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Clinical Study on Camel Mastitis (*Camelus Dromedarius*) at Beni Guecha Area, Algeria

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Abstract

THIS STUDY aimed to identify different types of mastitis and their incidence in camels in Southeastern Algeria. Data were collected via a questionnaire from nine herds in the Beni Guecha area, Talbi Larbi district, Oued Souf Province, encompassing a total of 240 camels over three seasons (autumn, winter, and spring) from October 2023 to May 2024. Factors such as season, age, lactation stage, number of calving, use of anti-suckling devices, and udder lesions were considered. Gross lesions of affected udders were observed and recorded. The prevalence of clinical mastitis, as determined from the questionnaire, was 8.75%. Two forms of clinical mastitis were identified based on clinical signs and visible milk alterations, with chronic mastitis being the most common at 6.25%, followed by acute mastitis at 2.5%. The study found that 71.42% of mastitis cases involved the use of anti-suckling devices, while 28.53% did not use any device. Tick infestation and anti-suckling devices were significantly associated ($p < 0.05$) with lactating camel mastitis prevalence among the putative risk factors. Mastitis prevalence was 4.16% during the late stage of lactation, 5.45% during the middle stage, and highest at 20% during the initial stage. The various pathological lesions included chronic mastitis (71.42%) and acute mastitis (28.57%) among the affected udders.

Keywords: Acute Mastitis; Camel, Chronic Mastitis, Clinical Study, Udder.

Introduction

The one-humped camels (*Camelus dromedarius*) adapt exceptionally well to arid and semi-arid environments, continuing to thrive and produce milk even during severe droughts, when cattle, sheep, and goats suffer high mortality rates. These characteristics make dromedaries essential for the survival of pastoralists [1]. Camels are crucial multipurpose animals, providing milk, meat, and transportation. They serve as financial reserves for pastoralists and hold significant cultural and social value. Camel milk, known for its exceptional nutritional properties, is considered a valuable substitute for human milk [2, 3].

In Algeria, 80% of milk production comes from cattle, with the remainder supplied by sheep, goats, and camels. However, local production falls short of meeting the country's milk demand, making Algeria the third-largest importer of milk and dairy products globally. In 2006 alone, over $500 million was spent on importing milk powder to address this production gap [4]. An alternative to this low milk production is to encourage milk production of other animal species, particularly camel. However, like other dairy animals, dromedary camels can be affected by udder infections such as mastitis [5], a common and costly disease in dairy camels that significantly impacts milk yield, quality, and hygiene, as well as the household economy [6]. Mastitis, which stands for

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breast inflammation (mast=breast, itis= inflammation), is defined as inflammation of the mammary gland or udder in dairy animals, including cows and camels, regardless of the cause [2, 7] and is characterized by physical, chemical, and usually bacteriological changes in the milk [8].

Two main forms of mastitis can be distinguished. The clinical form (chronic, acute, and gangrenous) is less common and characterized by systemic symptoms in the animals and noticeable abnormalities in the udder and/or milk. In contrast, subclinical mastitis is more common and results in decreased milk production without visible clinical signs in the udder or abnormalities in the milk [9-10].

Clinical mastitis presents with a swollen, reddened, hardened udder that is painful up on palpation, along with alterations in the color and consistency of milk depending on the degree of inflammation [11]. Acute mastitis typically occurs within the first few days following parturition and is characterized by symptoms such as anorexia, fever, general depression, swelling, severe inflammation, and pain in the udder. Chronic mastitis is identified by the presence of a firm, swollen, fibrous udder often with nodular indurations, atrophy of one or more quarters, and the presence of pustules on the surface. Gangrenous mastitis is characterized by a bluish, edematous udder that feels cold to the touch, with teat secretions typically appearing purplish-violet and mixed with gas [12].

