the naked eye for growth.

Plates that did not show growth were considered to be negative. All species of bacteria isolated and identified according to the procedures described by Barrow and Feltham (1993).

The isolates were stored in a refrigerator and subcultured weekly on fresh sheep blood agar or nutrient agar, the pure culture were then stored in cooked meat medium at 4°C and transferred to fresh medium every three months till bacteriological studies were completed.

Various equipment were used in the course of this study, these were located in the Faculty of Veterinary Science at Shambat and at the Custom Administration Laboratory in Port Sudan city.

2.11 Sterilization:

Sterilization is the freeing of an article from all living organisms, the sterilization of culture media, container and instruments is essential.
2.11.1 Dry heat:

2.11.1.1 By red heat:

Inoculating wires, points and forceps were sterilized by holding the object near vertical in the flame of Bunsen burner as possible until it became red hot.

2.11.1.2 By hot–air oven:

The oven was used in sterilizing dry glassware such as test tubes, Petri dishes, flasks, Pipettes and instrument such as forceps, scalpels and scissors. The temperature and time of exposure were 170°C for 90 minutes respectively.

2.11.1.3 Flaming:

This method was used for the cotton plugged tubes openings with cotton plugs, scalpels and glass slides. It was done by exposing the object to flame for 0.5 to minutes.

2.11.2 Moist heat:

2.11.2.1 By autoclaving:

Autoclave are made of strong metal jackets used to sterilized culture media, more effective to destroy or eliminate any living organisms present, also used of contemned material. The temperature applied for autoclaving was 115’ C to 121’ C, the holding time was 15 to 20 minutes and the pressure was ten to 15 pounds per square inch.

2.11.3 Filtration:

Sterile Millipore filters were used to sterilize serum and cystiene hydro-chloride.

2.11.4 Ultraviolet radiation:

Ultraviolet radiation is used to sterilize surfaces before pouring the media in the plates, tube and bottle to prevent contamination.
2.12 Bacteriological media:

Bacteriological media is essential to obtain culture by growing the organism in an artificial culture media. Culture media are specifically designed to encourage the growth of particular organism by providing necessary to use solid medium for colony formation.

All media were dispensed under aseptic condition in laminar air flow cabinet type provided with fan, ultra violet lamp and flame. All media prepared were sterilized according to instruction for each type of media, PH was adjusted.

2.12.1 Liquid media:

2.12.1.1 Nutrient broth (Oxoid)(g\L) :

This simple medium contained the basic growth factors for most bacteria. It was composed of lab - lemco, peptone, yeast extract and sodium chloride. The medium was prepared by dissolving 13 grams of powder in one liter distilled water and sterilized. It was used as basis for enriched and general purpose media.

2.12.1.2 Peptone water (Oxoid)(g\L):

Peptone water contents peptone and sodium chloride, prepared by adding 15 grams to one liter of distilled water mixed well and distributed into ten ml test tubes in three ml amounts and sterilized by autoclaving at 121°C for 15 minutes.

2.12.1.3 MR-VP medium (Oxoid) (g\L):

MR-VP medium was obtained in a dehydrated form. It contained peptone, dextrose and phosphate buffer. It was prepared by dissolving 15 grams of the medium in one liter of distilled water. The prepared medium was kept at 4°C until use.
2.12.1.4 Hugh and Leifsons (O/F) medium (Barrow and Feltham, 1993)

Hugh and Leifsons medium was used to test the ability of the organism to attack dextrose under aerobic and anaerobic condition. The medium contains peptone, sodium chloride, dipotassium hydrogen phosphate, agar and bromothymol blue and 0.2 aqueous solution. The medium was prepared by dissolving all ingredients in one liter of distilled water except bromothymol blue solution which was added after adjustment of the PH to 7.1. Then sterile solution of the appropriate carbohydrate was added aseptically to give a final concentration of 1%.

2.12.1.5 Peptone water sugars (Barrow and Feltham, 1993):

Peptone water sugars were used as an indicator of the fermentative properties of the less fastidious organisms. Media were prepared by adding of Andrade's indicators (0.1%) to desired carbohydrate (1%) to peptone water, then distributed in sterile test tubes and sterilized by autoclaving at 10 p.s.i for 10 minutes, then stored at 4°C until use.

2.12.2 Solid media:

2.12.2.1 Blood agar (Barrow and Feltham, 1993):

This is one of the enriched media that was composed of nutrient agar and sterile defibrinated sheep blood. It was prepared by dissolving 28 grams of the basal medium to one liter distilled water, sterilized at 121°C for 15 minutes, cooled at 45-50°C and 7% sterile defibrinated sheep blood were added aseptically. The media were gently mixed and then poured onto sterile Petri dishes.

2.12.2.2 MacConkey agar (Oxoid):

This selective medium was obtained in a dehydrated form. It consisted of peptone, lactose, bile salts, sodium chloride, agar No.3 and neutral red.
The medium was prepared according to the manufacturer's instructions by suspending 52 grams of the powder in one liter of distilled water, then boiled to dissolve completely and sterilized by autoclaving at 121°C for 15 minutes, distributed in Petri dishes and kept at 4°C until used.

2.12.2.3 Simmon's citrate agar (Oxoid):

Simmon's citrate agar was used to test the ability of organisms under study to utilize citrate for growth. The medium contained Magnesium sulphate, Ammonium dihydrogen phosphate, sodium ammonium phosphate, sodium citrate, sodium chloride, Bromthymol blue and agar No.3. The medium was prepared by dissolving 23 grams of the medium in one liter of the distilled water, the prepared medium was kept at 4°C until use.

2.12.2.4 Motility medium (Barrow and Feltham, 1993)(g/L):

Motility medium was used to detect motility of microorganisms. The medium consists of peptone, meat extract, sodium chloride, agar and gelatin. Dissolved in one liter of distilled water, heated to dissolve completely and sterilized at 115°C for 20 minutes.

2.12.2.5 Triple sugar iron agar (Difco):

Triple sugar iron agar was used to test the ability of organisms to produce hydrogen sulphate (H₂S). The medium was obtained in a dehydrated from. Its ingredient are bacto-beef extract, bacto-yeast extract, bacto-Peptone, proteose peptone, bacto-dextrose, bacto-lactose, saccharose, ferrous sulphate, sodium chloride, bacto-agar and bacto-phonel red. It was prepared by adding 65 grams of the medium to one liter of distilled water.

2.12.2.6 Edwards medium (modified) (Oxoid) (g/L):

Edwards medium was prepared by adding 41g of Edward dehydrated medium (Oxoid) to one liter of distilled water, sterilized by autoclaving at 115°C for 20 minutes and cooled to 50°C before adding 50 ml of sterile
sheep blood. The prepared medium was then distributed aseptically into sterile Petri dishes.

2.12.2.7 Nutrient agar (Oxoid)

Nutrient agar constitutes of lab-lecmco powder, yeast extract, peptone, sodium chloride and agar No.3. The medium was prepared by dissolving 28 grams of the medium in one liter distilled water, autoclaving at 121°C for 15 minutes. Cooled at 45-50°C and distributed into sterile Petri dishes in 15 ml portion each.

2.12.2.8 Urea agar base (Oxoid):

Urea agar base is consisted of peptone, dextrose, sodium chloride, disodium phosphate, potassium dihydrogen phosphate, phonel red and Agar No3. It was prepared by adding 2 -4 grams suspended in 95ml distilled water, then sterilized at 115°C for 20 minutes. The medium was cooled to 50°C and aseptically 5 ml of sterile 40% urea solution was added and poured in to MacCarteny bottles and allowed to set in slope position. The prepared medium was kept at 4°C unit use.

2.12.2.9 Robertson's cooked meat medium:

This medium contained minced meat and 0.05 NaoH .The medium was prepared by added 1000g of fat free Ox heart minced meat to alkali solution, then boiling for 20 minutes then the PH adjusted to 7-5, dried and distributed in five gram amount into bijou bottles. Nutrient broth was added to cover the meat particles to about two cm high. The medium was then sterilized by autoclave at 121°C for 15minutes.

2.12.2.10 Aesculin agar: (Barrow and Feltham , 1993):

The medium is consisted of Aesculin, ferric citrate, agar and peptone water. It was prepared by dissolved the ingredients in peptone water, sterilized by autoclaving at 115°C for 10minutes, poured into sterile
MacCarteny bottles aseptically and allowed to set in slope position to solidify, then stored at 4°C until use.

2.13 Reagents:

2.13.1 Hydrogen peroxide:

This was obtained from Agropharm Limited as 3% aqueous solution for the catalase test.

2.13.2 Oxidase test reagent (Barrow and Feltham, 1993):

It was obtained from British Drug House London (B.D.H) and prepared as fresh 1% solution of tetramethyl-p-phenylenediamine dihydrochloride.

2.13.3 Potassium hydroxide (Barrow and feltham,1993):

This was obtained from B.D.H and prepared as 40% aqueous solution for V-P test.

2.13.4 Kovac's reagent (Barrow and feltham,1993):

An amount of five grams of p-dimethylaminobenzaldehyde were dissolved in 75 of amyl alcohol in water bath (50°C-55°C). Then cooled and 25 ml of concentrated hydrochloric acid was added carefully, mixed well and stored at 4°C for indole test.

2.13.5 Methyl red solution (Barrow and Feltham, 1993):

An amount of 0.04 grams of methyl red was dissolved in 40 ml ethanol and diluted to 100 ml distilled water. It was used for M.R test.

2.13.6 α - naphthol solution (Barrow and Feltham, 1993):

This reagent was obtained from B.D.H and prepared as 45 aqueous solution for Voges–Proskaur test.
2.14 Indicators:

2.14.1 Bromothymol blue:
This indicator was obtained from B.D.H and prepared by dissolving 0.2 gram powder in 100 ml distilled water.

2.14.2 Phenol red:
Phenol red was supplied by Hopkins and William Ltd, London.

2.14.3 Andrade's indicator (Barrow and Feltham, 1993):
Five grams of acid fuchsin was dissolved in one litre of distilled water, then 150 ml of N-NaoH was added, mixed and left at room temperature for 24 hours, the colour should change from red to brown.

2.15 Biochemical test:

2.15.1 Catalase test:
On a clean microscope slide a loopful of 3% hydrogen peroxide was placed. A colony of test culture, on nutrient agar, was picked using a wooden stick or glass rod and put in the reagent. Production of gas bubbles indicated positive result.

2.15.2 Oxidase test:
Pieces of filter paper were soaked in 1% solution of tetramethylene P-Phenylene diamine dihydrochloride and dried. A colony of an over-night growth, on nutrient agar, was picked with sterile bend glass rod and rubbed on the filter surface placed in a Petri dish. A dark purple colour within 5-10 seconds was considered as positive reaction.

2.15.3 Motility test:
The Craigie tube method using semi-solid nutrient agar was used. A small piece of colony of the bacterium under test was picked by the end of the straight wire and stapped in the center of the semisolid agar in the inner side of Craigie tube. This preparation was incubated at 37°C overnight the
organism was considered motile if there was turbidity in the medium in and outside the Craigie tube.

2.15.4 Sugar fermentation test:
The test organism was inoculated into peptone water sugar medium, incubated at 37°C and then examined daily for up to 7 days. Acid production was indicated by the development of red colour in the medium, whereas gas production was shown by development of an empty space in Durham tube.

