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Physico-chemical characteristics of milk in the diagnosis of caprine clinical mastitis

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Abstract
Mastitis is a disease known to affect the economy of farmers since ages and is the main concern of dairy farmers. The key factors which alter in the milk during mastitis are the physical (colour, consistency and odour) and chemical characteristics (pH and electrical conductivity) which are mainly focused in this article. The study was carried out at Large Animal Medicine Unit, Veterinary College and Research Institute, Tirunelveli over a period from January 2024 to October 2024 with five groups of six animals each (n=6). The mastitis affected does which received antibiotic plus antioxidant showed a better recovery rate when compared to groups which received antibiotic alone and among the antibiotic plus antioxidant group Enrofloxacin with Vitamin E and Selenium had a better recovery rate than rest of the groups.

Keywords: Caprine mastitis, pH, electrical conductivity, antioxidant therapy

Introduction
Goat is a versatile animal and is known as the "poor man's cow" in India. Goat serve as a multi functional animal and are reared for milk, meat, hair and hide. India ranks first in goat milk production globally with a total of 7.59 million tonnes as per 2023 census and contributes 3.3 per cent of the country's total milk production. Goat milk is used by the rural population as a source of milk which differs from cow milk in having better digestibility, alkalinity, buffering capacity and certain therapeutic values (Park *et al.*, 2010) [1]. Mastitis is a disease with different disease complex having different causes, different degrees of intensity and variation in duration and residual effects (Schalm *et al.*, 1971) [2]. Mastitis is classified into three distinct forms based on the degree of inflammation, sub-clinical, clinical and chronic (Chen and Han, 2020) [3]. The does affected with clinical mastitis showed variation in physico-chemical characteristics of milk which aided in the diagnosis of mastitis.

Materials and Methods
The study was carried out at Large Animal Medicine Unit, Veterinary College and Research Institute, Tirunelveli over a period from January 2024 to October 2024. The goats presented to Large Animal Out-patient Medicine Unit of Veterinary Clinical Complex, Veterinary College and Research Institute, Tirunelveli with systemic signs (increased body temperature, increased heart rate and reduced appetite), altered physical characteristics of udder (redness, swollen, hard painful) and milk (colour, consistency, odour) were taken up for the study. Milk samples were collected from the affected quarter and physical characteristics of milk (colour, consistency, odour) and chemical characteristics of milk (pH and electrical conductivity) were evaluated. The design of study is as shown below:

S. No	Group (n=6)	Details
1	I	Control : Apparently healthy lactating goats
2	II	Mastitis affected goats: Treated with Injection Enrofloxacin @ 5 mg/kg intramuscular for 8 days
3	III	Mastitis affected goats: Treated with Injection Enrofloxacin @ 5 mg/kg intramuscular for 8 days + Injection Vitamin E and Selenium @ 1mL/25kg intramuscular
4	IV	Mastitis affected goats: Treated with Injection Gentamicin @ 4 mg/kg intramuscular for 8 days
5	V	Mastitis affected goats: Treated with Injection Gentamicin @ 4 mg/kg intramuscular for 8 days + Injection Vitamin E and Selenium @ 1mL/25kg intramuscular
	***	Injection Vitamin E and Selenium were administered intramuscularly on day 0 and day 4 only

Results

Physical Characteristics of Milk

Goats affected with clinical mastitis showed changes in the colour (whitish, greenish, yellowish and reddish), consistency (watery, thick, flaky, clotted and curded) and odour of milk (odourless, foul and pungent) and the same was recorded on day 0 and presented in Table 1.

Table 1: Physical characteristics of milk recorded on Day 0

Group	A. No.	Udder halves Affected	Colour	Consistency	Odour	Organism Isolated
II	1	Left	Whitish	Watery	Foul	*Proteus sp*
	2	Left	Yellowish	Thick	Foul	*Staphylococcus sp*
	3	Left	Yellowish	Thick	Foul	*Staphylococcus sp*
	4	Both Right and left	Yellowish	Thick	Foul	*Staphylococcus sp*
	5	Left	Whitish	Watery	No odour	*Bacillus sp*
	6	Both Right and left	Yellowish	Thick	Foul	*Staphylococcus sp*
III	1	Right	Yellowish	Thick	Foul	*Staphylococcus sp*
	2	Right	Greenish	Flaky	No Odour	*Klebsiella sp*
	3	Left	Yellowish	Thick	Foul	*Staphylococcus sp*
	4	Left	Whitish	Watery	No Odour	*Bacillus sp*
	5	Left	Whitish	Clotted	Foul	*Mixed infection (Bacillus + Klebsiella sp)*
	6	Left	Yellowish	Watery	No Odour	*Staphylococcus sp*
IV	1	Right	Whitish	Watery	Foul	*Escherichia coli*
	2	Left	Reddish	Clotted	Pungent	*Mixed infection (Pseudomonas + Proteus)*
	3	Left	Greenish	Curdled	Foul	*Klebsiella sp*
	4	Right	Whitish	Clotted	Foul	*Mixed infection (Clostridum + Bacillus sp)*
	5	Right	Whitish	Curdled	Foul	*Escherichia coli*
	6	Both Right and left	Whitish	Watery	No Odour	*Bacillus sp*
V	1	Left	Greenish	Curdled	No Odour	*Klebsiella sp*
	2	Left	Yellowish	Watery	No Odour	*Staphylococcus sp*
	3	Left	Whitish	Clotted	Pungent	*Mixed infection (Clostridum + Bacillus sp)*
	4	Both Right and left	Whitish	Watery	No Odour	*Bacillus sp*
	5	Left	Greenish	Clotted	No Odour	*Streptococcus sp*
	6	Right	Whitish	Curdled	Foul	*Escherichia coli*

