NOTES ON CAMEL MASTITIS; A REVIEW

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ABSTRACT

Camels are well recognized as the primary source for milk and meat production in desert regions. Camels are considered the animal of food security under the marginal environmental conditions of Egypt, beside its important role against climate changes under desert conditions. They are seen as valuable assets and a form of insurance against natural disasters that frequently occur in these areas, often resulting in the death of livestock. As a result, protecting them and their products from infection is the most formidable challenge they face. Despite camels being immune to numerous infectious diseases, studies have demonstrated that they are susceptible to acquiring mastitis, if left undetected and untreated; it might result in significant economic losses.

Camel milk has significant amounts of calcium (Ca), sodium (Na), magnesium (Mg), iron (Fe), and copper (Cu). It has low sugar content and reduced cholesterol levels, while also being rich in vitamin C. Mastitis has been documented in nearly all countries where camels are raised. In addition to reducing milk supply, it has detrimental effects on both humans and nursing calves. Several pathogenic pathogens have been identified as the underlying causes of mastitis in camels.

Nevertheless, bacterial infections are widely recognized as the main underlying factor responsible for mastitis in camels like *Staphylococcus aureus* and *E. coli.* Hence, it is imperative to focus on directing preventive and control measures towards early detection, treatment, and the avoidance of potential risk factors. This is crucial for protecting the camel due to its significant value.

Keywords: Camel, Mastitis**,** Bacteria, Prevention

INTRODUCTION

Camelus dromedaries, or the one-humped camel, is an important mammal that can endure in hot and dry conditions. Many Arab nations view camels as playing a fundamental and significant role in agricultural and technological advancements; their unique physiological makeup enables them to play a key role in desert . they are useful for transportation, milk, meat, and drought relief, millions of people in arid regions of the world rely on them to survive (Abdella and Mohammed, 2014; Volpato et al., 2015).

There are an estimated 41 million camel heads in the world, with 78.22% of them found in Africa, 21.71% in Asia, and only 0.07% in the remaining regions. (FAO, 2024). Livestock is regarded as a valuable investment and a form of insurance against the frequent natural disasters

that occur in the desert, often resulting in the death of animals. Camels hold a great importance in the life of desert dwellers (Abdi et al., 2013). Camel milk is a vital dietary staple for nomads living in semiarid and arid regions. It serves as a crucial source of sustenance and may be the sole milk option in areas where other milking animals cannot be sustained (Jilo and Mata, 2017).

Camel milk possesses important nutritional characteristics due to its abundance of antibacterial compounds and higher levels of vitamin C compared to cow milk. Milk is a rich source of minerals and vitamins, and it has a higher concentration of lactoferrin. Furthermore, camel milk has the ability to fulfill a significant portion of people' daily nutritional requirements due to its high concentration of important elements (Abdurahman, 2006).

Camels hold significant importance as dairy animals in both Middle Eastern and African Horn countries due to their ability to thrive in arid regions predominantly inhabited by Arabic tribes. Camels maintain lactation even in stressful conditions such as drought, while other milk-producing animals stop producing milk. Camels have an extended period of lactation and can produce 5-6 liters of milk each day, even in times of drought. Due to the escalating desertification and frequent occurrence of drought and famine in sub-Saharan Africa, the camel serves as a highly important resource for milk, meat, and labor (Jilo and Mata, 2017). In Egypt, unfortunately the number of camels has dropped from 141 thousand to 110 thousand in recent years. Compared to other Egyptian domesticated animal species, the camel has gotten relatively less attention (FAO, 2024).

The Arabian camel is a significant provider of sustenance and dairy in numerous places over the globe, particularly in emerging nations of Asia and Africa. Two-humped camels are able to thrive in cold climates, resulting in their milk fat content reaching up to 8%. Safeguarding them and their produce from mastitis is their most formidable challenge. **Hence, the main objective** of this review article ~~study~~ is to present a comprehensive overview on Camel mastitis, including its etiology, transmission, diagnostic techniques, prevalence, economic significance, treatment options, review economic Importance of Camel mastitis and existing preventative and control strategies.

