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Influence of parity, stage of lactation, lactation strength and quarter position on intramammary infection in dairy cattle

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Abstract
Mastitis is a multi-factorial and multi-etiological disease which adversely affects dairy animals and economics of milk production of dairy farms in developed and developing countries like India. A variety of factors affect the incidence of clinical mastitis in crossbred cows. During the study period, a total of 50 crossbred lactating cows suffered from clinical mastitis with any one quarter were undertaken for evaluation. During the study, we tried to investigate the effect of four non-genetic factors viz., parity, stage of lactation, lactation strength and quarter position on incidence of clinical mastitis in crossbred cows. The percentage of incidence of clinical mastitis was significantly highest ($p<0.05$) in right rear quarter (38%). Similarly maximum incidence of clinical mastitis was observed in third parity (40%). Stages of lactation also have a significant effect on incidence of mastitis and it was found highest (48%) in early lactation (up to 90 days) followed by mid and late lactation. It was also observed that incidence of mastitis was significantly ($p<0.05$) highest in cattle which produces more than 15 litres of milk/day. Therefore it can be inferred that hind quarters are more affected to mastitis due to frequent exposure of dung and urine. Animals in advance parity were also more affected, it indicate that widened teat canal, elongated teat shape and peak lactation predisposes animal to mastitis. One important reason for higher prevalence of clinical mastitis during early lactation is that, many a time the new infections are observed in the dry period and most of these infections persist until the next lactation, causing clinical symptoms within the first 2 week after calving. High-producing animals are more prone to mastitis due to lactational stress.

Keywords: Clinical mastitis, incidence, parity

Introduction
Mastitis is defined as inflammation of parenchyma of mammary gland and is characterized by physical, chemical and usually bacteriological changes in milk and pathological changes in glandular tissues (Constable *et al*., 2017) [6]. It is a multi-factorial disease which adversely affects dairy animals and economics of milk production of dairy farms in developed and developing countries like India. Mastitis could be classified as clinical and subclinical (Duguma *et al*., 2014) [9]. In contrast to absence of visible change in subclinical form of mastitis, there is visible change in milk or udder in case of clinical mastitis. Cow suffered with clinical mastitis is usually accompanied by swelling, heat, pain and indurations of udder along with discolouration, appearance of clots, flakes, pus and change in consistency of milk.

India has a cattle population of 192.49 million, out of which 50.42 million were crossbred (Livestock census, 2019) [20]. Despite all efforts to control its spread, mastitis remains the most costly disease for dairy farmers worldwide (Cressier and Bissonnette, 2011) [7]. It is responsible for heavy economic losses due to reduced milk yield (up to 70%), milk discard after treatment (9%), cost of veterinary services (7%) and premature culling (14%) (Bhikane and Kawitkar, 2000) [4]. In India, total losses due to mastitis per lactation in nondescript (ND) cow, crossbred (CB) cow and buffalo were Rs. 868.34, Rs. 1,314.10 and Rs. 1,272.36 respectively (Singh *et al*., 2014) [27]. The crossbred cattle showed more mean reduction in milk yield due to clinical mastitis than indigenous cows (Kumar *et al*. 2010; Bangar *et al*. 2018) [16, 2]. The high losses in crossbred cows may relate to high milk production. Additionally, crossbred cows were more susceptible to intra mammary infection as compared to indigenous cows (Constable *et al*., 2017; Sharma and Maiti 2010) [6, 25]. The incidence of mastitis was low and ranged between 5.96 and 27.9% in indigenous cows (Shinde *et al*. 2001; Dhakal 2002; Pal 2003; Taraphder *et al*. 2006; Khate and Yadav 2010) [26, 8, 24, 32, 15], while the prevalence of

clinical mastitis in crossbred cows ranges between 5 and 37% (Bangar *et al*. 2016) [1] and it is associated with many animal and environmental level factors (Van Den Borne *et al*. 2010) [34]. It commonly occurs in cows with high milk production and has an adverse long-lasting effect on milk yield. An animal, once affected with mastitis, can never reach to pre-mastitis milk yield and produces less milk throughout the rest of the lactation (Lescourret and Coulon 1994) [19]. A variety of factors affect the incidence of clinical mastitis in crossbred cows. So this study aimed to investigate the incidence of clinical mastitis during different parity, stage of lactation, lactation strength and quarter position in crossbred cows.

