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Association between Clinical Mastitis and Zootechnical Performance in Algerian Dairy Cows

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ABSTRACT

Background: Clinical mastitis is one of the most important diseases in dairy cattle. This research aimed to assess the prevalence and risk factors of clinical mastitis, as well as to estimate their impact on the zootechnical performance of dairy cows.

Methods: The data was collected from 1134 lactations among 288 cows with clinical mastitis during the reference lactation, between 2019 and 2022.

Result: The prevalence of clinical mastitis was 12.2% and this increased with the parity. The cows in 2nd, 3rd and 4th lactation had prevalence rate of 10.7%, 12.3% and 18.8% respectively, compared to 7.3% in cows during their 1st lactation ($P<0.05$). Similarly, the incidence of clinical mastitis varied significantly with the calving season and the calving year ($P<0.01$). The clinical mastitis had a significant impact on reproductive performance; including days open (DO), conception rate at first service (CRF) and services per conception (SPC) ($P<0.05$). Furthermore, clinical mastitis had a significant negative impact on the dairy production performances ($P<0.05$). The cows with mastitis produce 321.2 liter of milk and 19.1 kg of fat, less than the cows that had no evidence of mastitis. In conclusion, Clinical mastitis continues to have a negative impact on the performance of dairy cows. It is recommended to support research for the development of new tools for early diagnosis and treatment of the disease in Algeria.

Key words: Dairy cow, Mastitis, Milk, Performance, Reproduction, Risk factors.

INTRODUCTION

Dairy farming is considered one of the pillars of Algerian agriculture, meeting 50% of the demand for milk consumption. Cow's milk accounts for 70% of this production (Houssou *et al*., 2024). A new development strategy was implemented to achieve a production of 2.5 to 4.5 billion liters of milk by 2022 in Algeria. However, various diseases and reproductive problems hamper the development of dairy farms and significantly affect farm profitability. Among these challenges, clinical mastitis remains the most prevalent disease affecting dairy herds (Waseem *et al*., 2020).

Mastitis can manifest as a clinical, subclinical or chronic form. Chronic and subclinical mastitis causes damage to the tissue of the mammary gland and a decrease in milk yield (Djeddi *et al*., 2025). Subclinical mastitis leads in milk loss of about 15% (Kalkan *et al*., 2025). This condition causes economic losses to the producer, including treatment costs, reduce herd productivity and veterinary and medication fees, as well as the marked increase of culling of incurable cows (Jia-Zhong *et al*., 2010; Karabasanavar *et al*., 2021). A recurrent mastitis is any infection that occurs in a period equal or less than 14 days from the previous infection (Molina *et al*., 2018).

Beyond the negative impact of clinical mastitis on the quantity and quality of milk, numerous studies have shown that clinical mastitis has a detrimental effect on the reproductive performance of dairy cows (Djeddi *et al*., 2024). Schrick *et al*. (2001) reported that bacterial clinical mastitis can prolong the interval from calving to first insemination. Other studies support these findings, showing that cows that developed mastitis early in lactation had prolonged calving-first insemination, increased days open and required more inseminations per conception (Kirk, 2004; Schrick *et al*., 2001). The clinical mastitis prevalence and risk factors have been reported in Algeria (Hocine *et al*., 2021; Seddar-Yagoub *et al*., 2024; Bouamra *et al*., 2024; Djeddi *et al*., 2024). However, the association between clinical mastitis with cows performances (fertility and milk production) is insufficiently investigated. The information

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related to the recurrent cases, the occurrence of clinical mastitis during calving season and calving year are rare. Such information is important when designing strategies to avoid this disease and control its effects.

The aim of this research was to estimate the prevalence of clinical mastitis, to assess the associated with key risk factors and performances (fertility and milk production) of cows in Souk Ahras in Algeria, an area renowned for its density of dairy cattle breeding. This information is required to avoid economic losses resulting from reproductive failures, reduced milk production and milk quality of dairy products.