2.15.5 Oxidation fermentation (O/F) test:
Two tubes of Hugh and Leifson's medium were inoculated with the test culture. One of the tubes was covered by a layer of sterile paraffin oil to about 3cm above the surface of the medium; the other was left unsealed. Both were then incubated at 37°C and examined daily up to two weeks. Fermentative organisms were indicated by change in colour to yellow in both tubes, while oxidative organism was indicated by change in unsealed tube only. A blue colour in both tubes was considered negative (alkaline production).

2.15.6 Tube coagulase test (Barrow and Feltham, 1993):
One ml of plasma was added to nine ml normal saline to make 1:10 dilution. Then 0.5 ml of this dilution was mixed with 0.5 ml of broth culture in agglutination tube, incubated at 37°C and examined after four hours. The positive result was indicated by definite a clot. Negative tubes showed no clot formation when examined after overnight incubation at 37°C.

2.15.7 Aesculin hydrolysis:
The slant of aesculin medium was streaked with the tested isolate, incubated at 37°C and examined daily up to 14 days. Blackening of the medium indicated positive reaction.
2.15.8 Indol production test:
The test culture was inoculated in peptone water and incubated at 37°C for 24 or 48 hours. Kovac's reagent was added and shaken well. Development of the red colour between the medium and reagent layer indicated a positive reaction.

2.15.9 Hydrogen sulphide (H₂S) production:
The test organism was inoculated in peptone water and filter paper soaked with lead acetate solution was inserted between the neck of the tube and the cotton plug, incubated at 37°C for 48 hours and examined daily for seven days. A brown or black colour of paper indicated positive result.

2.15.10 Voges-Proskauer (V-P) test:
Glucose phosphate medium (M.R - V.P medium) was inoculated with the tested organisms and incubated at 37°C for 48 hours. An amount of 0.2 ml of 40% potassium hydroxide and 0.6 ml of 5% α-nephthol solution were added to one ml of culture, then shaken, placed in slope position and examined after 15 minutes and one hour, a positive reaction was indicated by bright pink or red colour.

2.15.11 Methyl red tests:
The same culture of V-P test was used for this test. An amount of 5 - 6 drops of methyl red reagent was added, a positive reaction was indicated by a red colour of the medium.

2.15.12 Urease activity:
The urea agar medium was inoculated with test organism and incubated at 37°C, examined daily for up to 14 days. Positive reaction was indicated by production of red colour.
2.15.13 Citrate test:

The slants of simmon's citrate medium were streaked with the test organism and incubated at 37°C. The cultures were examined daily for 14 days. A change of medium from green to blue was considered a positive result.

2.15.14 CAMP test:

β -haemolytic *Staphylococcus aureus* was streaked on middle of the surface of 5% blood agar plate. The organism under test was streaked vertically to that line and the plate was incubated over night at 37°C. Positive reaction was indicated by a half –moon shaped clear haemolysis when the line of the isolate passed the hemolytic zone of the *Staphylococcus aureus*.

2.15.15 Eijkhman test:

MacConkey broth was inoculated with the isolate and incubated in water bath (44 ± 0.1°C) for 48 hours with control tube of uninoculated medium. Production of acid and gas indicated positive result.

2.15.16 Novobiocin sensitivity test:

A volume of two ml of diluted culture were spread on the surface of nutrient agar. The excess fluid discarded and the plate was allowed to dry, then Oxoid discs of novobiocin (5mg) was applied to the surface of the medium by sterile forceps and incubated at 37°C for 24 hours. Zone of inhibition was determined whether the organism was sensitive or not to novobiocin.

2.16 Pathological examinations:

2.16.1 Gross Pathology:

Postmortem examination was carried out immediately after slaughtering. Different body lymph nodes, livers and lungs were examined carefully for presence of any pathological lesions. The tissue specimens
were processed in paraffin and sections 5 - 6 μ were prepared and stained with Haematoxylin and Eosin (H&E) as described by Drury and Wallington (1980).

2-16-2 Histopathological techniques:

2-16-2.1 Fixation:  
About 1 cm³ of each sample was fixed in formal saline (10% formalin + 6.5g sodium dihydrogen orthophosphate + 4g di-sodium hydrogen phosphate).

2-16-2.2 Trimming:  
After at least 24 hours the samples were trimmed to a thickness of 0.3 cm.

2-16-2.3 Processing the samples:  
Before processing, the trimmed samples were labeled and immersed in 70% alcohol for about 15 minutes. Processing was carried out using an Elliott automatic tissue processor.

2-16-2.3.1 Dehydration:  
The dehydration was completed using ascending grades of ethyl alcohol ranging from 70 per cent to absolute alcohol to prevent the distortion that would accompany the direct transfer of the tissue from 10% formal saline to absolute alcohol.

2-16-2.3.2 Clearing:  
For clearing of the samples xylene and chloroform were used.

2-16-2.3.3 Wax impregnation and embedding:  
Melted paraffin at (54-56°C) was used for the impregnation. Plastic moulds were filled with freshly filtered paraffin and the surface of the processed tissue sample that contains the lesion was pressed against the base of the mould using a wormed smooth tipped forceps. After about five
minutes at room temperature, the blocks were immersed in cold water for up to one hour to attain their solidification. The blocks were stored at 4°C in a refrigerator.

2.16.2.4 Microtomy of the blocks:

A Rotary microtome (Baird and Tatlock Ltd. England) with a sharp cold knife was used for sectioning the embedded tissues at thickness of 4-6 microns.

2.16.2.5 Staining of the sections:

Before staining of the sections, the paraffin wax removed using xylene that was also removed by absolute alcohol. The sections were rehydrated using descending grades of alcohol (90, 85, 80 and 70 per cent alcohol) for two minutes in each. The section was then passed from the last grade (70 percent) alcohol to distilled water for two minutes.

2.16.2.5.1 Haematoxylin and Eosin stain:

The sections were stained with haematoxylin (Ehrlich haematoxylin) for two minutes and washed in running tap water for three minutes. Excess stain was removed by decolorizing the sections in one per cent hydrochloric acid in 70 per cent alcohol for few seconds. The slides were washed in running water to regain the blue colour of the haematoxylin and then stained with one percent aqueous eosin for five minutes. They were washed with tap water, dehydrated in two changes of absolute alcohol for two minutes in each and cleared in xylene for one minute. Coplin jars and stainless steel slide racks were used for handling the slides throughout that process.

2.16.2.6 Mounting of the sections:

Cover slips of 22X22 millimeter and 22X40 millimeter sizes were used to protect the sections. The mounting media used was xylene –balsam.
The prepared slides were left for 24 to 48 hours at room temperature to dry before they were examined.

2.16.2.7 **Microscopic examinations of the sections:**

The sections were examined under different powers: low, medium and high for tissue and cellular changes.

2.17 **Statistical analyses:**

The statistical analysis was carried out using statistical computer programme (Statistical Package for Social Sciences. SPSS).
Results

3.1 Field investigations:

The incidence of abscesses among camels in the Red Sea State was investigated in different locations (Figure 1). A total of 6974 camels (field and slaughterhouse) of both sexes and different ages were used in this study. Camel herds were regularly examined during the different seasons of the year (summer, winter and autumn). The survey started in June, 2005 and continued up to September, 2006.

Superficial abscesses constituted about 444 out of 6677 (6.64%) involving the region or lymph nodes. The most frequently affected sites were ventral superficial cervical nodes (Figures 3, 4, 5, 6 and 7). Male animals showed a higher percentage of abscesses compared to females (Figure 13).

Internal abscesses constituted about 186 (64.8%) and were seen in 44 (16.29%) in the lung, 24 (8.88%) in the liver parenchyma and 202 (73.45%) in the lymph node.

3.2 Clinical findings:

6964 heads of camels were examined visually to determine the incidence of superficial abscesses among camels during an intensive working period of fifteen months to collect samples for bacteriological investigation.

A total of 184 (40.08%) pus samples were collected aseptically from superficial lymph nodes and skin abscesses of the affected camels during the field investigation. Some of the abscesses were hot and painful on palpation and often were discharging. The abscesses were surrounded by thick capsule. These involving lymph nodes and with infrequently swelling of
surrounding tissue (Figures 6, 7 and 9). They contained odorless, non-granular and non calcified thin pus sometimes mixed with blood and some lymph nodes were enlarged without pus formation (Figures 2, 3).
Figure (1): Study area in the Red Sea State showing localities from where samples were collected. (Source: Animal Resources Administration - Port Sudan - Red Sea State).
Table (2): Total number of camels examined and the number affected with abscesses in the Red Sea State - Sudan (age range: 2 -15 years).

<table>
<thead>
<tr>
<th>Geographical Location</th>
<th>number of total camel examined</th>
<th>number with abscesses</th>
<th>% of total affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 -Port Sudan</td>
<td>No.♀♀♂♂</td>
<td>No.♀♀♂♂</td>
<td></td>
</tr>
<tr>
<td>Port Sudan city</td>
<td>275♀♀♂♂ 51♀♀♂♂</td>
<td>90♀♀♂♂ 14♀♀♂♂</td>
<td>8.09%</td>
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<tr>
<td>Vet. clinic</td>
<td>18♀♀♂♂ 15♀♀♂♂</td>
<td>7♀♀♂♂ 10♀♀♂♂</td>
<td>2.38%</td>
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<tr>
<td>Vet. quarantine</td>
<td>2879♀♀♂♂ 143♀♀♂♂</td>
<td>305♀♀♂♂ 21♀♀♂♂</td>
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<tr>
<td>Livestock market</td>
<td>10♀♀♂♂ 1♀♀♂♂</td>
<td>2♀♀♂♂ 1♀♀♂♂</td>
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<tr>
<td>Slaughterhouse</td>
<td>287♀♀♂♂ 186♀♀♂♂</td>
<td>165♀♀♂♂ 102♀♀♂♂</td>
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<td>75♀♀♂♂ 3♀♀♂♂</td>
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<tr>
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<td>20♀♀♂♂ 0♀♀♂♂</td>
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<td>2 -Elgonoub and Elaolib Salum</td>
<td>622♀♀♂♂ 32♀♀♂♂</td>
<td>195♀♀♂♂ 12♀♀♂♂</td>
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<td>24♀♀♂♂ 3♀♀♂♂</td>
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<tr>
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<td>385♀♀♂♂ 30♀♀♂♂</td>
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<td>3 -Suakin</td>
<td>812♀♀♂♂ 54♀♀♂♂</td>
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<td>4 -Gabeat Madden</td>
<td>46♀♀♂♂ 6♀♀♂♂</td>
<td>34♀♀♂♂ 2♀♀♂♂</td>
<td>0.95%</td>
</tr>
<tr>
<td>5 -Sinkat</td>
<td>270♀♀♂♂ 14♀♀♂♂</td>
<td>195♀♀♂♂ 8♀♀♂♂</td>
<td>2.22%</td>
</tr>
<tr>
<td>6 -Haya</td>
<td>30♀♀♂♂ 6♀♀♂♂</td>
<td>14♀♀♂♂ 4♀♀♂♂</td>
<td>0.95%</td>
</tr>
<tr>
<td>7 -Dordeab</td>
<td>380♀♀♂♂ 11♀♀♂♂</td>
<td>150♀♀♂♂ 7♀♀♂♂</td>
<td>1.74%</td>
</tr>
<tr>
<td>Total</td>
<td>6964♀♀♂♂ 630♀♀♂♂</td>
<td>2529♀♀♂♂ 279♀♀♂♂</td>
<td>100</td>
</tr>
</tbody>
</table>

*Out of 630 affected camels.
Figure (2). Camel: Enlarged submandibular lymph node.

Figure (3). Camel: Enlarged ventral superficial cervical lymph node.
Figure (4). Camel: Discharging ventral superficial cervical lymph node.