Materials and Methods

The crossbred cows presented with symptoms of clinical mastitis in Veterinary Clinical Complex, Bihar Veterinary College, Patna which were mostly coming from local cow sheds/khatals, dairy cows affected with clinical mastitis from Livestock Farm Complex, Bihar Veterinary College, Patna and different Private dairy farm in and around district of Patna, Bihar state from March 2020 to February 2022 were taken for study.

The dairy cows presented with any or combined clinical signs suggestive of clinical mastitis like chunks, flakes, clot or blood in milk, swelling, redness, hardening, heat or pain in affected quarter or udder and the general condition of animal like high fever (103-105^{0}F), loss of appetite and rumination along with affection of quarter or milk etc. were included in the study. A total of 50 crossbred cattle irrespective of stage of lactation, lactation strength and parities having only one quarter affected were selected for study.

The data on stage of lactation, parity, level of milk production and quarter position were classified as per the variation(s) observed. On the basis of parity order, animals were divided into four parity groups: First Parity, Second Parity, Third Parity and Fourth& above Parity. For level of milk production, the data were classified into three production groups i.e. low producer (5-10litres/day), medium producer (>10-15litres/day) and high producer (>15litres/day). The Stage of lactation was calculated from the difference of date of calving to the date of onset of clinical mastitis in the animals. The number of days in milk at the time of onset of mastitis was considered to define the stage of lactation for each animal. The lactation data were partitioned as early (0–90days), mid (91–180 days) and late (above 180 days) stage. The quarter position were classified as left fore (LF), left rear (LR), right fore (RF) and right rear (RR).

Statistical analysis

Data thus generated was statistically analysed by using different software. Chi-square test was applied to evaluate the significance of difference of the incidence of infection. It was performed for comparison of quantitative data among the groups using Graph Pad Calculator. The values with $p \leq 0.05$ were considered as statistically significant.

Results and Discussion

Patna district is situated between 25º13′ and 25º45′ North latitude and 84º 43′ and 86º 44′ East longitude with a height of 51 meters above mean sea level. Patna is located on the southern bank of the river Ganges. The city is bounded in the north by river Ganga, in the south and east by river Punpun and in the west by river Sone.

A total of 50 crossbred lactating cows were screened during the study which suffered from clinical mastitis. These cows belonged to local cow sheds/khatals (29/50), private dairy farms (14/50) and livestock farm complex, BASU, Patna (7/50).

During present study, the highest percentage (58%) of mastitic cow was observed in local cow sheds/khatals followed by private dairy farm (28%). The lowest percentage (14%) of mastitic cow was observed in livestock farm complex, BASU, Patna (Table 1). The possible cause of lowest mastitic infection among cattle of livestock farm complex might be due to good management practices and hygienic milking procedure. A variety of non-genetic factors affect the incidence of clinical mastitis in crossbred cows. The data on stage of lactation, parity, level of milk production and quarter position were recorded as per the variations observed.

Quarter wise incidence of clinical mastitis

Total 200 quarters of 50 mastitic cows were physically examined for inflammation, pain, flakes or clots in milk etc. Studies on the quarter wise incidence of clinical mastitis indicated significantly ($p<0.05$) highest incidence in the right rear quarter (38% ; 19/50) followed by left rear quarter, right fore quarter and left fore quarter, as 32% (16/50), 16% (8/50) and 14% (7/50) respectively (Table 2). The finding was in conformity to the finding of Khan and Muhammad (2005) [14] who reported highest prevalence in left hind quarter (34.70%) followed by the right hind quarter (27.80%), right fore quarter (19.40%) and left forequarter (18.10%). The finding also is in agreement with Sudhan *et al.* (2005) [31], who reported that right hindquarter, was the most affected (38.18%) compared with the other quarters. The observation is appreciated with finding of Srinivasan *et al.* (2013) [30] who reported 11.11, 46.30, 5.5 and 37.04% prevalence of subclinical mastitis in LF, LR, RF and RR quarters respectively. Thakur *et al.* (2021) [33] also observed that hind quarters (32.31%) are more prone to mastitis than front quarters (15.46%) in bovine and right hind quarter was having the highest prevalence while left front quarter was found to be the least prevalence. More frequent exposure of hindquarters to dung and urine might be responsible for a higher prevalence of mastitis (Chakrabarti, 2007 and Thakur *et al.* 2021) [5, 33]. Many a time, unusual stress caused due to pulling of the hind quarters forward and sideways during milking make them more prone to mastitis as compared to fore quarters (Srinivasan *et al.*, 2013) [30]. In most of the dairy cattle rear teats are larger in size and produces more milk which might predispose it to mastitis more as compare to forequarters.