CAMEL MASTITIS

1. Definition

Mastitis is defined as the inflammation of the mammary gland, or udder, in dairy animals such as cows, camels, sheep, and others. The inflammation may arise due to physical trauma, chemical exposure, thermal damage, or as a response of the body's immune system to bacterial infection and the toxins they produce, which have affected the teat canal and caused damage to the gland (Viguier,et al., 2009).

Mastitis has a substantial impact on the dairy industry's economy since it decreases farm profitability by adversely affecting both the quality and quantity of milk (Keefe, 1997). This condition is distinguished by alterations in the milk that involve physical, chemical, and bacteriological changes. Additionally, it is distinguished by pathological alterations in the glandular tissue (Otaibi and Demerdash. 2013). The primary alterations observed in the milk include coloring, the presence of milk clots, and a high concentration of leucocytes (Ruwaili et al 2012). Although clinical cases of mastitis can be easily identified through manual palpation and visual examination of the milk using a strip cup, presence of swelling, heat, pain, and abnormal milk appearance (Tofaily and Alrodhan, 2011). A significant number of mastitis cases are not

immediately apparent. These cases are known as subclinical mastitis. In the later instances, the Diagnosis now relies primarily on indirect tests. The leucocyte content of the milk is a determining factor for mastitis. Mastitis is less common in camels compared to cattle, although the occurrence of mastitis may rise in dairy camels due to hand milking and teat deformity. Acute mastitis has been shown to occur within the initial days after giving birth, experiencing difficult labor, or undergoing a cesarean section in dromedary camels. In some instances, the mammary secretions are characterized by being watery, yellowish, or including traces of blood (Amel 2003). The bacteria that have been identified in these situations include *Klebsiella pneumoniae* and *Escherichia coli* (Barbour, et al., 1985).

Subclinical or chronic mastitis is detected when the young animals do not grow normally and when there are abnormalities in the shape of the udder, such as shrinkage of one or more quarters, unevenness, or the appearance of pus-filled sores on the surface.

Rapid identification and prompt treatment can effectively minimize both tissue injury and milk production decline. Nevertheless, prioritizing prevention and control is consistently more effective, as therapy does not always yield the desired level of success (Shearer and Harris, 2003).

2. Causes

Published information is limited on camel mastitis compared to bovine mastitis. Bacterial infections are the main factor responsible for mastitis in domestic animals. Several studies suggest that *Staphylococcus aureus, streptococcus spp., Micrococcus spp., Streptococcus agalactiae, coagulase negative staphylococci, Staphylococcus epidermidis, Mannheimia haemolytica, Escherichia coli,* and *Corynebacterium spp*. have been identified as potential causes of mastitis in camels (Faye, 1997 and Fischer et al., 2013).

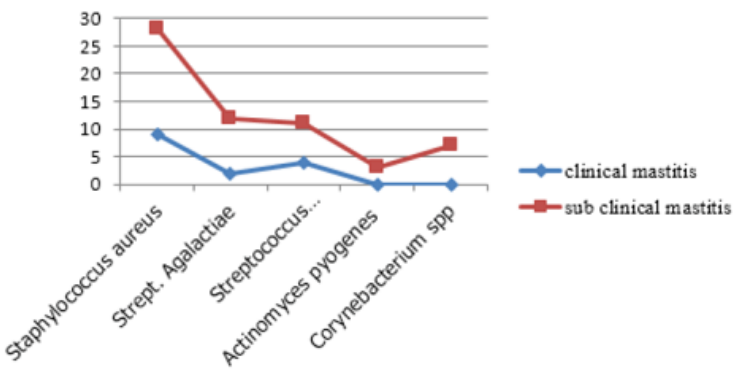

Fig. (1). Prevelence of pathogens in sub-clinical and clinical camel mastitis (Shishay and Mulugeta, 2018)

3. Types

The intensity of inflammation is categorized into three types: clinical, subclinical, and the uncommon chronic mastitis. The extent of inflammation of each type is influenced by various factors, including the nature of the pathogen, the breed of the animal, the age of the animal, health and immune condition of the animal, (Eisa and Mustafa, 2011). Clinical mastitis refers to a type of mastitis that produces observable symptomes in the udder and milk.