Figure (5). Camel: Lobulated ventral superficial cervical lymph node.
Figure (6). Camel: Enlarged mature abscess in ventral superficial cervical lymph node.

Figure (7). Camel: Lymphadenitis, ventral superficial cervical lymph node.
Figure (8). Camel: Ruptured dorsal superficial cervical lymph node discharging pus.

Figure (9). Camel: (1) Dorsal superficial cervical lymph node discharging pus and (2) Enlarged ventral superficial cervical lymph node.
Figure (10): Camel: Abscess in lateral (right) aspect of lower neck after medication.
3.3 Percentage of infection at field investigation:

A higher percentage of external abscesses were found in the veterinary clinic (83.3%). The second high percentage was that of the slaughterhouse (64.8%) of 287 camel carcasses examined. The lowest incidence was in Dordeab area and in the veterinary quarantine with respective percentage of 2.8% and 4.96 (Table 2 and Figure 11).

During the field investigation, 6.64% of camels examined in the Red Sea State were found to be affected with external abscesses. The majority of lesions were found in the hind and fore limb (55 lesions, 11.98 %), shoulder (35 lesions, 7.62 %), hump (22 lesions, 4.79 %), neck (18 lesions, 3.92 %), chest (18 lesions, 3.92%), mammary gland (18 lesions, 3.92%), breast pad (5 lesions, 1.08%) and others (18 lesions, 3.92%) as shown in Figure (12) and Table (12).
Figure (11): Percentage distribution of the abscesses and the bacterial isolates according to the different locations at Port Sudan city.

Figure (12): Distribution of external abscesses according to different locations in the Red Sea State -Sudan.
3.4 Frequency of camel abscesses according to location:

Table (3) and Figure (13) show the means and the standard errors of the number of camels affected with abscesses. Statistical analysis of results indicated that the overall mean was 26.4 ± 0.041. The mean incidence in the veterinary clinic and slaughterhouse was 46.3 ± 0.08 and 43.2 ± 0.08 and were significantly different from those in the veterinary quarantine (3.5 % ± 0.08) and Port Sudan city (12.4 ± 0.08).
Table (3): Means and standard errors of affected camels classified by location at Port Sudan city.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>S.E.</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Sudan</td>
<td>12.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.79</td>
<td>0.33</td>
</tr>
<tr>
<td>Vet Clinic</td>
<td>46.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.26</td>
<td>0.67</td>
</tr>
<tr>
<td>Vet Quarantine</td>
<td>3.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.17</td>
<td>0.24</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>43.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.08</td>
<td>0.23</td>
<td>0.63</td>
</tr>
<tr>
<td>Overall</td>
<td>26.4</td>
<td>0.04</td>
<td>162</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Figure (13): Percentage distribution of the abscesses according to sex and locations in the Red Sea State - Sudan.
Figure (14): Percentage distribution of abscesses in the different locations in the Red Sea State-Sudan.

Figure (15): The incidence of the abscesses according to sex in the field and slaughterhouse investigations in the Red Sea State-Sudan.
3.5 Age susceptibility:

Camel ages was obtained by asking the camel owners. All ages were found susceptible but the disease incidence was found to be less among camels that were three years of age. The highest infection rate was found in camels 5-17 years of age followed by camels 10-12 years old. Almost similar levels of incidence were recorded in the ages 8 and 10 years.

3.6 Sex susceptibility:

Both sexes seemed to be fairly equally affected which is indicated by the highly significant correlation between incidence in males and females. The disease abscesses occurred in all breeds and sexes. In this study the total number of camels examined in the field and slaughtered animals was 6964. Of these the number of females was 2529 (36.4%) and the number of males was 4435 (63.6%). The total number and percentage of diseased animals among female and male camels from 630 were 279 (44.3%), 351 (55.7%) respectively (Table 2 and Figure 13, 15).
3.7 Frequency of camel abscesses according to sex and location:

Table (4) presents the mean of female camels affected with abscesses (18.9±0.07) and the mean number of affected males (17.3±0.07). There was significant difference between the two sexes.

Table (5) presents the analysis of variance of abscess incidence after transformation of counts to logarithms. The effects of location were significant (P<0.05) while the effects of sex approached significance with a probability of 0.078.

As shown in Table (7) there was a highly significant association between the occurrence of the abscesses in females and males. Both Pearson’s Chi-square test and Fisher’s Exact test were highly significant.

Table (8) indicates that there was a highly significant correlation between incidence in males and females. Pearson’s correlation between incidence in males and females was 0.052 and was highly significant (P<0.01).
Table (4): Means and standard errors of affected animals classified by sex.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Mean</th>
<th>S.E.</th>
<th>Lower Limit</th>
<th>Upper Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined</td>
<td>42.9</td>
<td>0.07</td>
<td>.254</td>
<td>.604</td>
</tr>
<tr>
<td>Females</td>
<td>18.9</td>
<td>0.07</td>
<td>0.01339</td>
<td>.364</td>
</tr>
<tr>
<td>Males</td>
<td>17.3</td>
<td>0.07</td>
<td>.002430</td>
<td>.348</td>
</tr>
</tbody>
</table>

Table (5): Analysis of variance of abscess incidence classified by location and sex.

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df.</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>0.419</td>
<td>3</td>
<td>0.140</td>
<td>6.808</td>
<td>0.023</td>
</tr>
<tr>
<td>Sex</td>
<td>0.165</td>
<td>2</td>
<td>0.08251</td>
<td>4.020</td>
<td>0.078</td>
</tr>
<tr>
<td>Error</td>
<td>0.123</td>
<td>6</td>
<td>0.02052</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>1.541</td>
<td>12</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

R Squared = 0.826 (Adjusted R Squared = 0.68)
Table (6): Association between sex and camel abscesses using Chi -Square test.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Disease</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>abscesses</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>44.29%</td>
<td>2529</td>
</tr>
<tr>
<td>Male</td>
<td>55.71%</td>
<td>4435*</td>
</tr>
<tr>
<td>Total</td>
<td>630</td>
<td>6334</td>
</tr>
</tbody>
</table>

*More than one lesions were found in same organ.

Table (7): Chi -Square tests for the significance of association between incidence in males and females.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>d.f.</th>
<th>Asymp. Sig. (2 -sided)</th>
<th>Exact Sig. (2 -sided)</th>
<th>Exact Sig. (1 -sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi -Square</td>
<td>19.026</td>
<td>1</td>
<td>.000</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fisher's Exact Test</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>6964</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Table (8): The correlation between incidence of camel abscesses in males and females in the Red Sea State -Sudan.

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Asymp. S.E.</th>
<th>Approx. T</th>
<th>Approx. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interval by Interval</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson's R</td>
<td>0.052</td>
<td>0.012</td>
<td>4.367</td>
<td>.000</td>
</tr>
<tr>
<td><strong>Ordinal by Ordinal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spearman Correlation</td>
<td>0.052</td>
<td>0.012</td>
<td>4.367</td>
<td>.000</td>
</tr>
<tr>
<td><strong>N of Valid Cases</strong></td>
<td>-</td>
<td>6964</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
3.8 Frequency of camel abscesses in the field and slaughterhouse surveys:

Table (9) presents the mean and standard errors of abscess incidence in the field and slaughterhouse. Incidence in the slaughterhouse (14.84±4.34) was slightly higher than that in the field (14.54±4.19).

Table (10) shows that the mean percentage of affected camels in the field was 47.38±5.13 and the mean of affected camel at the slaughterhouse was 52.6±5.13. There was significant difference between the occurrence of abscesses in the field and slaughterhouse.

As shown in table (11) there was a highly significant association between the occurrence of the abscesses in camels in field and slaughterhouse indicating that there is difference in occurrence between the two.
Table (9): The means and standard errors of abscess in the field and slaughterhouse at Red Sea State-Sudan.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>N</th>
<th>S.D.</th>
<th>S.E. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>14.54</td>
<td>19</td>
<td>18.2981</td>
<td>4.19</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>14.84</td>
<td>19</td>
<td>18.8982</td>
<td>4.34</td>
</tr>
</tbody>
</table>

Table (10): Correlation between the percentage of affected camels in the field and slaughterhouse at Red Sea State -Sudan.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>N</th>
<th>S.D.</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>47.38</td>
<td>23</td>
<td>0.245857</td>
<td>5.13</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>52.62</td>
<td>23</td>
<td>0.245857</td>
<td>5.13</td>
</tr>
</tbody>
</table>

Table (11): Correlation between the occurrence of the abscesses in the field and slaughterhouse at Red Sea State -Sudan.

<table>
<thead>
<tr>
<th>Location</th>
<th>N</th>
<th>Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field &amp; Slaughterhouse</td>
<td>19</td>
<td>.966</td>
<td>.000</td>
</tr>
</tbody>
</table>
Table (12): Sites of abscesses in investigated camels in the Red Sea State - Sudan.

<table>
<thead>
<tr>
<th>Geographical Location</th>
<th>No. affected</th>
<th>No. of Sample</th>
<th>Hump</th>
<th>Neck</th>
<th>Shoulder</th>
<th>Mammary gland</th>
<th>Hind &amp; fore limbs</th>
<th>Brest pad</th>
<th>Chest</th>
<th>Other</th>
<th>Internal* abscesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Port Sudan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Sudan city</td>
<td>51</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Vet. clinic</td>
<td>15</td>
<td>15</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vet. quarantine</td>
<td>143</td>
<td>70</td>
<td>1</td>
<td>8</td>
<td>14</td>
<td>5</td>
<td>22</td>
<td>6</td>
<td>9</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Livestock market</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>186</td>
<td>275**</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>270</td>
</tr>
<tr>
<td>Alzareab</td>
<td>13</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alshahinat</td>
<td>5</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 -Elgonoub and Elaolib Salum</td>
<td>32</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Hoshiry</td>
<td>7</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Klaneab</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aros</td>
<td>39</td>
<td>10</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arbat</td>
<td>44</td>
<td>10</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 -Suakin</td>
<td>54</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4-Gabeat Madden</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 -Sinkat</td>
<td>14</td>
<td>5</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 -Haya</td>
<td>6</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 -Dordeab</td>
<td>11</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>206(72.85)</td>
<td>72(4.79)</td>
<td>18(3.92)</td>
<td>5(7.62)</td>
<td>18(3.92)</td>
<td>5(11.98)</td>
<td>5(1.08)</td>
<td>18(3.92)</td>
<td>270(58.82)</td>
<td></td>
</tr>
</tbody>
</table>

* Internal abscesses were explained in Table (16).

** More than one lesions were found in the same camels.
3.9 Contagious skin necrosis:

Out of 6964 camels examined in the Red Sea State, 3(0.04%) were found to be affected with contagious necrosis. It is characterized by skin necrosis, abscessation, sinus formation and enlargement of local lymph node. The lesion starts as painful swelling after which the skin become hard and dry and then the dead centre separated from surrounding skin leaving an ulcer with pus formation.

Out of 15 cases examined at the veterinary clinic one case of contagious skin necrosis (6.6%) was diagnosed. A second case was found in Salum area north Port Sudan city constituting 0.16% of animals examined. The last case was found in veterinary quarantine amounting to 0.03% of animals examined. The lesions occurred in different sites of the body including the neck, flank and hind limbs.

The bacterial isolates from this cases were *Staphylococcus species*, three isolates (50%); *Corynebacterium spp*, one isolate (16%); *Ecoli*, one isolate (16%) and *Actinomyces spp*, one isolate (16%). The predominant bacteria species was *Staphylococcus species* either as pure isolates or in mixed cultures.