MATERIALS AND METHODS

Study area

The data were collected between 2019 and 2022 in the Souk Ahras wilaya. Average monthly rainfall in this region, calculated from 1/01/2017 to 31/03/2023was 56.3 mm, reaching as high as 163 mm during the wettest months of the year. The average annual temperature was 18.7°C, with a minimum of 0°C recorded in February and a maximum of 41°C recorded in August.

Data collection

The dataset used in this study included detailed information on each cow's pedigree, reproductive performance, milk production and mastitis status. The cow's pedigree (cow number, sire number, breed, date of birth, origin, lactation rank); reproduction performance (calving interval (CI), days from calving to first insemination (DCFI), days from first insemination to conception or days open (DO), services per conception (SPC), conception rate at first service (CRF), calving season and calving year) and milk production (milk quantity per 305 days and fat content). The information collected on mastitis cows (date of occurrence of each case of clinical mastitis and the number of infections per reference lactation). Clinical mastitis is detected just before each milking. Therefore, the milkers examine all cows for signs of clinical mastitis. A case of clinical mastitis is defined by the alteration of the composition and appearance of the milk or by the inflammation of one or more quarters of the udder (redness, heat, tumor and pain). The cows' breeds in the herd are Montbeliard and Prim' Holstein, coming from two different origins: Europe and Algeria. The initial file consisted of 331 cows. To conduct a proper analysis, we eliminated lactations with missing or abnormal information: cows with an unknown date of birth, that represented 0.9% (3 cows); culled cows, represented 7.5% (25 cows); lactations in which clinical mastitis occurred after 305 days, represented 4.5% (15 cows). The final dataset consisted of 1,134 lactations from 288 cows.

Statistical analysis

Statistical evaluations were conducted utilizing the SPSS software (Version 20). The effect of risk factors keys such as lactation rank, calving season, calving year, the occurrence of clinical mastitis and recurrent was analysed using the chi-square test. Effects of clinical mastitis on the reproductive and dairy performances of cows was analysed using ANOVA test. Values were considered significant at P<0.05.

RESULTS AND DISCUSSION

Herd characterization and prevalence of clinical mastitis

The average age of the cows was 47.6 months, ranging from 24 to 76 months. The lactation ranks of the cows studied ranged from first to fourth. Calving was distributed throughout the year, with 34% occurring in winter, followed by 29% in spring, 20% in autumn and 17% in summer (Fig 1). Out of a total of 1,134 cows monitored over a five-year period, 139 experienced at least one episode of clinical mastitis during the reference lactation (305 days), representing a prevalence rate of 12.2%. The occurrence of clinical mastitis varied across lactation stages. The occurrence of clinical mastitis varied across lactation ranks. Among cows with mastitis, prevalence increased with lactation rank: 7.3% in first lactation, 10.7% in second, 12.3% in third and 18.8% in fourth (Table 1).

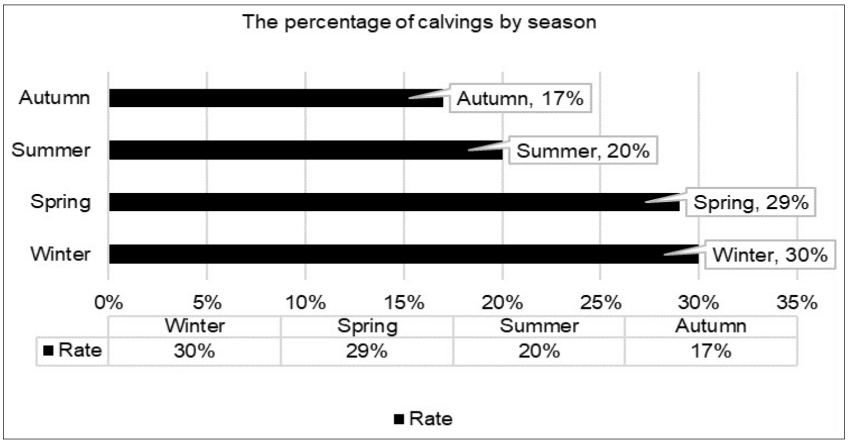

Fig 1: The percentage of calvings by season (Winter, spring, summer, autumn).