Similar to other countries, dromedaries are widely used in Algeria, with breeders often consuming the milk fresh or fermented. Some breeders also blend camel milk with goat milk to produce butter and fresh cheese, such as Oudi ouanamellen and tikamarine, which are traditional products among the Tuareg. These products are intended for self-consumption [13]. This practice poses a potential hygiene risk, as milk from animals with clinical or subclinical mastitis may contain pathogenic or potentially pathogenic species. Additionally, there is a risk of consuming antibiotic residues from treatments used to manage mastitis [7, 14]

In recent decades, cases of mastitis in dromedary camels have been reported in various camel-rearing countries across Africa and Asia, including Kenya, Somalia, Sudan, Egypt, Saudi Arabia, Iraq, and the UAE [15]. The first report documenting the economic impact of clinical mastitis in camels, conducted by [16] found that the highest cost was attributed to the purchase of drugs (43.63%), followed by the cost of discarded milk and milk production loss (18.17%), and the cost of veterinary services (17.03%).

There is limited literature on bovine mastitis, and even less on ovine and caprine mastitis in Algeria. However, no published data exists on mastitis in she-camels in the Oued Souf Province. From the few studies available on camels, the prevalence of mastitis in Algerian dromedaries was reported to be 35%, with 7.5% being clinical mastitis in M'sila and Biskra [9], and 3.22% in the Laghouat and Djelfa regions of southern Algeria [4]. Additionally, there is little information on the use of antimicrobials and the resistance of mastitis pathogens in dromedary camels in Algeria. Several factors, such as the animal's breed, age, parity, season of the year, stage of lactation, milk yield potential, and husbandry practices, can influence the risk of clinical mastitis in camels, similar to what has been reported in cattle [17, 18].

This study was conducted to investigate the incidence of various types of mastitis in diverse herds in the Beni Guecha area (Talbi Larbi), Algeria, using a questionnaire alongside a gross examination of pathological lesions in the udders of female camels.

Material and Methods

Description of the study area

The study was conducted in Beni Guecha at Talbi Larbi in the Provence of Oued Souf (El Oued), eastern south of Algeria. Beni Guecha administrative zone, is located in the northern part of Oued Souf Region, at 33°59′53″N North latitude; 7°20′10″E East longitude. There is virtually no rainfall all year long in Beni Guecha. The temperature here averages 21.1 °C. The rainfall here averages 101 mm the driest month is July. There is 1 mm of precipitation in July. With an average of 13 mm, the most precipitation falls in March. The precipitation varies 12 mm between the driest month and the wettest month. During the year, the average temperatures vary by 21.0 °C with an average of 31.9 °C, July is the warmest month and january has the lowest average temperature of the year (Fig .1).

The Survey

A cross-sectional study was conducted from October 2023 to May 2024 on lactating female camels of the local breed (Camelus dromedarius). Nine camel herds were surveyed to determine the incidence and types of mastitis. The study included a general questionnaire survey covering factors such as the age of the camel, parity number, housing conditions, feeding practices, source of water, economic impact of mastitis, milking order of lactating camels, traditional husbandry systems used by camel owners, stage of lactation, udder and teat lesions, use of antisuckling devices, seasonality, pre-milking udder preparation, and hygiene practices.

Study animals

The study focused on lactating camels under traditional management in the Beni Guecha area of Talbi Larbi municipality, Oued Souf Province. A total of 240 lactating camels were examined to assess the prevalence of clinical mastitis and identify its types. Physical examinations included checking for signs of inflammation such as swelling, redness, heat, or pain upon palpation of the udder or teat, as well as abnormalities in the color and consistency of milk. Additionally, tick infestations and the presence of lesions were noted during the examination.

Data analysis

The prevalence of clinical mastitis was determined by dividing the number of camels that tested positive for clinical mastitis by the total number examined. Statistical analysis was conducted using Microsoft Excel 2016, employing Chi-square and Fisher's exact tests to analyze the data and identify significant differences. A confidence level of 95% was used, with a probability value of $P < 0.05$ considered statistically significant.