3.10 Tick infestations:

The ticks infest soft part of the skin and attach themselves under the dock of the tail, in the perineum, inguinal and lower neck regions. Few ticks were found on the head, ears, the base of tail and hump. Infestation by ticks was sometimes heavy and caused slight bleeding or pustule at the site of biting.

3.11 Results at slaughterhouse:

Since the only slaughterhouse in the Red Sea State available is in Port Sudan city, all the samples were taken from it. The abscesses were
diagnosed in the live animals (antimortem examination) and in slaughtered camels, particularly the lymph nodes. Abscesses were diagnosed in 186 (64.8%) out of 287 camel examined (Table 2). The organs most frequently affected were the lung, liver and lymph nodes.

36.3% of total slaughtered camels were 2-3 years old and 63.6% were more than 3 years; up to 15 years.

3.11.1 Antimortem inspections:

287 camels were examined visually and carefully for various pathological lesions. Fifteen camels (5.22%) were found to be affected with abscesses in superficial part of the live animals and five samples (1.74%) were collected from affected ones.

3.11.2 Postmortem inspections:

At postmortem, many body lymph nodes were variable enlarged and congested with or without pus formation (Table 13). Multiple large abscesses were also found in internal organs particularly the lungs and liver (Figure 16 and 17). The abscesses were encapsulated by a relatively thick connective tissue capsule.

A total number of 275 abscesses were encountered in 186 camel carcasses. 44 (16.29%) abscesses were found in the lung, 24 (8.88%) in the liver parenchyma and 202 (73.45%) in the lymph nodes.

The distribution of the 202 abscesses found in the lymph nodes was as follows: 19 (6.9%) parotid, 21 (7.6%) submandibular, 18 (6.5%) retropharyngeal, 33 (12%) ventral superficial cervical, 6 (2.18%) dorsal superficial cervical, 8 (2.9%) superficial inguinal, 19 (6.9%) supramammary, 16 (5.8%) popliteal, 2 (0.72%) tuberal, 40 (14.5%) bronchial, 20 (7.27%) hepatic lymph nodes (Table 13 and Figure 18).
Figure (16): Camel lung: showing a large abscess.

Figure (17): Camel lung: showing a small abscess about to rupture.
3.11.2.1 Type of samples:

3.11.2.1.1 Lymph nodes:

Samples were taken from abnormal lymph nodes and apparently normal ones. 202 different lymph nodes were cultured; 60 (29.7%) were found negative for bacterial growth and 142 (70.29%) were positive. 182 (64.5%) isolates were obtained. (Table 13 and Figure 18).

3.11.2.1.2 Lungs:

Out of the 287 camel carcasses examined, 44 (15.33%) lungs were affected with abscesses and 60 (21.9) isolates were obtained from them (Table 13 and Figure 16).

3.11.2.1.3 Livers:

Out of the 287 slaughtered camels, 186 livers were affected with abscesses and 24 (8.7%) of these were collected for culture. 16 liver samples gave bacterial growth (32 isolates) and 8 liver samples were found bacterial negative (Table 13 and Figure 18).
Table (13): Number of sample collected from slaughtered camels in Port Sudan slaughterhouse and positive bacterial growth.

<table>
<thead>
<tr>
<th>Location of lesion</th>
<th>No. of sample collected</th>
<th>-ve growth</th>
<th>Samples showed positive bacterial growth</th>
<th>Total isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
<td>%</td>
</tr>
<tr>
<td>Superficial abscesses</td>
<td>5</td>
<td>1(0.36)</td>
<td>4</td>
<td>1.45</td>
</tr>
<tr>
<td>Lung</td>
<td>44</td>
<td>3(1.09)</td>
<td>41</td>
<td>14.9</td>
</tr>
<tr>
<td>Bronchial LN</td>
<td>40</td>
<td>8(2.9)</td>
<td>32</td>
<td>11.6</td>
</tr>
<tr>
<td>Liver</td>
<td>24</td>
<td>8(2.9)</td>
<td>16</td>
<td>5.8</td>
</tr>
<tr>
<td>Hepatic LN</td>
<td>20</td>
<td>6(2.18)</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Supramammary LN</td>
<td>19</td>
<td>4(1.45)</td>
<td>15</td>
<td>5.45</td>
</tr>
<tr>
<td>Parotid LN</td>
<td>19</td>
<td>7(2.54)</td>
<td>12</td>
<td>4.36</td>
</tr>
<tr>
<td>Mandibular LN</td>
<td>21</td>
<td>10(3.63)</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Retropharyngeal LN</td>
<td>18</td>
<td>8(2.9)</td>
<td>10</td>
<td>3.63</td>
</tr>
<tr>
<td>Ventral superficial cervical node</td>
<td>33</td>
<td>5(1.8)</td>
<td>28</td>
<td>10.18</td>
</tr>
<tr>
<td>Dorsal superficial cervical node</td>
<td>6</td>
<td>4(1.45)</td>
<td>2</td>
<td>0.72</td>
</tr>
<tr>
<td>Superficial inguinal</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>1.45</td>
</tr>
<tr>
<td>Popliteal</td>
<td>16</td>
<td>3</td>
<td>13</td>
<td>4.72</td>
</tr>
<tr>
<td>Tuberal LN</td>
<td>2</td>
<td>1(1.8)</td>
<td>1</td>
<td>0.36</td>
</tr>
<tr>
<td>Total</td>
<td>275</td>
<td>72(26.18)</td>
<td>203</td>
<td>73.81</td>
</tr>
</tbody>
</table>

*Number between brackets indicated percentage.
- ve = Negative.
Figure (18): Distribution of the abscesses and the bacterial isolates in a live and slaughtered camels at Red Sea State - Sudan.
3.12 Port Sudan slaughterhouse record:

Information about the causes of condemnations in slaughtered camel at Port Sudan city were obtained from the slaughterhouse records and the records of the Animal Resources Administration, the Red Sea State during the period (2003-2008). Various causes of total and partial condemnations were recorded including: abscesses, calcification, congestion, liver cirrhosis, parasites, adhesions, necrosis, haematoma, pneumonia and other lesions (Table 14).

The condemnation records showed that out of 2527 slaughtered camels, 14 (0.55%) was totally condemned and in 1628 (64.2%) there was partial organ condemnation. Partial condemnations due to abscesses in lungs, livers, hearts, hind limb, fore limb and head were explained in Table (14) and Figures (19, 20, 21 and 22).
Table (14): Total and partial condemnations of slaughtered camel at Port Sudan slaughterhouse (Annual Report 2003 - 2008).

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of total slaughtered camel</th>
<th>Total condemnations due to</th>
<th>Partial condemnations</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>♂</td>
<td>♀</td>
<td>abscess</td>
</tr>
<tr>
<td>2003</td>
<td>231</td>
<td>143</td>
<td>88</td>
<td>0</td>
</tr>
<tr>
<td>2004</td>
<td>466</td>
<td>153</td>
<td>313</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>625</td>
<td>210</td>
<td>415</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>480</td>
<td>288</td>
<td>192</td>
<td>0</td>
</tr>
<tr>
<td>2007</td>
<td>398</td>
<td>191</td>
<td>207</td>
<td>0</td>
</tr>
<tr>
<td>2008</td>
<td>327</td>
<td>152</td>
<td>175</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>2527</td>
<td>1137</td>
<td>1390</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td>44.99</td>
<td>55</td>
<td>0.55</td>
<td>0.18</td>
</tr>
</tbody>
</table>
Figure (19) : Frequency of partial condemnations due to absceses or other lesions at Port Sudan slaughterhouse during the period 2003 - 2008.

Figure (20) : Frequency of partial condemnations in different sites in slaughtered camels at Port Sudan slaughterhouse during the period 2003 - 2008.
Figure (21): Frequency of partial condemnations due to abscesses or other lesions in females and males at Port Sudan slaughterhouse during the period 2003 - 2008.

Figure (22): Distribution of partial condemnations due to abscesses or other lesions at slaughtered camels at Red Sea State - Sudan.
3.12.1 Frequency of camel abscesses according to total and partial condemnation incidence in the slaughterhouse:

Various pathological lesions have been associated with total and partial condemnations in camels at meat inspection. The main lesions are shown in Table (14). Statistical analysis of data is shown in Table (15). The highest mean partial condemnations due to abscesses or other reasons were seen in the lungs and livers. Condemnation due to other reasons was higher than that due to abscesses.

The condemnation of the hind limb was mainly due to presence of abscesses and was significantly higher than condemnations due to other reasons.

The data presented in Table 16 indicate that the mean percent of partial condemnation due to lesions other than abscesses (37.2±8.05) was significantly higher from the mean condemnation due to abscesses (7.55±8.05).

Table (17) illustrates the mean percent and the standard error of condemnation because of lesions in lungs (95.0±13.9) and livers (24.4±13.9) which were both significantly higher than condemnations resulting from lesions in the hind limb (5.833±13.9), heart (5.91±13.9), head (2.16±13.9) and fore limb (1.16±13.9).
Table (15): Means and standard errors of partial condemnation due to abscesses or other reasons in slaughtered camels.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Cause</th>
<th>Abscesses</th>
<th>Other reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>Abscesses</td>
<td>0.500±19.727</td>
<td>3.83±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hind limb</td>
<td>Abscesses</td>
<td>7.167±19.727</td>
<td>4.50±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fore limb</td>
<td>Abscesses</td>
<td>0.67±19.73</td>
<td>1.67±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td>Abscesses</td>
<td>15.33±19.73</td>
<td>33.50±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td>Abscesses</td>
<td>21.33±19.73</td>
<td>168.67±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart</td>
<td>Abscesses</td>
<td>0.33±19.73</td>
<td>11.50±19.73</td>
</tr>
<tr>
<td></td>
<td>Other reasons</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (16): Means and standard errors of partial condemnation classified by the reason of condemnation.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Mean</th>
<th>S.E.</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Abscess</td>
<td>7.556a</td>
<td>8.053</td>
<td>-8.554</td>
</tr>
<tr>
<td>Other reasons</td>
<td>37.278b</td>
<td>8.053</td>
<td>21.169</td>
</tr>
</tbody>
</table>
Table (17): Means and standard errors of partial condemnation at Port Sudan slaughterhouse.

<table>
<thead>
<tr>
<th>Organ</th>
<th>Mean</th>
<th>S.D.</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>Overall mean</td>
<td>22.417</td>
<td>5.69</td>
<td>11.026</td>
</tr>
<tr>
<td>Head</td>
<td>2.167&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.949</td>
<td>-25.735</td>
</tr>
<tr>
<td>Hind limb</td>
<td>5.833&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.949</td>
<td>-22.069</td>
</tr>
<tr>
<td>Fore limb</td>
<td>1.167&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.949</td>
<td>-26.735</td>
</tr>
<tr>
<td>Liver</td>
<td>24.417&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.949</td>
<td>-3.485</td>
</tr>
<tr>
<td>Lung</td>
<td>95.000&lt;sup&gt;b&lt;/sup&gt;</td>
<td>13.949</td>
<td>67.098</td>
</tr>
<tr>
<td>Heart</td>
<td>5.917&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.949</td>
<td>-21.985</td>
</tr>
</tbody>
</table>
3.13 Bacteriological finding:

The species of bacteria isolated were identified and characterized according to Barrow and Feltham (1993). Colony morphology, cultural and biochemical characteristics were observed and recorded.