Parity wise incidence of clinical mastitis

Studies revealeda significant ($p<0.05$) difference among animals of different parity in relation to susceptibility to clinical mastitis and the highest incidence was found in third parity (20/50 i.e., 40%), followed by second parity (14/50 i.e., 28%), fourth and above parity (9/50 i.e., 18%) and first parity (7/50 i.e., 14%) (Table 3). Nauriyal and Verma (2009) [23] also recorded highest prevalence of subclinical mastitis in second parity. However, Singh *et al.* (2021) [29] observed a different pattern with highest prevalence of mastitis in2nd parity (66.67%), followed by 1st parity (43.33%), 4th parity (40.75%), 3rd parity (30.00%), 5th parity (19.44%), 6th parity (13.04%) and lowest at 7th and above parity (8.57%). In contrast to present study, several other workers (Islam *et al.*,

2008 [12], Maheshwari *et al.*, 2016 [21] and Mourya *et al.*, 2020 [22]) reported highest prevalence of subclinical mastitis in fourth parity. Sinha *et al.* (2019) [28] also observed that in Karan Fries and Sahiwal cows, the percentage of incidence of clinical mastitis was maximum in fourth parity i.e. 41.1% and 52.8% respectively. The results are also in agreement with Lalrintluanga *et al.* (2003) [18] who reported a higher prevalence rate of mastitis in 3-6 years of age, might be predisposed by peak lactation. Animals in advance parity were more affected to clinical mastitis indicate that widened teat canal, elongated teat shape and peak lactation predisposes animal to mastitis.

Incidence of clinical mastitis as per stage of lactation:

Studies on the occurrence of clinical mastitis with respect to stage of lactation differ significantly ($p<0.05$) and it was found to be highest (24/50 i.e., 48%) in early lactation (up to 90 days) followed by mid lactation (17/50 i.e., 34%, 91-180 days) and lowest (9/50 i.e., 18%) in late lactation (above 180 days). (Table 4)

The finding is in close agreement with the observation of Gebrekrustos *et al.* (2012) [10] who observed that clinical mastitis was highly prevalent at the early stage of lactation (5.8%) followed by mid and late stage of lactations with the rates of 3.4% and 3.1% respectively. Singh *et al.* (2021) [29] also recorded highest (36.54%) prevalence in early stage of lactation followed by late (34.38%) and mid (27.78%) stages of lactation. In contrast to present study Kurjogi and Kaliwal (2014) [17] observed that cows with latter part of lactation period were more prone to mastitis. However Sinha *et al.* (2019) [28] observed that stage of lactation had no significant effect ($p>0.05$) on incidence of clinical mastitis in Karan Fries and Sahiwal cows.

The present study is in agreement with Constable *et al.* (2017) [6] which suggested that the mammary gland is more susceptible to new infection during the early and late stage of lactation, due to the absence of udder washing and teat dipping, which in turn may have increased the number of potential pathogens on the skin of the teats. One important reason for higher prevalence of clinical mastitis during early lactation is that, many a time the new infections are observed in the dry period and most of these infections persist until the next lactation, causing clinical symptoms within the first 2 week after calving.