Results and Discussion

Nine camel herds (240 females) were examined to investigate the prevalence and types of clinical mastitis in the Beni Guecha area, Oued Souf, Algeria. Approximately 68% (17 out of 25) of interviewed camel owners from Ben Gacha area acknowledged mastitis as a disease that significantly reduces milk yield and causes economic losses, including veterinary costs and the necessity to sell affected animals for slaughter if more than two quarters are affected.

The primary signs observed included enlargement, hardness, heat, and pain in affected quarters, accompanied by changes in the color and consistency of milk. Notable symptoms also included congestion and enlargement of teats, along with severe inflammation of the supra-mammary lymph nodes. Chronic mastitis was identified by a swollen and fibrosed udder, often exhibiting nodular induration, while some cases displayed mammary gland tissue atrophy or teat canal obstruction). No instances of gangrenous mastitis were observed during the study.

Milking routine

During the herd visits, hand-washing was not observed on any occasion before milking. Only one herd reported cleaning the udders or teats before milking, and no post-milking teat disinfection was practiced in any of the herds. The lack of proper hygiene practices is attributed to the limited availability of water, as water sources are far from the herding areas, making it difficult to transport sufficient quantities. During the day, the lactating mothers graze while their young remain near the herder's tent. At milking time, the young camels are released one by one to suckle from their mothers, stimulating milk let-down. All camels were hand-milked by male herders. Additionally, in 100% of the herds, the camels were milked only once a day.

The effect of anti-suckling devices

The study found that 52.08% of camel owners use anti-suckling devices, which are either pre-made pieces of cloth cut and sewn to fit the camel's udders or custom-made pieces woven from cotton (Fig 2). These devices cover the udder without causing injuries but are often reused without proper cleaning, posing a risk of contamination. Among the 21 cases of mastitis identified, approximately 71.42% (15 cases) were associated with the use of these anti-suckling devices (Fig 3). The remaining 28.57% (5 cases) of mastitis occurred in camels that were not using these devices (Table 2).

Effect of tick infestation on mastitis

The study's results revealed that ticks were present on various parts of the body. Their widespread distribution across the body can lead to the development of skin lesions and mastitis, particularly if a severe infestation occurs on the udder. The incidence of mastitis was higher in udders infested with ticks (85.71%) compared to those without infestation (14.29%) (Table 2) (Fig 3). These results suggest that tick infestation and the presence of an anti-suckling device have statistically significant effects on clinical mastitis ($P < 0.05$).

Seasonal effects on mastitis

In the survey, mastitis was found in 47.82% of cases during autumn and spring combined, while the highest prevalence (47.61%) occurred during winter (Table 2) (Fig 4). Acute mastitis was most common in winter (50%), followed by spring (33.33%) and autumn (16.66%) (Table 1). Chronic mastitis had its highest occurrence in autumn (53.33%), followed by winter (26.66%) and spring (20%) (Table 1). These results suggest that none of the seasons show a statistically significant effect on clinical mastitis (*p*-value = 0.067).

Prevalence of mastitis among age groups

Camels suffering from clinical mastitis, whether acute or chronic, were observed across ages ranging from 5 to 27 years (Table 2) (Fig 5). Acute mastitis was predominantly found in the 10-15 years age group (50%), followed by the 5-9 years age group (33.33%), and the 16-27 years age group (16.66%) (Table 1). Chronic mastitis showed its highest prevalence in the 16-27 years age group, accounting for 73.33% of cases according to the survey findings (Table 1).

Effect of stage of lactation on mastitis

Mastitis cases were relatively low during the late stage of lactation (4.16%), increased during the middle stage (5.45%), and were most prevalent during the initial stage of lactation (20%), (Table 2) (Fig 6).