Lactation rank had a significant effect on mastitis prevalence (P<0.05). Calving season and year also influenced the rate significantly (P<0.01). Mastitis occurred year-round but was most frequent in cows that calved in winter, the wettest season. The incidence of clinical mastitis varied by year, peaking in 2020 and 2021 and decreasing in 2019 and 2022. Cows suffered from clinical mastitis several times during 305 days of lactation. The period of appearance of clinical mastitis in cows during the reference lactation was on average 45.9±29.4 days after calving, finally, the number of cases of mastitis during the reference lactation ranged from 2 to 4 with rate 10.8% and its coefficient of variation was 55% (Table 1).

Effects of clinical mastitis on reproductive performance

The impact of clinical mastitis on reproductive performance was assessed by comparing cows that had experienced at least one case of mastitis during the reference lactation period with those that had not. Consequently, the calving interval, days open and services per conception were all significantly influenced by clinical mastitis. (P<0.05), nevertheless, no significant effect of the calving-to-first insemination interval (P>0.05). Cows that experienced clinical mastitis had a 26.3-day longer interval from first insemination to conception (DO) compared to cows without mastitis. Cows affected by mastitis required more services per conception, averaging 2.99 inseminations. This was 0.98 inseminations higher than the average for healthy cows (Table 2).

Effects of clinical mastitis on milk production

Milk production was compared between cows with and without clinical mastitis during the reference lactation. The milk yield and fat content were significantly influenced by clinical mastitis (P<0.01 and P<0.05), respectively. Cows with clinical mastitis produced 321.2 liters less milk and 19.1 kg less fat than cows without mastitis during the same lactation period (Table 2).

Herd characterization and prevalence of clinical mastitis

In this research, it is a follow-up of the same cows for four years in succession, which makes cows with and without mastitis cases had similar lactation rank, ages at calving. The rate of clinical mastitis in the studied herd was 12.2%, very close to value 12.8% reported by Girma and Tamir (2022) in Ethiopia. This rate is higher than those reported

Table 1: Prevalence of clinical mastitis by risk factor in dairy cows (n = 1134 lactations).

Risk factors	N	Prevalence of CM (%)	CV %	P-value
Lactation rank	1134	12.2	51	0.04
1	288	7.3		
2	288	10.7		
3	282	12.3		
4	276	18.8		
Calving season	139	100		
Spring	33	23.7	105	0.004
Summer	21	15.1		
Autumn	30	21.6		
Winter	55	39.6		
Calving year	139	100		
2019	10	7.2	73	0.007
2020	40	28.7		
2021	59	42.5		
2022	30	21.6		
Variables	N	Mean ± SD	CV %	P-value
Occurrence of CM	139	45.9±19.4	44	/
CMR	15	10.8%	55	/

N: Number, CM: Clinical mastitis, CMR: Clinical mastitis recurrent, CV %: Coefficients of variation, SD: Standard of deviation.

Table 2: Comparison of reproductive and milk production parameters between cows with and without clinical mastitis.

Cows	CI (D) N=1134	DCFI (D) N=1134	DO (D) N=1134	SPC N=1134	CRF (%) N=1134	MP (L) N=564	Fat (kg/l) N=564
With mastitis	372±9.37	72.3±4.25	105.5±7.13	2.99±0.61	31	4677.9±88.7	190.6±1.71
Healthy	361±5.94	69.1±3.12	79.2±5.02	1.96±045	40	4356.7±57.6	171.5±2.33
P	0.028	0.145	0.037	0.032	0.041	0.003	0.043

CI: Calving interval; DCFI: Days from calving to first insemination; DO: Days open (Interval between calving and conception (days); SPC: Services per conception; CRF: Conception rate at first service; MP: Milk production; D: Days, L: Liter, Kg: Kilogram.

by Hocine *et al*. (2021) and Akkou *et al*. (2024) in Algeria, 9.80% and 6.3% respectively. This rate is lower than those reported by Saidani *et al*. (2024) in Algeria, Krishnamoorthy *et al*. (2021) in India and Borş *et al*. (2024) in Romania, which are respectively 15.1%, 17.25%, 18% and 19.1%, Krishnamoorthy *et al*. (2021) report that clinical mastitis affects around 29% of cows in Europe and approximately 22% in North America. However, it is slightly less prevalent in Asia (18%) and Africa (12%).