Chemical Characteristics of Milk

The Mean ± S.E. of chemical characteristics of milk in Group I, Group II, Group III, Group IV and Group V are presented in Table 2.

Table 2: Mean ± S.E of Chemical Characteristics of milk in Group I, Group II, Group III, Group IV and Group V

Groups	pH			Electrical conductivity (mS/cm)		
	Day 0	Day 4	Day 8	Day 0	Day 4	Day- 8
Group I	6.51^{a} ± 0.04	6.54^{a} ±0.04	6.58^{a} ±0.04	4.39^{a} ±0.03	4.40^{a} ±0.03	4.41^{a} ±0.03
Group II	7.45^{b} ±0.12	7.05^{b} ±0.11	6.73^{b} ±0.06	7.00^{b} ±0.06	5.60^{c} ±0.06	5.16^{c} ±0.08
Group III	7.50^{b} ±0.03	7.00^{b} ±0.04	6.50^{a} ±0.04	6.95^{b} ±0.08	5.15^{b} ±0.08	4.25^{a} ±0.04
Group IV	7.46^{b} ±0.06	7.16^{b} ±.0.06	6.90^{c} ±0.04	6.98^{b} ±0.06	5.92^{d} ±0.05	5.72^{d} ±0.05
Group V	7.40^{b} ±0.06	6.95^{b} ±0.60	6.50^{a} ±0.06	6.95^{b} ±0.08	5.50^{c} ±0.09	4.80^{b} ±0.09
F value	38.70**	13.54**	15.73**	343.65**	78.97**	86.15**

** Highly Significant ($P \leq 0.01$)

Means bearing the same superscript within the same column do not differ significantly

pH

The Mean ± S.E. values of pH of milk recorded in Group I, Group II, Group III, Group IV and Group V are presented in Table 2. The Mean ± S.E. values of pH on day 0, 4 and 8 in Group I, Group II, Group III, Group IV and Group V in were 6.51 ±0.04, 7.45 ±0.12, 7.50 ±.03, 7.46±0.06 and 7.40 ±0.06, 6.54 ±0.04, 7.05 ±0.11, 7.00 ±0.04, 7.16 ±0.06, 6.95 ±0.60, 6.58 ±0.04, 6.73 ±0.06, 6.50 ±0.04, 6.90 ±0.04 and 6.50±0.06

respectively.

Electrical Conductivity

The Mean ± S.E. values of electrical conductivity of milk (mS/cm) recorded in Group I, Group II, Group III, Group IV and Group V are presented in Table 2. The Mean ± S.E. values of electrical conductivity (mS/cm) on day 0, 4 and 8 in Group I, Group II, Group III, Group IV and Group V were 4.39±.03, 7.00±0.06, 6.95±0.08, 6.98±0.06, 6.95±0.08, 4.40±.03, 5.6±0.06, 5.15±0.08, 5.92±0.05, 5.50±0.09, 4.41±.03, 5.16±0.08, 4.25±0.04, 5.72±0.05 and 4.8±0.09 respectively.

Milk Culture and Antibiogram

A variety of organisms namely *Staphylococcus sp*, *Bacillus sp*, *E.coli*, *Klebsiella sp*, *Proteus sp*, *Streptococcus sp*, *Clostridium sp*, *Pseudomonas sp* respectively were isolated from the milk samples of clinical mastitis cases. The organisms isolated from each clinical case is presented in Table 1.

Out of twenty four clinically affected mastitis cases, twenty had single organism (83 per cent) while four had multiple organism (17 per cent) and the same is represented in Figure 1. Single organisms isolated from clinical mastitis include *Staphylococcus sp* (40 per cent), *Bacillus sp (*20 per cent), *E.coli* (15 per cent), *Klebsiella sp* (15 per cent), *Proteus sp* (5 per cent) and *Streptococcus sp* 5 per cent respectively and the same is presented in Figure 2. Mixed organisms in the milk samples include *Clostridium* sp and *Bacillus sp* (50 per cent), *Bacillus* sp and *Klebsiella sp* (25 per cent) and *Pseudomonas sp* and *Proteus sp* (25 per cent) and the same is presented in Figure 3.