Effect of number of calvings on mastitis

This study demonstrated a clear correlation between the number of calvings and the occurrence of clinical mastitis (Fig 7). The highest prevalence of clinical mastitis was observed during the third calving followed by second, fourth subsequent ones, and first calvings, accounting for 11.90%, 11.11%, 7.94%, and 5% of cases, respectively (Table 2).

Putative Risk Factors Associated with the Occurrence of Mastitis in Lactating Camels

A chi-square analysis indicated that tick infestation and the use of antisuckling devices were significantly associated ($p < 0.05$) with the prevalence of mastitis in lactating camels. These factors were identified as significant risk factors in the study, as shown in (Table 2).

Mastitis prevalence and risk factors analysis

The results of the present study contribute to the existing knowledge on the prevalence of clinical mastitis in lactating she-camels living under the desert conditions of Oued Souf (Algeria).The prevalence of clinical mastitis (8.75%) in the current study is higher than the prevalence report of 2.1% from Borena lowland pastoral area, Southwestern Ethiopia,(4.3%) in Gomole District of Borena Zone Southern Ethiopia [7], 4.4% in southern Algeria [4], 4.9% in Jijiga town of eastern Ethiopia [8, 10], 5.4% in Borena zone of Oromia Regional State [19], 5.7% in pastoral area of Borena lowland [18], 6.3% in Gursum district of eastern Hararghe zone [20]. This result is in agreement with the findings reports by [10], 8.3% in Jijiga, Eastern Ethiopia. Conversely, the current finding is lower than the report of 12.5% in Borena Zone [21], 19.5% reported by [22], 22.78% in the Deyniile district of Benadir Region, Somalia [23], 24.7% in Abu Dhabi, United Arab Emirates [24], and 24.7% in Kordofan state, Sudan [25]. In the present study, clinical mastitis with single quarter involvement was recorded in 85 % cases, while in rest 15% cases, two or more than udder quarters were affected.

In all cases of acute clinical mastitis observed in this study, inflammatory symptoms such as udder and teat swelling, redness, palpation pain, along with mild to moderate discoloration and the presence of flakes in milk were evident. Acute mastitis in camels, a form of clinical mastitis, was characterized by watery, yellowish, or bloody mammary secretions and enlarged mammary lymph nodes. These observations have been similarly reported by various researchers in the past [9, 19, 21].

The findings of the current survey were consistent with those of [9, 11], who identified acute and chronic mastitis as significant pathological conditions in she-camels in eastern Sudan. In this study, chronic mastitis had the highest prevalence (6.25%), followed by acute mastitis (2.5%). These results differed from those reported by [12] in the Butana area of Sudan, where acute, chronic and gangrenous mastitis had prevalences of 6.91%, 12%, and 0.061%, respectively. [26], also in the Butana area, reported prevalences of acute, chronic and gangrenous mastitis as 24.14%, 72.41%, and 3.45%, respectively.

Acute mastitis in camels accounted for 24.14% (6 out of 21 cases) of the cases observed in the study area. A study by [27] reported acute mastitis in camels constituting 22% of mastitis cases. Similarly, [28] found acute mastitis in camels to account for 24.14% of cases in the Butana region, Sudan, making it the second most common form after chronic mastitis. This condition is typically caused by pathogens like *Staphylococcus aureus* and *E. coli*, leading to symptoms such as fever, inflammation, and changes in milk composition [8].

Chronic mastitis in camels involves symptoms such as udder hardening, teat blockage, and sometimes atrophy. Affected udders often exhibit hardness due to fibrosis, without the presence of abscesses. In the study area, chronic mastitis was diagnosed in 71.42% (15 out of 21 cases) of instances. A significant factor associated with chronic mastitis was the texture of the udder. According to [27], camels with chronic mastitis are 3.61 times more likely to have hard udders compared to those with soft udders.