3.13.1 General characteristics of the isolates:

From 459 samples collected in Red Sea State (both field and slaughterhouse), 365 (79.5%) samples were positive for bacterial growth and 20.5% samples were negative. Out of a total 558 isolates, 351 (62.9%) were identified as Gram-positive bacteria and the rest (37.1%) Gram – negative bacteria (Table 18).

Only one type of bacteria was isolated from 199 (43.35%) samples, while 166 (36.35%) samples contained two types of bacteria. Table (19) and Figure (23) show the species of bacteria isolated.
Table (18): Bacterial isolates obtained from camel abscesses in the
Red Sea State -Sudan.

<table>
<thead>
<tr>
<th>Geographical location</th>
<th>Total No. of camels</th>
<th>No. with abscesses</th>
<th>No. of sample collected</th>
<th>-ve growth</th>
<th>+ve growth</th>
<th>Isolates Gram +ve</th>
<th>Gram -ve</th>
<th>Total isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Port Sudan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Port Sudan city</td>
<td>275</td>
<td>51</td>
<td>15</td>
<td>3</td>
<td>12</td>
<td>8</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Vet clinic</td>
<td>18</td>
<td>15</td>
<td>15</td>
<td>2</td>
<td>13</td>
<td>8</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>Vet quarantine</td>
<td>2879</td>
<td>143</td>
<td>70</td>
<td>8</td>
<td>62</td>
<td>79</td>
<td>33</td>
<td>112</td>
</tr>
<tr>
<td>Livestock market</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>287</td>
<td>186</td>
<td>275*</td>
<td>72</td>
<td>203</td>
<td>173</td>
<td>109</td>
<td>282</td>
</tr>
<tr>
<td>Alzareab</td>
<td>150</td>
<td>13</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Alshahinat</td>
<td>30</td>
<td>5</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2 -Elgonoub and Elaolib</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slum</td>
<td>622</td>
<td>32</td>
<td>11</td>
<td>1</td>
<td>10</td>
<td>13</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Hoshiry</td>
<td>44</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Klaneab</td>
<td>45</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Aros</td>
<td>396</td>
<td>39</td>
<td>10</td>
<td>1</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>Arbat</td>
<td>670</td>
<td>44</td>
<td>10</td>
<td>2</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td>3 -Suakin</td>
<td>812</td>
<td>54</td>
<td>19</td>
<td>3</td>
<td>16</td>
<td>16</td>
<td>5</td>
<td>21</td>
</tr>
<tr>
<td>4 -Gabeat Madden</td>
<td>46</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>5 -Sinkat</td>
<td>270</td>
<td>14</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>6 -Haya</td>
<td>30</td>
<td>6</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>7 -Dordeab</td>
<td>380</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>6964</td>
<td>630</td>
<td>459</td>
<td>94</td>
<td>365</td>
<td>351</td>
<td>207</td>
<td>558</td>
</tr>
</tbody>
</table>

*=More than one lesions were found in the same animals .
-ve = Negative
+ve = Positive
Figure (23) : Frequency of Gram +ve and Gram-ve bacteria isolated from camel abscesses at Red Sea State-Sudan
Table (19): Frequency and percentage of bacteria isolated from camel abscesses in the Red Sea State-Sudan.

<table>
<thead>
<tr>
<th>Type of isolates</th>
<th>Total isolates</th>
<th>Isolates from field</th>
<th>Isolates from slaughterhouse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td><strong>Staphylococcus species</strong></td>
<td>140</td>
<td>25.08</td>
<td>67</td>
</tr>
<tr>
<td><strong>Micrococcus species</strong></td>
<td>39</td>
<td>6.98</td>
<td>26</td>
</tr>
<tr>
<td><strong>Streptococcus species</strong></td>
<td>75</td>
<td>13.44</td>
<td>41</td>
</tr>
<tr>
<td><strong>Enterococcus species</strong></td>
<td>12</td>
<td>2.15</td>
<td>8</td>
</tr>
<tr>
<td><strong>Corynebacterium species</strong></td>
<td>22</td>
<td>3.94</td>
<td>10</td>
</tr>
<tr>
<td><strong>Kurthia species</strong></td>
<td>7</td>
<td>1.25</td>
<td>0</td>
</tr>
<tr>
<td><strong>Actinomyces species</strong></td>
<td>2</td>
<td>0.35</td>
<td>0</td>
</tr>
<tr>
<td><strong>Bacillus species</strong></td>
<td>54</td>
<td>9.67</td>
<td>26</td>
</tr>
<tr>
<td><strong>Escherichia species</strong></td>
<td>92</td>
<td>16.48</td>
<td>43</td>
</tr>
<tr>
<td><strong>Acinetobacter species</strong></td>
<td>7</td>
<td>1.25</td>
<td>5</td>
</tr>
<tr>
<td><strong>Moraxella species</strong></td>
<td>15</td>
<td>2.68</td>
<td>6</td>
</tr>
<tr>
<td><strong>Pseudomonas species</strong></td>
<td>1</td>
<td>0.17</td>
<td>0</td>
</tr>
<tr>
<td><strong>Pasteurella species</strong></td>
<td>2</td>
<td>0.35</td>
<td>0</td>
</tr>
<tr>
<td><strong>Vibrio species</strong></td>
<td>11</td>
<td>1.97</td>
<td>5</td>
</tr>
<tr>
<td><strong>Citrobacter species</strong></td>
<td>7</td>
<td>1.25</td>
<td>2</td>
</tr>
<tr>
<td><strong>Klebsiella species</strong></td>
<td>19</td>
<td>3.4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Proteus species</strong></td>
<td>30</td>
<td>5.37</td>
<td>15</td>
</tr>
<tr>
<td><strong>Enterobacter species</strong></td>
<td>18</td>
<td>3.22</td>
<td>7</td>
</tr>
<tr>
<td><strong>Shewenella species</strong></td>
<td>5</td>
<td>0.89</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>558</td>
<td>-</td>
<td>276</td>
</tr>
</tbody>
</table>
Bacteria isolated included:

3.13.2 Gram –positive bacteria:

A total of 351 (62.9%) bacterial isolates recovered from samples. 140 (39.88%) of them were *Staphylococcus* species, 75 (21.36%) *Streptococcus* species, 39 (11.11%) *Micrococcus* species, 12 (3.41%) *Enterococcus* species, 22 (6.26%) *Corynebacterium* species, 7 (1.99%) *kthuria* species, 2 (0.56%) *Actinomyce* species and 54 (15.38%) *Bacillus* species (Table 20).

3.13.2.1 *Staphylococcus*:

*Staphylococcus* represented the majority of isolates, it amounting to 140 isolate (25%). Out of these, 74(52.9%) isolates were coagulase – positive and 66 (47.1 %) were coagulase –negative. The frequency of *Staphylococcus* species isolated is shown in Figure (24).

3.13.2.1.1 Coagulase –positive *Staphylococci*:

Coagulase –positive Staphylococci represented the majority of *Staphylococcus* spp 74 (52.9%). On blood agar were grayish, white, smooth and produced β – haemolysis.

3.13.2.1.2 Coagulase –negative *Staphylococci*:

These represented 66 (47.1 %) of total *Staphylococcus* spp isolates. On blood agar, ranged from grayish creamy to yellowish white. Haemolysis varied from non to β–haemolysis. These organisms were fermentative catalase positive.

3.13.2.1.3 Colonial characteristics:

The organisms were isolated from external and internal abscesses. They grew well, on 10% sheep blood agar and colonies usually appeared in 24 hours. These were round, smooth and glistening. Growth was achieved on ordinary media incubated aerobically at 37°C.
3.13.1.2.4 Pigmentation:

Colonies were yellow to green in colour or occasionally white; on nutrient agar the colonies were white or creamy in colour. *Staphylococcus aureus* strains usually golden. Yellow pigment, the *Staphylococcus intermedius* and *Staphylococcus hyicus* are also pigmented

3.13.1.2.5 Morphology:

The organisms were seen as Gram-positive cocci, mainly arranged in clusters, but also found in pairs or singly. In blood agar incubated aerobically at 37°C the organisms produced white, yellow or grey colonies. They were non-motile, non–spore forming, aerobic and facultative anaerobic.

3.13.1.2.6 Biochemical properties:

The biochemical properties of the organisms were catalase – positive, oxidase – negative (except three species), acid without gas.

3.13.1.2.7 Haemolysis:

On blood agar, partial and complete haemolysis were seen in haemolytic strains. Zones of haemolysis were seen more clearly when cultures were incubated under CO₂ tension.
Figure (24): Frequency of *Staphylococcus species* isolated from camel abscesses at Red Sea State–Sudan.
Table (20): Frequency and percentage of Gram-positive bacteria species isolated from camel abscesses at Red Sea State-Sudan.

<table>
<thead>
<tr>
<th>type of isolates</th>
<th>No. of total isolates</th>
<th>Isolates from field investigation</th>
<th>Isolates from slaughterhouse</th>
<th>Percentage of total Gram +ve&amp;-ve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Staphylococcus species</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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Continue Table 20
3.13.2.2 Streptococcus:

The *Streptococcus* species amounted to 75 (13.44%) from total isolates. Some of them were obtained in mixed culture with *Staphylococcus* species 25 (33.33%). From total isolates 16 (2.86%) *Streptococcus agalactiae*, 20 (3.58%) *Streptococcus faecalis*, 6 (1.07%) *Streptococcus pneumoniae*, 20 (3.58%) *Streptococcus* pyogenes and 13 (2.32%) *Streptococcus anginosus* (Table 20).

3.13.2.2.1 Colonial characteristics:

The colonies were small, smooth, glistening and shiny, regular and semi transparent and dew –drop like.

3.13.2.2.2 Morphology:

The *Streptococcus* species were Gram – positive, non-motile, non-sporing, cocci occur in pairs or chains of varying lengths.

3.13.2.2.3 Haemolysis:

On blood agar incubated aerobically at 37 C° it produced small pale haemolytic colonies; differentiation of the Streptococi by the type of haemolysis which were β or α.

3.13.2.3 Corynebacterium:

The numbers of isolates were 12 (2.15%) from the total isolated and 3. 4% of total Gram- positive isolates. *Corynebacterium* species are Gram –positive small pleomorphic rods (small rad or coccobacilli) arranged in palisades. They are aerobic, non –motile, irregular swellings at one end give the organisms a club –shaped and arranged in a Chinese letter slender or curved rods.

3.13.2.3.1 Colonial characteristics:

On sheep blood agar the colonies are small, white, dry and produced β-haemolysis.
3.13.2.4 Micrococcus:

The organisms represented 39 (6.9%) from total isolate and (11.11%) of the total Gram-positive isolates. They are Gram –positive, spherical, arranged in pairs, tetrads or in small clusters.

3.13.2.4.1 Colonial morphology:

Morphologically it was similar to *Staphylococcus* spp but it differed in the biochemical proprieties. The *Micrococcus* spp was found as an obligate aerobic and produced yellow, small, round, glistening and non-haemolytic colonies.

3.13.2.5 Actinomyces:

These organisms represented 0.35 % of the total isolates and 0.56 % of the Gram-positive bacteria.

3.13.2.5.1 Colonial morphology:

The morphology of the organisms showed Gram .positive, growth improved by CO₂ and on 10 % blood agar, non acid fast, small, pleomorphic rods, produced small moist grayish colonies surrounded by a zone of β-haemolysis.

3.13.2.6 Bacillus:

*Bacillus species* are large, Gram –positive, endospore forming rods.

3.13.2.6.1 Colonial characteristics:

The colonies were large, flat and there was a clear zone of β-haemolysis on sheep blood agar. This genus represented 9.67% of total isolates and 15.38% of the Gram- positive bacteria.