According to the International Dairy Federation (IDF) in 1999, clinical mastitis (Photo (1)) is classified into three categories: mild, moderate, and severe. The mild variety is characterized by an abrupt beginning, the presence of flakes and clots in the milk, which may be accompanied by a small infection and swelling of the quarter. Moderate and severe forms of mastitis are characterized by abnormal milk secretion, redness and swelling of the udder, and symptoms such as fever, depression, dehydration, quick pulse, and loss of appetite.

In the most severe cases, mastitis can be fatal. Under these circumstances, the milk typically exhibits a diluted texture. Subclinical mastitis does not result in observable alterations in the udder or the milk, making it challenging to detect in its early stages. Its presence can only be confirmed through laboratory analysis. However, the increase in Somatic Cells Count (SCC) leads to a drop in quantity production, resulting in a loss of cost. Furthermore, it primarily impacts older breastfeeding animals rather than younger ones. The presence of somatic cell count (SCC) has a reversible effect on milk production. When SCC increases, milk yield decreases, and vice versa. An SCC count in milk exceeding 300,000 is indicative of abnormality and the presence of udder irritation. Subclinical mastitis is more prevalent than clinical mastitis, with a ratio of approximately 1:14-15 instances. Therefore, it holds greater significance.

Photo (1). Clinical mastitis (El Tigani-Asil et al., 2020)

Subclinical mastitis typically precedes clinical mastitis and can persist for an extended duration without being detected. However, it gradually impacts the quality and supply of milk while also creating a conducive environment for these bacteria are capable of proliferating and subsequently infecting the animal at a later time. Chronic mastitis, a less common kind, causes long-lasting inflammation in the mammary gland. (Schroeder, 2012). The periods of most vulnerability to infection from environmental pathogens occur throughout the dry period, specifically within the first two weeks, as well as during the early lactation phase within the last 10 days prior to calving. The occurrence or frequency, the prevalence during calving is twice as high as during the drying off time (Khan and Khan, 2006). The impact of mastitis on the dairy industry includes a decrease in the animal's milk production capacity, which can be either temporary or permanent. Additionally, the quality of the milk is compromised, resulting in less desirable features. This ultimately leads to a drop in milk yield. The price is affected by the high presence of SCC (somatic cell count) in the milk, as well as the loss of milk due to antibiotic treatment. Additionally, there are costs associated with the treatment and veterinary care, as well as an increase in labor costs. Laboratory testing is also necessary to control the quality of the

milk. A decrease in overall dairy production due to the country's demands results in annual losses (Viguier et al., 2009).

4. **Pathogenesis**

Effects caused by infectious organisms and the harmful substances they produce. The persistence of inflammation leads to internal swelling of the mammary epithelium, which cannot be noticed through external inspection. This inflammation leads to damage to the gland alveoli, resulting in a loss of their form. When the integrity of the blood-milk barrier is compromised, various constituents of the extracellular fluid, including sodium, chloride, hydrogen, potassium, and hydroxide ions, will infiltrate the gland. Upon entering the gland, these materials will combine with milk, potentially containing blood in cases of severe injury.

During this phase, noticeable indications can be detected on the udder, including swelling and redness. Additionally, changes in the milk can be observed, such as alterations in color, pH levels, water content, and the presence of flakes and clots. Mastitis begins when germs infiltrate the teat canal and the mammary glands.

The bacteria undergo rapid replication and subsequently release their toxins, resulting in an adverse impact on the tissue responsible for milk secretion. The elevated somatic cell count (SCC) in the milk has a direct impact on both the volume of milk produced and the quality of milk products, resulting in a decrease in quantity. In order to prevent infection, the udder is safeguarded by the teat, which serves as the initial line of defense. This is because the teat canal possesses a sphincter that acts as a barrier, preventing bacteria from entering and milk from flowing out. Additionally, the canal is lined with keratin, a waxy substance that adheres to microorganisms responsible for mastitis.