Several risk factors are known to significantly influence the incidence of camel mastitis, including factors related to the pathogen, the host, and the environment. Table (2) illustrates the correlation between tick infestation, the use of anti-suckling devices, stage of lactation, parity, and production system with the prevalence of mastitis. The findings of this study are consistent with [29, 26]; who highlighted that factors such as age, parity, season, stage of lactation, and husbandry practices can influence the risk of clinical mastitis in camels, similar to observations in cattle. Managing large camel herds requires stringent management practices, including maintaining high hygiene standards during milking, which can be particularly challenging in pastoral areas due to limited access to clean water, potentially leading to higher infection rates. [1, 27] identified age, parity, and lactation period as

significant risk factors for mastitis and noted that farmers often exhibit inadequate knowledge, practices, and attitudes towards mastitis control and management. Moreover, older camels may experience diminished physiological immune responses in their mammary glands, increasing their susceptibility to bacterial penetration and subsequent mastitis development.

The findings of this study demonstrated a positive association between the age of she-camels and the occurrence of clinical mastitis. Specifically, 57.14% of mastitis cases were identified in camels aged 15-27 years, 28.57 % in those aged 10-15 years, and 14.28% in the 5-9 years age group. Similarly, [19] did not find a significant effect of age on camel mastitis in Ethiopia, indicating variability across different studies and regions. Conversely, [26], along with [30], reported that she-camels above 9 years old were most susceptible to clinical mastitis. The observed increase in mastitis rates with years of camel husbandry can be attributed to several factors. After the age of 14 years, immunity of the animals is affected making them vulnerable to diseases [31]. Experienced farmers often manage larger herds, necessitating intensive management practices such as stringent milking hygiene standards. This can be particularly challenging in pastoral areas with limited access to clean water, potentially increasing infection rates. Additionally, older farmers may adhere to traditional management practices like teat tying, which can predispose camels to mastitis [1]. Moreover, the study by [16] revealed that the effects of parity, year of calving, and breed were statistically non-significant.

The current study indicates a significant association between the use of antisuckling devices and camel mastitis ($P < 0.05$). In the traditional husbandry practices observed in the study area, anti-suckling devices are used by tying them to the teat to prevent calves from suckling their dams. This practice aligns with the findings of [10, 28], who similarly reported that camel herders in the Afar region use soft bark to tie around teats to prevent suckling when calves begin herding with their dams.

In the current study, tick infestation was found to be significantly associated with camel mastitis ($p < 0.05$), as shown in (Table 2). This finding aligns with previous research [22], which suggested that heavy tick infestation of the udder, along with aggressive treatments like cauterization and the use of anti-suckling devices, could predispose camel udders to bacterial infections. Similarly, [32] reported a high prevalence of mastitis in dromedary camels in Borena, potentially linked to high rates of tick infestation in the examined herds.

Furthermore, the current study identified tick infestation on udders, causing skin and teat lesions that facilitate bacterial entry and lead to permanent tissue damage [31, 17]. However, [33,34] presented contrasting findings regarding the relationship between tick infestation and teat lesions, which could be attributed to differences in the sample sizes of camels examined with tick infestations compared to those with tick lesions.

The results of the univariate analysis indicated that the parity level influenced the prevalence of mastitis cases (Fig 8). This finding is in line with previous studies by [10, 16], which also observed that age and parity number affect mastitis prevalence. As camels age or increase in parity, physiological defense mechanisms of the udder may decrease, potentially allowing minor pathogens and opportunistic organisms to penetrate the glandular tissue and induce inflammation [10].

Moreover, treatments aimed at curing the disease may not always be effective, leading to persistent infections in camels or the persistence of disease until the next calving. Another possibility is that prolonged exposure to various risk factors increases the likelihood of infection, as noted by [35].

In this study, although there was no statistically significant variation in the prevalence of clinical mastitis concerning the stage of lactation, a positive relationship was observed between mastitis and lactation stage. The prevalence of mastitis was significantly higher in the early stages of lactation. According to [11], this could be attributed to new infections occurring primarily during the early dry period and within the first two months of lactation, particularly from environmental pathogens. However, this finding contrasts with the study by [12], who reported that the percentage of mastitis increased as lactation progressed.