3.13.3 Gram –negative bacteria:

The Gram - negative isolates represented 207 (37.1%) of isolates recovered from field investigation and slaughtered camels. The organisms were identified as 92 (44%) *Escherichia specie*, 30 (14.49%) *Proteus species*, 19(9.17%) *Klebsiella species*, 18 (8.96%) *Enterobacter species*,...
15(7.24%) Moraxella species, 11(5.31%) Vibrio species, 7 (3.38%) Actinobacter species, 5(2.41%) Shewenella species, 2(0.96%) Pasteurella species, 7(3.38%) Citrobacter species and 1(0.48%) Pseudomonas species (table 21).

3.13.3.1 Escherichia:

These are Gram –negative rods, they IMVC (Indole +/-MR + /VP- /Citrate-) is a group to test which are useful as mean of distinguishing Escherichia coli from other members of the other group.

3.13.3.1.1 Colonial characteristics:

The colonies were circular, convex and smooth with entire edges. On EMP media they are highly pigmented and have a metallic green .On MacConkey's agar Escherichia coli fermented lactose producing pink colonies.

3.13.3.2 Proteus:

Proteus species were Gram –negative straight rods, pleomorphic, motile and non-sporing.

3.13.3.2.1 Colonial characteristics:

On blood agar and other solid media the isolates produced characteristic swarming over the surface of the media causing spreading of their colonies over the media, often obscuring other organisms. On MacConkey's agar produced individual pale yellow, non-lactose fermenting colonies after overnight incubation. It rapidly hydrolyzes urea, and this test differentiates proteus from other Enterobacteria. 30 (14.49%) isolation were achieved during this study.

3.13.3.3 Pseudomonas:

Pseudomonas species were growing well on 10% blood agar.

3.13.3.3.1 Colonial characteristics:

Pseudomonas species produce radiating with raised center, mucoid, metallic to blackish grey α –hemolytic colonies.
3.13.3.4 *Klebsiella:*

*Klebsiella species* is a small non-motile, non-sporing, Gram-negative bacillus with rounded ends, occur in pairs single and in short chain.

3.13.3.4.1 **Colonial characteristics:**

On blood agar they produced large grey–white colonies, usually mucoid colonies on MacConkey's agar.

3.13.3.5 *Moraxella:*

*Moraxella species* are short, plump, Gram–negative rods, characteristically in pairs, oxidative, oxidase positive, non-motile and do not attack carbohydrates.

3.13.3.6 *Vibrio:*

*Vibrio species* are recognised as short, non–flexuous curved rods. They are Gram–negative and mostly motile having polar flagella.

3.13.3.6.1 **Colonial characteristics:**

*Vibrio species* produced small, mucoid, grayish white and non-hemolytic colonies.

3.13.3.7 *Pasteurella:*

The growth morphology of the *Pasteurella species* in the blood agar, incubated aerobically at 37 C was small Gram–negative rods or coccobailli non-sporing, fermentative. Exhibited bipolar staining and β-haemolytic, round, non motile, mucoid blackened the blood agar in old culture. Only two isolates (0.96%) of these organisms were obtained.

3.13.3.8 *Entrobacter:*

*Enterobacter species* were small pleomorphic rods, fermentative and grow in MacConkey’s media.

3.13.3.8.1 **Colonial characteristics**

Colonies were minute, metallic white, mucoid and non haemolytic.
Table (21): Frequency and percentage of Gram-negative bacteria species isolated from camel abscesses at Red Sea State – Sudan.

<table>
<thead>
<tr>
<th>Type of isolates</th>
<th>No. of total isolates</th>
<th>Isolates from field investigation</th>
<th>Isolates from slaughterhouse</th>
<th>Percentage of total Gram–ve &amp;+ve</th>
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<td></td>
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<td>%</td>
<td>No.</td>
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3.14 Pathological finding:

3.14.1 Lymph nodes:

3.14.1.1 Gross description:

The abscesses were found involving lymph nodes only, their consistency was caseous and granular, hard or calcified. In many cases affected lymph nodes were markedly enlarged, caseated and encapsulated with fibrous capsules.

3.14.1.2 Histopathological finding:

Some lymph nodes showed lymphoid depletion and wide area of fibrosis (Figures 26 and 27).

Many sections of affected lymph nodes showed areas of caseous necrosis with fragmented nuclear debris surrounded by a thin zone of macrophages. Affected lymph nodes also showed necrosis of lymphoid follicles surrounded by neutrophils (Figure 28).
Figure (25). Lymph node camel showing lymphoid depletion and congestion. (H &E x 250)

Figure (26). Lymph node camel showing lymphoid depletion. (H &E x 250)
Figure (27). Lymph node camel showing widening trabeculae and strangled lymphoid tissue. (H &E x 250)

Figure (28). Lymph node camel showing lymphoid follicles with necrotic center. (H &E x400).
3.14.2 Lungs:

3.14.2.1 Gross description:

44 lungs from slaughtered camels at Port Sudan slaughterhouse showed the presence of one or several abscesses close to each other or scattered throughout the lung tissue surrounded by a hyperemic zone. These abscesses contained thick pus. The distribution of the abscesses was variable. In most instances, the apical lobes were affected.

3.14.2.2 Histopathological finding:

In section prepared from the affected lungs, multiple small abscesses were seen in the lung's parenchyma. Many bronchioles were surrounded by large number of inflammatory cells composed of lymphocyte, neutrophils and macrophage. The abscesses showed necrotic center with nuclear debris, surrounded by neutrophils and outer most by fibrous tissue capsule (Figure 29). Other areas of lung tissue showed fibrosis and emphysema (Figure 30 and 31), elongated compressed bronchial epithelium (Figure 32 and 33) and calcified areas (Figure 34 and 35).
Figure (29). Lung camel showing severe necrosis (N) and fibrosis (F). (H &E x 250)

Figure (30). Lung camel showing fibrosis (F) and emphysema (E). (H &E x 250)
Figure (31). Lung camel showing fibrosis (F) and emphysema (E). (H & E x 250)

Figure (32). Lung camel showing collapsed airways. (H & E x 250)
Figure (33). Lung camel showing inner zone of necrosis and fibrosis with collapse surrounded lung tissue (H & E x 250)

Figure (34). Lung camel showing severe necrosis and calcification. (H & E x 250)
3.14.3 Livers:

3.14.3.1 Gross description:
In this study of liver abscess in slaughtered camels was diagnosed in 24 (8.36%) out of the 287. The abscesses were often seen projecting from the liver surface and occasionally deeply situated in the liver parenchyma. They were either small, seen as pale yellowish nodules with weak connective tissue capsule or as large abscesses surrounded by thick capsule.

3.15.3.2 Histopathological finding:
Different types of tissue reaction were observed characterized by degenerative changes or inflammatory cells infiltration. The abscesses consisted of necrotic tissue, which appeared pink in colour, and surrounded with fibrous tissue capsule and zone of slight cellular infiltration with calcification in the center. The surrounding liver tissue was degenerated, compressed and atrophied with dilation of sinusoid. Increased interlobular septa, widening and fibrosis of portal area were also seen (Figure 35). Some liver showed typical abscesses (Figures 38), vacuolar degeneration (Figures 39) and showing leucocytic foci, it could be a growing abscess (Figure 40).
Figure (35). Liver camel showing fibrosis and widening of portal area and increased interlobular septa. (H & E x 100)

Figure (36). Liver camel showing vacuolar degeneration (V) and fibrosis (F). (H & E x 250)
Figure (37). Liver camel showing hepatocyte vacuolar degeneration (fatty change). (H &E x400)

Figure (38). Liver camel showing typical mature abscesses (H &E x 250)
Figure (39). Liver camel showing fibrosis of portal area and vacuolar degeneration. (H & E x 250)

Figure (40). Liver camel showing leucocytic foci, it could be a growing abscess (H & E x250)
Discussion

Camel is an important domestic animal in Sudan and forms a major part of total livestock population in certain geophysical region of the Red Sea State. Because of its wide range of adaptability, the camel is serving in almost all types of environments; in remote and difficult area in sandy desert and dry mountainous areas in the Red Sea State.

Camel has been for long a neglected species of domestic animals, concentrated efforts as well as intensive investigation on their disease problems have been carried out but they have not been boosted for the greater potentials of the camel in term of meat, milk and hide production. Beside the significant tolerance to water shortage in desert areas which constitutes the majority of the Red Sea State, camel rearing might have the potential to become of a pivot in economic activities in the area.

Camels are the backbone of the Beja pastoralist's economy and also central to their culture. Camel milk is a key ingredient in their diet and almost the source of protein exclusive when absent meat and vitamins. Cash is received from camels sold in the animal markets in Egypt and in racing markets in the Gulf area. Exportation of camels has been one of the sources of the country's foreign exchange. For the last period (2003-2008) about 266,541 camel were exported to Saudi Arabia (42,520 camel) and Egypt (224,021 camel) (Reports of Veterinary Quarantine, 2008). Idris (2003) reported that the Egyptian market is the main market for Sudanese camels. About 200,000 camels are exported (and smuggled) to Egypt annually and small number is exported to the Gulf Countries for racing.

Drought and desertification that hit the Sudan source years ago did not cause any harm in camel population and their number was even
increased due to the reduction of the competitors on ranges. For these reasons, camels have intensely got attention as a substitute for other vulnerable animal species. Beside the camels feed on a variety of wild plants that many other animals avoid, such as dry thorn and salty plants.

In Sudan very little information about the local breed of camels and their health problems is available especially in Red Sea State. This may be due to the non-sedentary nature of the herds, constantly moving in search of grazing and water, with shortage of veterinary services.

Camel diseases are always accompanied by heavy economic losses, mainly due to fatalities, loss of productivity as well as the high cost of compulsory medication required for the infected animals.

Literature on the prevalence and etiology of camel abscesses in the Sudan seems to be limited in comparison with that on other animal species. The work undertaken here was carried out to survey the microorganisms causing abscesses in live and slaughtered camels and their public health significance. Pus from ruptured abscesses may be a source of infection to the other animals and contaminates their surroundings (feed and water). Abscesses affect camel’s exportation, cause sizable economic loss and therefore require adequate control.

In the present study, camels abscesses were investigated for the first time in Red Sea State where large numbers of camels were reared (202,106 heads, Anon, 2002).

Camel abscesses constitutes a problem facing the camel exporters and leads to substantial decrease in the local market value of camel and degrade the quality of skin. In addition it might constitute a public health hazard especially in rural area where raw camel meat, like liver, is consumed.
It is worth mentioning that taking samples from live camels is very difficult because pastoralists usually refuse to allow any stranger to approach them.

6964 camels were surveyed in seventeen different areas in Red Sea State for the prevalence of camel abscesses. 630 (9 %) of the surveyed camels had abscesses. The highest percentage of external abscesses was found in slaughtered camels (29.52%) followed by camels examined at the veterinary quarantine (22.69%). 83.3% of the camels, brought to the clinic had abscesses.

186 out of 287(64.8 %) of slaughtered camels had abscesses. Camels brought for slaughter, especially older ones, may have chronic infections (i.e. pneumonia) and internal parasites, and abscesses are often accidentally diagnosed in these animals. The same was observed by Bekele (2008) who diagnosed pulmonary abscesses (3.85%) among other pulmonary lesions in camels from Eastern Ethiopia.

Moreover, camel meat consumption in the Red Sea State is not high and slaughtering of camels is a mean of culling. Approximately 40-50 camels are slaughtered monthly in Port Sudan abattoir (Annual reports, 2008) for culling.