The prevalence of clinical mastitis in dairy cattle farms could be due to the failure of standard recording systems (Houssou *et al*., 2024). The different results obtained from similar studies may be related to the age of cows, level of milk production, the genetic makeup of the cows, the methods of mastitis treatment or the percentage of primiparous cows. There could also be the possibility of under-recording of cases of clinical mastitis, particularly in the context of a retrospective study (Krishnamoorthy *et al*., 2021; Hocine *et al*., 2021; Saidani *et al*., 2024).

Lactation rank has a significant effect on the clinical mastitis rate. Cows in their second, third and fourth lactations showed higher mastitis rates: 10.7%, 12.3% and 18.8%, respectively compared to 7.3% in first-lactation cows (P<0.05). These finding are consistent with that reported by several authors (Krishnamoorthy *et al*., 2021), who reported that cows beyond their first lactation are at greater risk of developing clinical mastitis. Our results also align with those of Hocine *et al*. (2021) in Algeria, who observed a similar trend, reporting mastitis rates of 3%, 10%, 14% and 23% in first to fourth lactations, respectively. The increased susceptibility in higher-parity cows may be attributed to changes in the physical characteristics of the cows' udder; the proximity of the teats to the ground and the increase in the permeability of the teat canal sphincter (Cheng and Han, 2020).

The incidence of clinical mastitis is significantly influenced by the calving season (P<0.01). In our study, mastitis incidence was highest in cows that calved during winter. The incidence of mastitis recorded during winter is 39.6%. A similar value 36% was found by Kumar *et al*. (2016) during the same period. However, this result is not consistent with that reported by Hogan and Smith (2003) who indicated that calving in warm periods is more predisposing to mastitis, this is related to the high prevalence of environmental germs. Rainy conditions increase udder moisture, favouring bacterial growth. Environmental conditions that increase udder humidity, particularly rainfall, can elevate the risk of mastitis by promoting bacterial proliferation (Krebs *et al*., 2023). Indeed, the humidity and temperature of the litter are two key criteria supporting bacterial development. Furthermore, the increase in the rate of clinical mastitis during the winter may be linked to poor bedding hygiene, where high moisture and temperature levels promote microbial contamination and increased teat soiling. On the other hand, the building design system in the farm studied (free stall and completely open buildings) may expose cows to cold stress and increased risk of udder injuries during the winter.

The period of occurrence of clinical mastitis in cows during the reference lactation was on average 45.9±29.4 days after calving. This could be explained by the fact that cows in early lactation are more vulnerable to clinical mastitis due to metabolic peak vulnerability during early lactation due to a combination of immune system compromise and metabolic stress (Zigo *et al*., 2021). The risk of clinical mastitis is generally highest during the first two months of lactation, which coincides with the period of peak production. This observation aligns with (Lescourret *et al*., 1995) who stated that the first months of lactation represent the periods of greatest risk. This increased risk may result from residual infections originating at dry-off, or from new infections introduced during early post-calving milking or *via* contaminated bedding.

The rate of clinical mastitis recurrent recorded (CMR) (10.8%), due to poor bedding and hygiene practices in cow stalls, or antimicrobial resistance following misdiagnosis of mastitis. According, Molina *et al*. (2018), the CMR can result from cow-related factors such as immune response, pathogen characteristics (*e.g*., antimicrobial resistance, virulence, pathogenicity) and treatment-related issues including incomplete therapy, inappropriate administration route, or insufficient drug concentration and spectrum.