Furthermore, the immune system of dairy camels significantly influences the incidence of mastitis and the severity of its clinical manifestations. It has been observed that severe mastitis occurs more frequently during early lactation. This finding is consistent with research by [36] in dairy cows.

Conclusions

This study enabled us to assess the incidence of clinical mastitis among camel herds in southeastern Algeria. Further research is needed in the region to explore the clinical aspects, causes, and antibiotic susceptibility of mastitis in female camels (Camelus dromedarius), involving a larger sample size in future studies.

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Conflicts of interest

The authors declared no competing interests.

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TABLE 1. Prevalence of clinical mastitis(Acute mastitis and Chronic mastitis) among she-camels according to the age group and season in Beni Guecha area.

	Number tested	Acute mastitis		Chronic mastitis		Overall	
		+ve	Prevalence (%)	+ve	Prevalence (%)	+ve	Prevalence (%)
Age group							
5-9 years	45	02	33.33	01	6.66	03	14.28
10-15 years	55	03	50	03	20	06	28.57
16-27years	140	01	16.66	11	73.33	12	57.14
Overall	240	06	2.5	15	6.25	21	8.75
Season							
Autumn	240	02	33.33	08	53.33	08	3.33
Winter	240	03	50	04	26.66	10	4.16
Spring	240	01	16.66	03	11.53	03	1.25
Overall	240	06	2.5	15	6.25	21	8.75

TABLE 2. Incidence of clinical mastitis with respect to risk factors

Risk factors	Unaffected	Affected	Incidence (%)	*P*- value
Anti-suckling device	06(06/21)	15 (15/21)	71.42	P < 0.05
Tick infestation	03 (03/21)	18 (18/21)	85.71	P < 0.05
Lesion of udder / teat	19 (19/21)	02 (02/21)	9.52	0.40
Saison				
Autumn	232	08	3,44	0.99
Winter	230	10	4,34	
Spring	237	03	1,26	
Age				
5-09	45	03	14.28	0.06
10-15	55	06	28.57	
16- above	140	12	57.14	
Number of calving				
1	20	01	5	0.80
2	27	03	11.11	
3	42	05	11.90	
04- above	151	12	7.94	
Lactation stages				
Early (0-3 month)	65	13	20	0.053
Mid (4-6 months)	55	03	5.45	
Late >7 months	120	05	4.16	
Overall	240	21	8.75	