Once the milking process is finished, the teat canal may remain partially open for approximately 1 to 2 hours. During this time, bacteria that are present near the teat opening have the opportunity to enter the canal. This can lead to damage to the keratin and subsequently disrupt the protective mucous membrane inside the canal. Should germs successfully penetrate the teat canal, they will encounter the mammary gland, which serves as the second line of defense. Upon reaching the gland, bacteria have the ability to reproduce and generate toxins. However, the gland will initiate the process of stimulating the production of inflammatory mediators in order to attract phagocytes, which are specialized cells that eliminate the pathogens. The degree of an inflammatory reaction is determined by both the host and the infection. The host's age, immunological condition, SCC (somatic cell count), lactation stage, and parity all contribute to defining the severity of the disease.

The severity of the disease is determined by the species, strain, virulence, and inoculum size of the pathogen. As the leukocyte count in the milk rises due to an inflammatory reaction, the number of somatic cells also increases. Dead leukocytes and mammary epithelial cells, as well as clotting factors, are released into the milk, causing the creation of clumps that contribute to the formation of clots. These blood clots obstruct the ducts and hinder the discharge of milk, ultimately leading to the development of scars that create small pockets that are resistant to treatment with antibiotics. Practices that exacerbate trauma to the animal's mammary glands

include: inadequate preparation of the animal for milk stimulation, excessive milking, utilization of infected tubes and cannula with mastitis, handling wet teats without utilizing teat dips, poor use of udder washes, and physical trauma (Khan and Khan, 2006).

5. Prevalence

The global prevalence of camel mastitis, as determined by various researches, is 45.66%. The lowest prevalence was found in Somalia at 16% (Mohamud et al., 2020), while the highest prevalence was observed in Pakistan at 90.5% (Qamar et al., 2011), based on individual study findings. The prevalence of mastitis in different countries ranges from 57.5% in Pakistan to 42.8% in Ethiopia. It is important to mention that prevalence studies should be updated by include a larger sample size.

6. Diagnosis

The presence of obvious abnormalities in the udder; such as redness, swelling, increased warmth, and pain upon physical examination, as well as abnormalities in the milk, such as the presence of clots, clear or serum-like secretions, or bloody discharges, make clinical mastitis easily detectable. Indirect inflammatory markers are necessary to detect subclinical mastitis. In contrast to clinical mastitis, subclinical mastitis in animals is characterized solely by a decrease in milk production (Bobbo et al., 2017; Martins et al., 2020). Therefore, the diagnosis necessitates further tests that rely on the somatic cell count (SCC) of milk (Adkins and Middleton, 2018). The SCC serves as a reliable measure of the well-being of the mammary gland and the quality of milk.

Typically, cows who are in good health produce milk with a somatic cell count (SCC) of fewer than 100,000 cells per milliliter (mL). However, cows that have mastitis, an infection of the udder, have a minimum SCC of 200,000 cells per mL (Kelly et al., 2011). The California Mastitis Test (CMT) (Photo (2)) is a method used to assess the somatic cell count (SCC) in milk. It can be conducted directly at the cow's side to identify cases of mastitis (Bhutto et al., 2012; Godden et al., 2017).

Electronic somatic cell count (SCC) is a diagnostic procedure conducted on the composite milk obtained from all quarters of each cow. It is used to monitor the effectiveness of control programs (Alhussien and Dang, 2018). Microbiological analysis of milk samples from individual quarters or composite samples of individual animals is a method used to identify the specific strain of E. coli responsible for clinical mastitis (Royster et al., 2014; Ferreira et al., 2018). Nevertheless, due to the limited quantity of bacteria, they cannot be discovered using conventional techniques, resulting in approximately 30% of samples showing no bacterial presence (El-Sayed et al., 2017; Singh et al., 2018). In certain instances, it may be necessary to employ culture methods that are performed repeatedly and are specifically tailored to the desired outcome.

Photo (2). California Mastitis Test (Jilo and Mata, 2017).