The present investigation indicates that, all ages are susceptible to abscesses, but the older camels have greater opportunity of acquiring abscesses. This confirms what was reported by Nasr (2003) who noticed that older camels with poor general condition were more susceptible to respiratory infections which were usually chronic, while younger camels showed respiratory signs without any lung lesions. Similarly, Mustafa (1992) reported that older camels were the most affected with pneumonia than young ones in different regions in the Sudan, especially in animals with poor health status. Islam (2003) reported similar results during her
investigation on pathological change in camel lungs in Khartoum State. She found that the older animals are more exposed to various infections.

In the present study, external abscesses constituted 6.6 % (444 out of 6677) and this was similar to the findings of Agab and Abbas (1998) who found the percentage of camel abscesses and wounds in Butana region, to be 8.4% (315 out of 3731). The result of this study also agrees with those reported in Egypt by Ali (1999) who reported abscesses in 6.29 % (22 out of 350) of the camels examined in Egypt. Also the present results agree with the results obtained by Agab (2006) who reported high incidence of skin wounds and abscesses in intensively kept dromedary camel in dairy farms in Saudi Arabia. Also Ali, et al. (2001) reported 4.44% prevalence of cutaneous abscesses in camels in Egypt.

The most frequently affected lymph nodes in this study were ventral superficial lymph nodes but the lesions were also observed in the shoulder, fore legs and hind legs. This agrees with Younan, et al. (2007) who examined camel calves in Kenya and found the abscesses to be located around the elbow, tarsus, carpus, knee and fetlock joints.

Al-Ani, Sharrif, Al-Rawashdeh, Al-Qudah and Al-Hammi (1998) reported that singular or multiple skin abscesses were commonly seen in camels. Caseous lymphadenitis was diagnosed quite frequently in camels and skin wounds of varying degrees were seen on different part of the body.

Abubakr, et al. (1999) reported sporadic cases of subcutaneous localized abscesses due to *Corynebactrium species*, in camels and these were found in the prescapular area, pectoral region, head, neck, hind limbs, shoulder and flank; similar sites were reported in the present study. Also Ali, et al. (2001) examined camels clinically in Egypt, and observed cutaneous abscesses in the lower mandible and upper thigh. Abscesses were also seen in sheep in Sudan. Hamad (1989) observed that
12.6 % of slaughtered sheep abscesses, most commonly seen, in order of frequency, in the mandibular, parotid, prescapular and popliteal lymph nodes.

The abscesses in camels might be attributed to drinking contaminated water from stagnant pool, which is used by many camels. This was supported by the observation of Maddy (1953) who stated bronchial and mediastinal lymph nodes might be affected primarily in case of ingestion or inhalation of infections bacteria which cause abscesses.

According to our results most of the ticks were found on the under the dock of the tail, in the perineum ,inguinal and lower neck regions . Fewer ticks were found on the head and ears ,the base of tail and hump. These results agrees with that obtained by Richard (1979) and Hawari (2008) who conducted study in Jordan, during outbreak of natural *Corynebacterium species* infection in camels , he found that 8 % of camels affected with multiple muscle and subcutaneous abscesses at various sited of the body. The camels were also heavily infested with ticks.

In this study ticks were seen in camels with external abscesses, in a different sites of the camel body, these finding are similar to finding by many authors (El-Amrousi , *et al.*,1986; Mustafa, 1987; Agab and Abbas 1998; Tibary and Anouassi, 2000 and Kane, *et al.*,2003).

The present study, showed that from 6964 camel examined three (0.04 %) was diagnosed as contagious skin necrosis. The disease characterized by a swelling that may burst leaving a discharge sinus, cutaneous abscesses which might discharge pus intermittently for months. Such lesions were found in the neck, flank and hind limbs. This result is comparable to that of Yagoub and Mohamed (1996) and Agab and Abbas (1998) who investigated the disease in Butana area of mid-western Sudan.
and found that 5.75 % (131 out of 2284) and 2.5 % (96 out of 1305) camels were affected with contagious skin necrosis, respectively. In this study the percentage of the disease was lower than that found in Butana which may be due to the difference in between two areas, as desert covers about one third of the total area of the Red Sea State.

Domenech, et al., (1977) reported that the disease affects mainly the growing camels. Al-Ani (1989) reported that camels of all ages were susceptible to the disease; adult camels being more susceptible. These results were found compatible with our results where the three diseased camels were adults (10-12) years old.

Previous studies have shown that the microorganism that were isolated from lesions in camels were *Staphylococcus* spp, *Corynebacterium* spp, *E.coli* and *Actinomyces* spp. This is in agreement with many authors who isolate the same bacteria (Cross 1917; Leese, 1927; Curasson, 1936; Demenech, et al., 1977; Nasr, 2003; Younan, et al., 2007).

Edelsten and Pegram (1974) reported a mild and less contagious skin necrosis in camels associated with *Streptococcus agalactiae*. They attributed the less severe necrosis to the fact that bush camels living under extensive conditions; ingest sufficient salt in their free diet to prevent the development of severe form of the disease. These results were found compatible with other authors (Cross, 1917 and Leese, 1927).

In the Sudan, there are public old slaughterhouses and modern abattoirs. Port Sudan slaughterhouse are classified as old ones and It is under direct supervision of the municipality of Red Sea State (Port Sudan Central Locality).

Old slaughterhouses are not provided with laboratories, and mostly lack proper hygienic measurements. This may contribute to the high bacterial load of meat.
The condemnation records obtained during the period 2003-2008 in Port Sudan slaughterhouse showed that the mean percent of partial condemnation due to abscesses was significantly lower than that due to other lesions.

In this study, the ventral superficial cervical lymph nodes were found to be the most frequently affected. This could be attributed to traumatic injuries and wounds inflicted during browsing. Thorns and sharp objects inflict scratches and wound which constitute the infection atrium. These finding are supported by most of the workers who showed that the ventral superficial lymph nodes were most common site for abscessation (Maddy, 1953; March, 1965 and Agab and Abbas, 1998).

Our result revealed that out of 202 affected lymph nodes, 21 (10.3 %) were mandibular. The infection might have been facilitated through injuries to the buccal mucosa during mastication of food (Wooddruff and Oxer, 1929).

In Saudi Arabia, ALhendi, EL Sanousi, AL-Ghasnawi and Madawi (1993) found abscesses affecting superficial lymph nodes of mainly those of the head, neck and shoulder. Their result agrees with the finding of the present study and those obtained by Fuente and Suarez (1985) and Hamed (1989).

The results of bacteriological examination of 202 lymph nodes revealed that 142 samples gave bacterial isolates. This finding agrees with the result reported by Mohamed (1992) who isolated bacteria from 89.2 % of the samples collected from camel lymph nodes at Tambul area and from all samples collected (100 %) at E Gedaref slaughterhouse. Also Adam (1989) conducted bacterial study of the bovine lymph nodes in the Sudan, 197 out of 272 (72.4 %) of lymph nodes examined showed bacterial growth.
EL Hag (2000) carried out a study on aerobic bacteria in lymph nodes of goats slaughtered at Omdurman abattoir. He isolated different species of bacteria from 83.46% of the samples.

Organisms from lymph nodes could gain access to the circulation and cause liver infection. It is worth mentioning that many of the organisms isolated from the livers of camel in this study had also been isolated by Mohamed (1992) from camels which had mastitis, pneumonia and other infections.

Lung lesions, and especially abscesses, are common problems in all domestic animals. The pulmonary abscesses found here were seen as multiple abscesses close to each other or as single abscesses on each lung filled with cheese like viscid pus. Pneumonia associated with cough was the most commonly observed disease in camels and was associated with abscess formation caused by different species of bacteria. This agrees with Shigidi (1973) who reported that bacteria can infect the respiratory tract of camels causing lung abscesses. The microorganisms present in the respiratory tract as commensal can play a pathogenic role when the general resistance of the host is lowered.

Lungs abscesses follow attacks of pneumonia if it is not treated or if partially treated and the camel was under work stress. In the beginning the camel may not show any symptoms except general weakness and fatigue. At this stage high number of lungs abscesses may be detected at post mortem examination in apparently healthy camels.

The number of condemned lungs in Port Sudan slaughterhouse exceeded 1140 during the years 2003-2008 (Annual Reports of the Animal Resources Administration, the Red Sea State, 2003-2008). The reason for the condemnation included inflammation, hypostatic congestion and abscesses. Mustafa (1992) found 96 pneumonic cases
among 125 camels examined at antemortem and at postmortem, sometimes with abscesses formation.

In Jordan Al-Tarazi (2001) observed lung abscesses in 10.2 % (No= 284) of slaughtered camels examined postmortem for presence of pneumonia. Suliman (2003) reported pulmonary abscesses in slaughtered camels during his study on respiratory tract infections in Tamboul, Sudan.

In the present study, lung abscesses were found in 44 out of 287 (15.33 %) animals examined. Al-Tigani (2003) reported that the main causes of lung condemnation in Tamboul were presence of parasites, pneumonia, necrosis, fibrosis and abscesses with corresponding rate of 40 %, 19 %, 5.9 %, 4 % and 2.9 % respectively. But in Nyala the percentage of lung abscesses were found to be 8.5 %.

During the years 2003-2008 in Port Sudan slaughterhouse, a total of 128 (7.86%) camel lungs were condemned, because of lung abscesses. From 44 lungs abscesses examined bacteriologically in the this study, *Staphylococcus spp*, *Streptococcus spp* and *Actinomyces spp* were isolated. These results agree with the results of other studies conducted by Al-Ani (1989); Costa, Spier and Hirsh (1998); Al-Tarazi (2001) and Nasr (2003).

The examination of livers constitutes an important part of meat inspection in the slaughtered animals particularly camels. The majority of people in Red Sea State eat fresh camel livers and this habit could lead to some dangerous public health hazards. Camels are often infected with ticks that produce multiple wounds at different sites of the body; bacteria may enter the blood circulation via such wounds and consequently cause abscesses in internal organs including liver.

In this study 24 out of 287 (8.36 %) of livers collected from slaughtered camel at Port Sudan, have abscesses. This finding agrees with the results reported by Obeid (1994) who found that 6.1 % of condemned
livers were due to liver abscesses. It was noticed that there was no distinct seasonal variation in the occurrence of these abscesses. Good animal management and husbandry were suggested to minimize their incidence. Mohamed, et al. (1997) investigated camel livers in Egypt. They found multiple abscesses with involvement of *Staphylococcus species* and *Proteus species*. On the other hand, Itman, et al. (1989) isolated *Clostridium species* as the main causative agent of liver abscesses in camel in Egypt.

Mai (2000) studied the pathological condition associated with liver condemnation in Khartoum State. She found that the condemnation due to abscesses represented 3.1% and 17.1% of total liver condemnation in cattle and sheep respectively. Also Pounden, Bell, Edgington and Thomas (1956) found that 17% of lambs slaughtered in USA, had liver abscesses. Norbaev (1989) found that in slaughtered sheep 3.7% had multiple abscesses. In general, many authors could diagnose liver abscesses in different animal’s species (Madin, 1949; Khalid, 1971; Rosa, et al., 1989 and Abusalama, 1995).

Abubaker, et al. (1999) found that internal abscesses were seen mainly in the liver, spleen and lungs with involvement of regional lymph nodes in slaughtered camels in Bahrain. The bacterial infection was due to *Staphylococcus spp, Streptococcus spp, E.cloii, Klebsiella spp, Citirobacter spp* and *Proteus spp*. This finding is in agreement with the finding of the present study. Similar isolates from liver abscesses were found by Abdel - Fatah and Saied (1995) and Manal (2001) in cattle and goats in Sudan respectively.