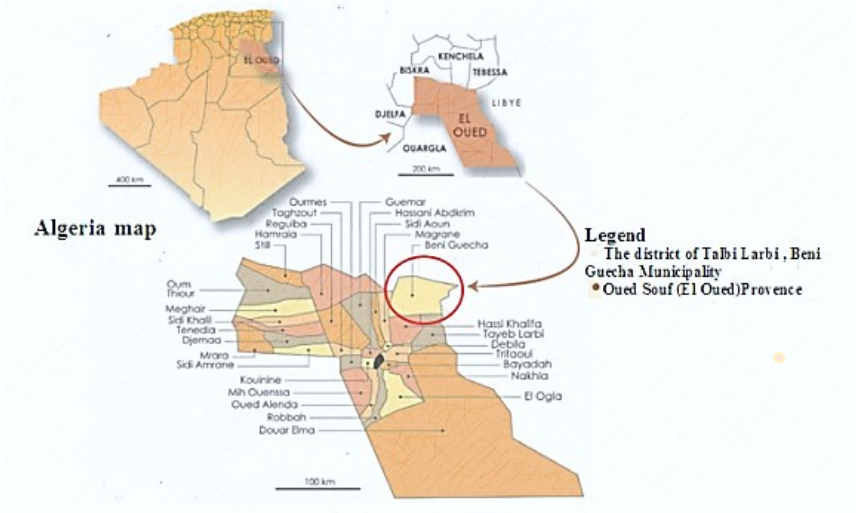

Fig.1. Algeria map

Fig.2. Antisuckling device

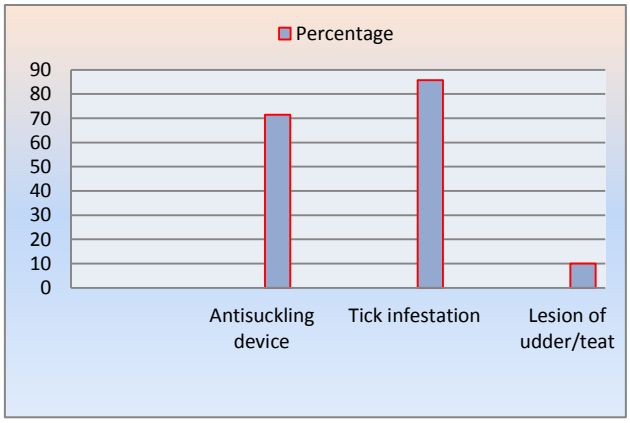

Fig. 3. The effect of anti-suckling devices, tick infestation and lesion of udders/ teat on camel mastitis