Incidence of clinical mastitis as per lactation strength

Studies on the occurrence of clinical mastitis with relation to lactational strength revealed significantly ($p<0.05$) highest incidence in cattle yielding more than 15 litres of milk / day (25/50 i.e., 50%) followed by 10 - 15 litres of milk production / day (16/50 i.e., 32%) and the least incidence (9/50 i.e., 18%) was recorded in cows producing5 - 10 litres of milk / day (Table 5). Similar observations were made by Jingar *et al.* (2014) [13] and Sinha *et al.* (2019) [28] who reported that the level of milk production significantly affect the incidence of clinical mastitis in cattle. The dairy animals having higher milk yield suffered more with mastitis in comparison to medium and low milk yielder. Grohn *et al.* (2004) [11] also found that mastitis occurred more frequently in cows with higher milk production. Barua *et al.* (2014) [3] also observed a significant ($p<0.05$) association of milk yield with occurrence of mastitis and reported that high yielding dairy cows are more prone to mastitis as the glandular tissues are more susceptible to infection. It is also attributed to the reduced immunity due to lactational stress.

Table 1: No. of Healthy & Mastitic cow selected for study from different sources.

Source of Animals	No. of Healthy Animals Selected for Study	Value of Chi-Square	*p*-value ($p<0.05$)	No. of Mastitic Animals Selected for Study	Value of Chi-Square	*p*-value ($p<0.05$)
VCC, BVC, Patna (Local Cow Sheds/Khatals)	5 (50)	χ22df 1.40 ^{NS}	0.4966^{NS}	29 (58)	χ22df 15.160**	0.0005**
Private Dairy Farm	3 (30)			14 (28)		
LFC, BASU, Patna	2 (20)			7 (14)		
Total	10			50		

Values within parenthesis indicate percentage (%)

** Significant at $p<0.01$, NS -Non significant at $p>0.05$

Table 2: Quarter wise incidence of clinical mastitis in cattle.

Quarter Disposition	No. of Quarter Screened	No. of Quarter Affected	Percentage (%)	Value of Chi-Square	*p*-value ($p<0.05$)
Right Fore (RF)	50	8	16	X^2 3df 8.400*	0.0384*
Right Rear (RR)	50	19	38		
Left Fore (LF)	50	7	14		
Left Rear (LR)	50	16	32		
Total	200	50			

* Significant at $p<0.05$

Table 3: Parity wise incidence of clinical mastitis in cattle.

Parity	No. of Cattle Screened	No. of Cattle Affected	Percentage (%)	Value of Chi-Square	*p*-value ($p<0.05$)
First	50	7	14	X^2 3df 8.080 *	0.0444*
Second		14	28		
Third		20	40		
Fourth and Above		9	18		
Total	50	50			

* Significant at $p<0.05$

Table 4: Incidence of clinical mastitis in cattle as per stage of lactation.

Stage of Lactation	Total No. of Cattle Screened	No. of Cattle Affected	Percentage (%)	Value of Chi-Square	*p*-value ($p<0.05$)
Early Lactation (0 – 90 days)	50	24	48	X^2 2df 6.760 *	0.0340*
Mid Lactation (91 – 180 days)		17	34		
Late Lactation (above 180 days)		9	18		
Total	50	50			

* Significant at $p<0.05$

Table 5: Incidence of clinical mastitis in cattle in relation to lactation strength.

Milk Production (litres/day)	Total No. of Cattle Screened	No. of Cattle affected with Clinical Mastitis	Percentage (%)	Value of Chi-Square	*p*-value ($p<0.05$)
5 to 10	50	9	18	X^2 2df 7.720 *	0.0211*
> 10 to 15		16	32		
> 15		25	50		
Total	50	50			

* Significant at $p<0.05$

Conclusion

It might be concluded that the quarter wise incidence was significantly ($p<0.05$) highest in right rear quarter (19/50 i.e., 38%) followed by left rear quarter (16/50 i.e., 32%), right fore quarter and left fore quarter. The parity wise incidence of clinical mastitis was found highest in third parity (20/50 i.e., 40%) followed by second, fourth and above and first parity. As per stage of lactation, incidence of mastitis was found to be highest (24/50 i.e., 48%) in early lactation (up to 90 days) followed by mid lactation (17/50 i.e., 34%, 91-180 days) and lowest (9/50 i.e., 18%) in late lactation (above 180 days). Incidence of mastitis was found significantly ($p<0.05$) highest in cattle which produces more than 15 litres of milk/day (25/50, i.e., 50%) followed by more than 10 to 15 litre and least in cow which produced 5 to 10 litres of milk/day.

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