Effects of clinical mastitis on reproductive performance

Clinical mastitis significantly increased the number of days open by 26.3 days (P = 0.037). Similar results were repored by Borş *et al*. (2024) who stated that cows had an interval from calving to first AI 30 days longer than that of healthy cows. According to Temesgen *et al*. (2022), it is the major parameter used to determine the reproductive performance and to make an economic decision in dairy herds. While no significant difference was observed in the calving-to-first insemination interval (DCFI) (P = 0.145), affected cows required significantly more services per conception (SPC), with an average increase of 1.03 inseminations (P = 0.032). The conception rate at first service was also significantly lower in mastitis cows (P = 0.041). These findings are consistent with reports by Borş *et al*. (2024), who observed longer intervals to conception and reduced reproductive efficiency in cows with clinical mastitis. Similarly, Borş *et al*. (2024) revealed that clinical mastitis influence significantly conception rate at first service. Houssou *et al*. (2024) reported that the occurrence of clinical mastitis (CM) during the period from the first insemination decreased the efficiency of the procedure, lowering the conception rate (CR) and increasing culling, as well as the percentage of embryo deaths and abortions.

Clinical mastitis caused by Gram-negative pathogens stimulates the production of prostaglandin F2α (PGF2α), which can lead to luteal regression and even loss of an established pregnancy (Kirk, 2004). Clinical mastitis in early lactation has an influence on energy balance; it increases body weight losses and prolongs the period of energy deficit, which delays follicle maturation and the resumption of the ovarian cycle (Borş *et al*. 2024; Houssou *et al*., 2024). Huszenicza *et al*. (2005) stated that the increase in the number of inseminations in cows with the first case of clinical mastitis between the first insemination and the fertilizing insemination can be explained by the production of bioactive molecules induced by clinical mastitis in the cow's genital tract. For example, *E. coli* endotoxin can induce a massive release of cytokines that cause neural and endocrine-mediated changes). Also, the effect of clinical mastitis on reproduction could be exerted at the level of the hypothalamic-pituitary-ovarian axis.

Effects of clinical mastitis on dairy performance

Clinical mastitis significantly reduced milk yield in affected cows, with an average loss of 321.2 kg per lactation. According to Hagnestam *et al*. (2007), milk losses varied from 0 to 902 kg depending on lactation rank. Heikkilä *et al*. (2018) in turn, estimated daily milk loss for *E. coli* mastitis of 3.5 kg/d. This aligns with our findings, as Bezman *et al*. (2015) also reported a 25% reduction in milk yield due to mastitis. The authors observed differences in the yield reduction depending on the mastitis-causing pathogen. Yield reduction varied by pathogen, with 20% for *S. dysgalactiae* and up to 50% for *E. coli* (Stanek *et al*., 2024). Chronic intramammary infections are often caused by environmental pathogens such as coagulase-negative staphylococci, non-agalactiae streptococci and coliforms (Cheng and Han, 2020; Jayasri *et al*., 2023; Stanek *et al*., 2024).

Clinical mastitis affects milk fat production in dairy cows, with an average fat loss of 19.1 kg over a 305-day lactation period. Bochniarz *et al*. (2023) also noted a decrease in milk fat content. During mastitis, fat degradation occurs due to the activity of various enzymes present at the site of inflammation, which impair milk composition and mammary gland function. According Jia-Zhong *et al*. (2010), pathogens responsible for clinical mastitis rapidly multiply and invade mammary tissue, leading to inflammation and tissue damage. The proliferation of germs is accompanied by the production of enzymes and toxins that will damage the secretory tissue and cause a qualitative change in the milk produced. Once the mammary gland inflammation is produced, the synthetic activity of the mammary gland decreases and the composition of the milk changes.

CONCLUSION

Analysis of lactations from records showed that the highest risk of mastitis was observed in cows calving during the winter period, also during 2021. This increase was likely due to adverse weather conditions, such as elevated rainfall and humidity, which contributed to a higher incidence of clinical mastitis. Clinical mastitis had a pronounced impact on reproductive performance, including prolonged calving intervals and increased days open, as well as a higher number of services required per conception. The dramatic effects of clinical mastitis on milk production were observed on both milk yield and fat content. The importance of increased screening and prevention of clinical mastitis in early lactation, but also with good diagnosis to avoid recurring cases of the disease are recommended.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

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