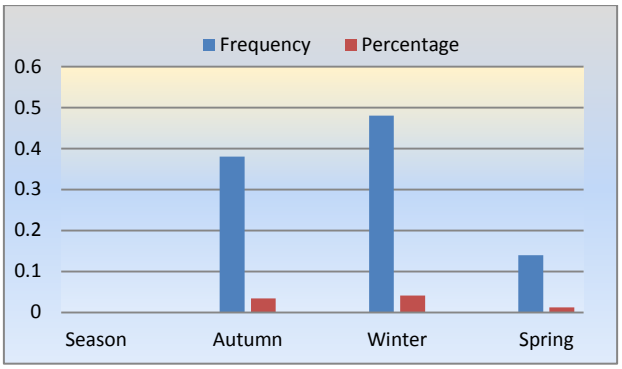

Fig. 4. Seasonal effects on mastitis

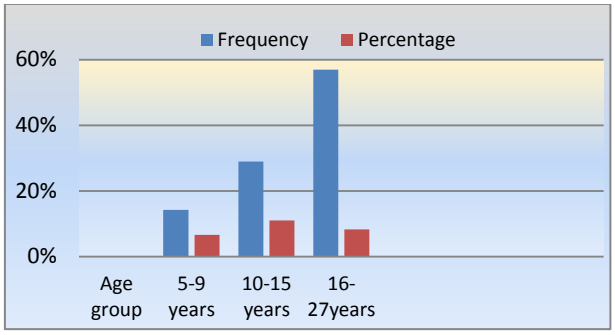

Fig. 5. Prevalence of mastitis among age groups

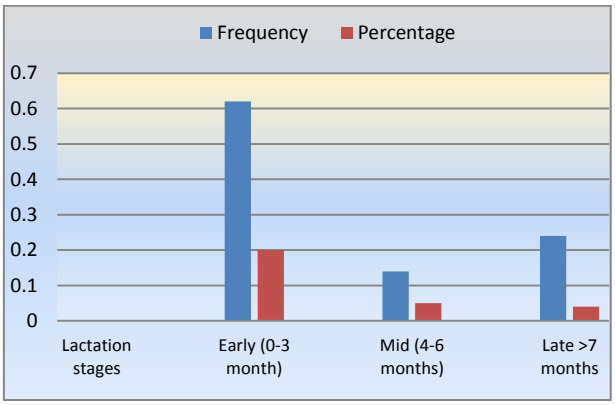

Fig. 6. Effect of stage of lactation on mastitis

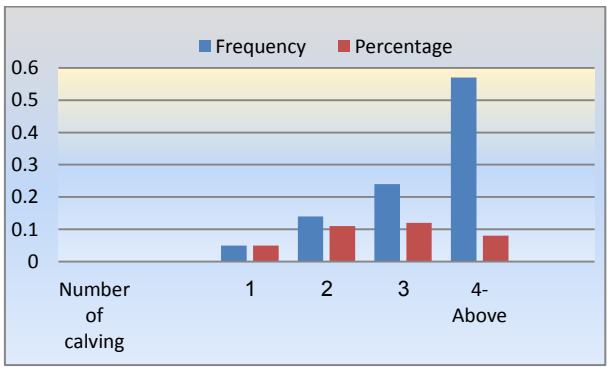

Fig.7. Effect of number of calvings on mastitis

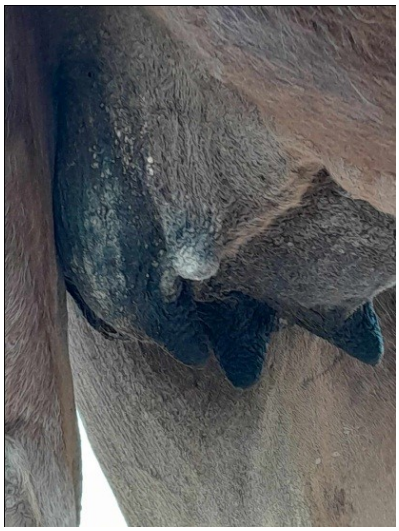

Fig. 8. Camel mastitis (Chronic mastitis)

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دراسة سريرية عن التهاب الضرع في الإبل (Camelus Dromedarius) في منطقة بني قشة، الجزائر

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الملخص

تهدف هذه الدراسة إلى تحديد أنواع مختلفة من التهاب الضرع وانتشارها في الإبل في جنوب شرق الجزائر. تم جمع البيانات من خلال استبيان شمل تسع قطعان في منطقة بني قشة، دائرة طالبي العربي، ولاية وادي سوف، حيث شملت الدراسة 240 جملاً على مدار ثلاثة فصول (الخريف، الشتاء، والربيع) من أكتوبر 2023 إلى مايو 2024. تم أخذ عوامل مثل الفصل، العمر، مرحلة الرضاعة، عدد الولادات، استخدام الأجهزة المضادة للرضاعة، وآفات الضرع في الاعتبار. تم ملاحظة وتسجيل الآفات الكبيرة في الضرع المصاب. بلغت نسبة انتشار التهاب الضرع السريري، كما تم تحديده من خلال الاستبيان، 8.75%. تم تحديد نوعين من التهاب الضرع السريري بناءً على العلامات السريرية والتغيرات الظاهرة في الحليب، وكان التهاب الضرع المزمن هو الأكثر شيوعًا بنسبة 6.25%، يليه التهاب الضرع الحاد بنسبة 2.5%. ووجدت الدراسة أن 71.42% من حالات التهاب الضرع تضمنت استخدام الأجهزة المضادة للرضاعة، في حين أن 28.53% لم تستخدم أي جهاز. كما كانت الإصابة بالقراد والأجهزة المضادة للرضاعة مرتبطة بشكل كبير ($p < 0.05$) بانتشار التهاب الضرع في الإبل الحلوب بين العوامل المحتملة. وبلغ انتشار التهاب الضرع 4.16% خلال المرحلة المتأخرة من الرضاعة، و5.45% خلال المرحلة المتوسطة، وبلغت النسبة الأعلى 20% خلال المرحلة الأولية. شملت الآفات المرضية المختلفة التهاب الضرع المزمن (71.42%) والتهاب الضرع الحاد (28.57%) بين الأضرع المصابة.

الكلمات الدالة: التهاب الضرع الحاد؛ الجمل، التهاب الضرع المزمن، دراسة سريرية، الضرع.