Our result revealed that 88% (162 out of 184) and 73.8% (203 out of 275%) of samples collected from camels at field investigation and slaughterhouse respectively were bacteriologically positive and this is a significant results.
Staphylococcus spp were the most prevalent organisms isolated (140 = 25.1%), and were found in both internal and superficial abscesses. It is often isolated in mixed cultures with other bacteria. In the present investigation, the bacteria isolated from superficial abscesses were Staphylococcus spp (25 %), Streptococcus spp (13.44 %), Bacillus spp (9.6 %), Micrococcus spp (6.9 %) E.coli (16.4 %) and Proteus spp (5.3%). In general, the present finding is similar to those reported by other authors elsewhere (Buchnev, et al., 1987; Ismail, et al., 1990; Ali, 1999; Ali, et al., 2001; Kane, et al., 2003 and Younan, et al., 2007).

Staphylococcus spp were isolated by other authors from the respiratory tract of camels, (Arara and Klara, 1973; Shigidi, 1973; Hafez, Razig, EL-Amrousi, and AL-Hendi, 1991 and Thabet, 1993) and from pyogenic infection in lymph nodes (Demench, et al., 1977; Mohamed, 1992 and Nasr, 2003). Abdel Rahim, Ben Haj and ELZurgani, (1990) examined slaughtered camel in Libya, and observed lesions in 6.9 % in lymph nodes from which Staphylococcus aureus was isolated.

Staphylococcus aureus was the most commonly isolated organisms from field and slaughtered camels in the present study, representing 4.6% from total bacterial isolates and 35.6 % from total Staphylococcus isolates. This result is compatible with Al-Tarazi (2001) and Al-Ani, et al. (1998) who reported Staphylococcus aureus as the most frequently isolated organisms from camel’s abscesses. Salih (1971) isolated Staphylococcus aureus at a rate of 73.5 % from liver of slaughtered camel, and Mohamed (1992) also isolated the organisms from different lymph nodes of slaughtered camel in Sudan. Qureshi, et al. (2002) reported the bacteria associated with wounds and abscesses on
camels, and found that the percentage of *Staphylococcus aureus* isolates was 23.39%.

*Streptococcus species* was reported as the second important pathogen involved in camel’s abscesses in this study. They constituted 21.36 % of total Gram -positive isolates and 13.44 % of total bacterial isolates. This agrees with the results of other studies conducted in Sudan and Ethiopia by Mohamed (1992) and Demenech, *et al.* (1977) respectively.

In the present study, bacteria isolated from bronchial lymph nodes represented 14.5 % from the total isolates including 32 Gram-negative organisms. This result is similar to that mentioned by Shigidi (1973) and Nasr (2003) who studied the aerobic bacteria of the respiratory tract and bronchial lymph nodes in camels. They found that the bacilli and Staphylococci were the most dominant isolates.

Thabet (1993) found that the main isolates from camel lungs were *Streptococcus spp, Staphylococcus spp, Klebsiella spp, E.coli* and *Pasteurella spp*. While Mahmoud, Sabah and EL-Yas (1988) reported *Proteus spp, Citrobacter spp* and *Micrococcus spp* as the main isolates from infected camel lungs in Egypt.

In the present study *Corynebacterium species* were isolated from internal organs and superficial abscesses with a rate of 3.94 % of total isolates and 6.26 % of total Gram-positive organisms. Mustafa (1992) isolated the organisms from camel lung abscesses and Nasr (2003) isolated *Corynebacterium spp* from bronchial lymph nodes in camels.

Radwan, *et al.* (1989) isolated the same organisms from subcutaneous abscesses, while Khalid (1971) and Rosa, *et al.* (1989) isolated *Corynebacterium spp* from hepatic abscesses with a rate of 3.9 % and 11.8 % respectively. Demench, *et al.* (1977) isolated *Corynebacterium spp* from pyogenic infection of camel in Ethiopia, and
Tejedor, et al. (2002) observed that Corynebacterium species are mainly associated with lymphadenitis and lymph node abscesses in camels.

Corynebacterium pseudotuberculosis (Radwan, et al., 1989 and Itman, et al., 1989) and Corynebacterium ulcerans (Tejedor, et al., 2000) have been isolated from caseous lymphadenitis in camels. Corynebacterium species constituted about 3.94% of total bacterial isolates in this study.

In the present study Bacillus species were isolated at the rate 9.67% (54 out of 558) isolates. This agrees with the results of Salih (1971), Mohamed (1992) and Ibrahim (1996).

Escherichia coli amounted to 44% from total Gram-negative bacteria and 16.48% from total isolates. This result agrees with the finding of many authors: Rosa, et al. (1989) who isolated this species of bacteria from hepatic abscesses with an incidence of 11.8%; Salih (1971) who isolated Escherichia coli from all samples of liver collected from camels slaughtered at Omdurman abattoir; Mohamed (1992) isolated Escherichia coli from lymph nodes of slaughtered camel in Sudan and Nasr (2003) isolated Escherichia coli which constituted 38.9% of the total Gram-negative isolates from lung tissue. Despite the large number of these organisms, their presence may be considered as commensally.

In the present study, Proteus spp was isolated from slaughtered camel abscesses. Besides Proteus spp, Klebsiella spp and Citrobacter spp were also identified. Salih (1971) also isolated Proteus organisms from camel liver. Proteus isolates were found in camel lymph nodes slaughtered at Tamboul and ElGedarif abattoir by Mohamed (1992).

Our results showed that, two isolates of Pasteurella haemolytica were obtained, represented 0.35% of total isolates and 0.96% of total Gram-negative bacteria. Similarly, Rosa, et al. (1989) isolated Pasteurella spp in 5% of hepatic abscesses from goat together with

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Proteus spp (5.9%). Hafez, et al. (1991) mentioned that Pasteurella spp is the probable cause of most cases of camel pneumonia and Nasr (2003) found that Pasteurella haemolytica was associated with the most severe lung lesions in camels.

Many of the organisms isolated from camel abscesses in this study had also been isolated by other authors from camels which had pneumonia and other infections.

Histopathologically, the abscesses could be classified as immature and mature abscesses. Necrosis, fibrosis and calcification can be seen in association with chronic abscesses.

In the presence of pulmonary abscesses, sizable damage could be inflicted on lung tissue leading to collapse, emphysema, necrosis, fibrosis and inflammatory changes. Abscesses may break bronchi or bronchioles or may drain in a blood vessel leading to bronchopneumonia and bacteraemia.

Vacuolar degeneration was seen in liver sections which is a reversible damage. Limited necrotic changes and focal inflammatory cell infiltration have noticed and fibrosis was seen in some sections. This indicates that various bacterial infections in camel could have some effects on some vital organs in the body.

Generally the histopathological finding observed in this study agree with those described in other reports (Thomson, 1978; Cotton, 1992; AL-Tarazi, 2001 and Zubair, et al., 2004).

Although the camel disease investigation is poor, most of the conducted researches were oriented towards the etiological, identification and little attention had been paid to correlate between the isolates and their pathological changes in the animal or even the affected organs. The present study was designed to study this correlation.
Planned investigations on camel diseases are needed. Efforts should not only concentrate on isolation and identification of etiological factors but also towards correlating the etiological factors with the various pathological changes that occur in organ of affected animals and their functions.
Conclusions:

The camel is the most important and better adapted animal species in the Red Sea State. From the finding of the present study it can be concluded that external and internal abscesses are common finding in slaughtered and live camels.

External abscesses involve superficial lymph nodes and subcutaneous tissue especially at the head, neck and shoulder regions. Internal abscesses are mainly seen in lungs, livers and bronchial lymph nodes.

In this study, 19 bacterial species have been isolated from abscesses after as mixed infections. Most common isolates were Staphylococcus species (25 %), E. coli (16.48%), Streptococcus species (13.44 %), Micrococcus species (6.98%), Bacillus species (9.67%), Proteus species (5.37 %) and Corynebacterium species (3.94 %). Staphylococcus aureus was the most commonly isolated constituting about 14.24 % of total bacterial isolates and 35.71 % of the Staphylococcal isolates.

Recommendation:

1- Planned investigations should be directed towards camel diseases in the Eastern States of Sudan and towards better husbandry and management systems to improve camel production.

2- Further studies will be needed for molecular characterization of isolated organisms.

3- Proper marketing is very important to commercialize the subsistence economy of camel production.

4- Extensive studies need to be conducted in the same topics in another place in the Sudan such as Western Sudan.
References


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Oxoid, (1973). The Oxoid manual of culture media ingredient and other laboratory services, 3rd, Oxoid Ltd, south work Bridge Road, London.


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Appendices

Appendix (1): The mean and standard errors of bacterial species isolated from field and slaughterhouse (Paired Samples Statistics).

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>N</th>
<th>S.D.</th>
<th>S.E. Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field</td>
<td>41.49</td>
<td>19</td>
<td>25.13</td>
<td>5.77</td>
</tr>
<tr>
<td>Slaughterhouse</td>
<td>58.50</td>
<td>19</td>
<td>25.13</td>
<td>5.77</td>
</tr>
</tbody>
</table>

Appendix (2): Test for the significance of the difference in percentage of the same bacterial species in field and slaughterhouse.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>95% Confidence Interval of the Difference</th>
<th>T</th>
<th>df</th>
<th>Sig. (2.tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field – Slaughterhouse</td>
<td>17.00</td>
<td>0.502 6</td>
<td>0.1153</td>
<td>-0.4123</td>
<td>0.0721</td>
<td>-1.475</td>
<td>18</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lower</td>
</tr>
<tr>
<td>Odds ratio for sex (Female: Male)</td>
<td>1.443</td>
<td>1.223</td>
</tr>
<tr>
<td>For cohort disease = Females</td>
<td>1.394</td>
<td>1.200</td>
</tr>
<tr>
<td>For cohort disease = Males</td>
<td>0.966</td>
<td>0.951</td>
</tr>
<tr>
<td>N of valid cases</td>
<td>6964</td>
<td>-</td>
</tr>
</tbody>
</table>

Appendix (4): The means and standard errors of abscess incidence in the field and slaughterhouse at Red Sea State -Sudan.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>S.D.</th>
<th>S.E.</th>
<th>95% Confidence Interval of the Difference</th>
<th>t</th>
<th>df</th>
<th>Sig. (2 .tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field- Slaughter-house</td>
<td>52.35</td>
<td>0.4917</td>
<td>0.102</td>
<td>-.264990</td>
<td>0.16027</td>
<td>-.511</td>
<td>.615</td>
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</table>
Appendix (5): T-test of the difference in abscess incidence in the field and slaughterhouse at Red Sea State -Sudan.

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
<th>SD</th>
<th>SE</th>
<th>Lower</th>
<th>Upper</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field – Slaughterhouse</td>
<td>31.58</td>
<td>4.8996</td>
<td>1.12</td>
<td>-2.6773</td>
<td>2.0457</td>
<td>-.281</td>
<td>18</td>
<td>.782</td>
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Appendix (6): Tests of Between -Subjects Effects.

<table>
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<th>Source</th>
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<th>Transformed</th>
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<td>df</td>
<td>MS</td>
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<tr>
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<td>16036.933</td>
</tr>
<tr>
<td>Cause</td>
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<td>15901.389</td>
</tr>
<tr>
<td>Organ*Cause</td>
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<td>10128.356</td>
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<tr>
<td>Error</td>
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<td>2334.861</td>
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