7. Prevention and control

To minimize the risk of bacterial contamination, it is important to limit the exposure of the te at end to bacteria. This can be achieved by maintaining a clean and dry environment for the anim als, ensuring that they do not have access to manure, mud, or stagnant water. It is also crucial to keep the calving area clean. After milking, it is recommended to dip the teats in a germicidal solu tion. Previous attempts to control environmental mastitis during the dry period using germicidal or barrier dips have been unsuccessful. To effectively manage environmental streptococci during the early dry period, it is advisable to administer proper antibiotic therapy to all quarters of all an imals at drying off. The management of udder infection in camels mostly relied on the administration of antibiotics through intra-mammary infusion. Oxytetracycline, tetracycline, gentamicin, chloramphenicol, penicillin G, and kanamycin exhibited efficacy against the primary microorganisms responsible for camel mastitis. The resistance patterns of certain mastitis pathogens in camels to routinely used antimicrobial drugs may be due to the extensive and prolonged usage of these medications for treating various infectious illnesses (Younan et al., 2001).

There is less knowledge on camel mastitis. However, cases of mastitis in camels have been reported in various countries, specifically in the pastoral production systems of East Africa, the Middle East, and Egypt (Moustafa et al., 1987; Karmy, 1990 ; Abo Hashem et al., 2020 and Darwish,2023).

CONCLUSIONS

The occurrence of camel mastitis has become a significant global concern in the past decade. The camel population as a whole is currently facing unsanitary circumstances, a lack of health education, and inadequate health infrastructure, which are likely significant factors contributing to the occurrence of mastitis. The reported cases highlight deficiencies in screening methods, including the lack of a defined threshold for somatic cell count and the presence of cell fragments that result in inaccurate enumeration of somatic cell count. From this review article, it is clear the importance to know how to prevent and control this economic disease to avoid not only loss of milk production but also protection of human being from health hazards to achieve “One Health” approach.

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الملخص العربي

التهاب الضرع في الابل، مقالة علمية

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مما لا شك فيه أن الإبل هي من المصادر الرئيسية لإنتاج الحليب في المناطق الصحراوية. كما يعتبر الإبل حيوان الأمن الغذائي في ظل الظروف التغيرات المناخية التي تؤثر على جميع دول العالم ومنها مصر. ونتيجة لذلك، فإن مكافحة امراض الابل وحمايتها من العدوى الميكروبية يمثل التحدي الأكبرللحصول على منتج صحي وامن منها. وقد أثبتت الدراسات الحديثة أن النوق معرضة للإصابة بالتهاب الضرع، إذا تركت دون اكتشافها أو علاجها؛ قد يؤدي إلى خسائر اقتصادية كبيرة.

يحتوي حليب الإبل على كميات كبيرة من الكالسيوم(Ca) ، والصوديوم(Na) ، والمغنيسيوم(Mg) ، والحديد (Fe)، والنحاس .(Cu) يحتوي على نسبة منخفضة من السكر ومستويات منخفضة من الكوليسترول، كما أنه غني بفيتامين .C وقد تم توثيق التهاب الضرع في جميع البلدان التي يتم فيها تربية الإبل تقريبًا. بالإضافة إلى تقليل إدرار الحليب، فإن له تأثيرات ضارة على كل من البشر والقعدان المرضعة. وتم تحديد العديد من المسببات الميكروبية التي تعتبر وراء التهاب الضرع في الإبل.

ومع ذلك، من المعروف على نطاق واسع أن الالتهابات البكتيرية هي العامل الأساسي المسؤول عن التهاب الضرع في الإبل مثل المكورات العنقودية الذهبية والإشريكية القولونية. ومن هنا لا بد من التركيز على توجيه تدابير الوقاية والمكافحة نحو الكشف المبكر والعلاج وتجنب عوامل الخطر المحتملة.

على الرغم من أن معدل انتشار التهاب الضرع في الإبل أقل مقارنة بالأمراض الأخرى في الإبل، إلا أنه يجب التعامل معه بعناية لمنع وتجنب انتشاره وتطوره إلى مرض واسع الانتشار. وهذا أمر بالغ الأهمية لحماية الابل نظرا لقيمته الكبيرة.

الكلمات الدالة: الابل، التهاب الضرع، البكتريا، الوقاية.