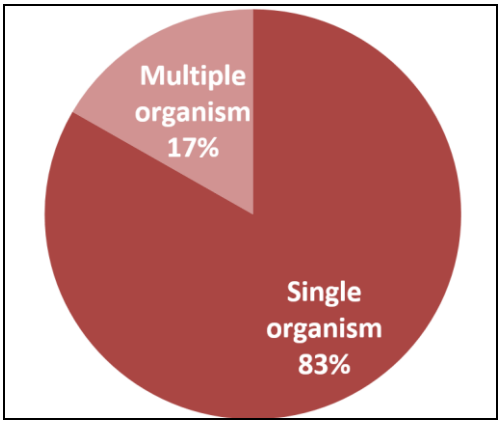

Fig 1: Organisms isolated from mastitis milk

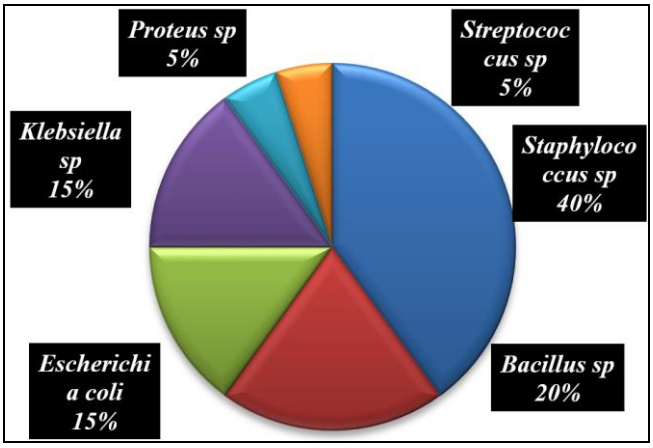

Fig 2: Single organisms isolated from mastitis milk

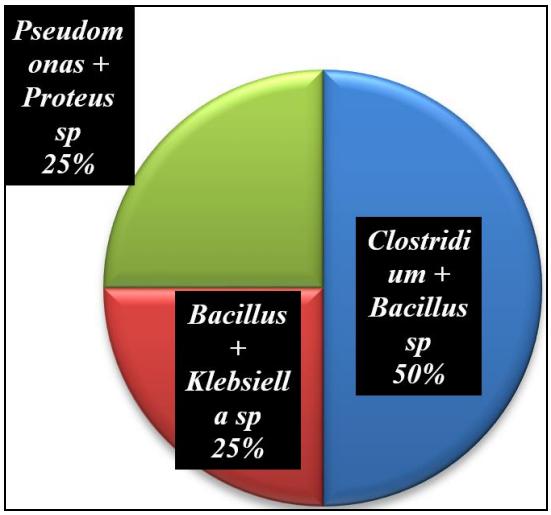

Fig 3: Multiple organisms isolated from mastitis milk

Therapy

Mastitis affected goats were randomly grouped into four namely Group II, III, IV and V of six animals each and treated for 8 days. The Group II animals were treated with antibiotic Enrofloxacin @ 5mg/kg body weight intramuscular daily, while Group III animals were treated with antibiotic Enrofloxacin @ 5mg/kg body weight intramuscular daily plus combination of Vitamin E and Selenium. Likewise Group IV animals were treated with antibiotic Gentamicin @ 4mg/kg body weight intramuscular daily and Group V animals were treated with Gentamicin @ 4mg/kg body weight intramuscular daily plus combination of Vitamin E and Selenium. Injection Vitamin E and Selenium were administered to Group III and Group V goats @ 1mL/25kg intramuscular only on day 0 and day 4 of treatment.

The order of recovery rate in mastitis affected does from highest to lowest were as follows: Group III (Enrofloxacin with Vitamin E and Selenium), Group V (Gentamicin with Vitamin E and Selenium), Group II (Enrofloxacin) and Group IV (Gentamicin).

Discussion

Mastitis is a disease known to affect the economy of farmers since ages and is the main concern of dairy farmers. In the recent years, importance is given to goat milk because of its high nutritive value and enhancement of immunity in the human health. The key factors which alter in the milk during mastitis is its physical and chemical characteristics which are mainly focused in this article.

The changes in physical characteristics of milk (colour, consistency and odour) observed on day 0 in caprine clinical mastitis is presented in Table 1. The present findings correlated with Islam *et al.* (2011) [4]. However Danmallam and Pimenov (2019) [5] in their study on clinical mastitis observed serous secretion in 51.7 per cent cases, catarrhal secretion in 31.0 per cent cases and purulent-catarrhal secretions in 5.0 per cent cases while Mavangira *et al.* (2013) [6] and Jesse *et al.* (2016) [7] observed serosanguineous foul smelling discharge in gangrenous mastitis.

The present study revealed a highly significant difference (P≤ 0.01) in the pH values between control and treatment groups on day 0 and day 4 (Table 2). The increase of pH in mastitis affected does correlated with Khodke *et al.* (2009) [8], Hassan *et al.* (2013) [9] and Mohanty *et al.* (2022) [10]. The comparison of Mean ± S.E values of pH in the treatment groups after 8 days of treatment trial showed reduction in pH values in all

the treatment groups but there was no statistical difference in the pH value among Group III, V and control group. (Table 2) but a highly significant difference ($P \leq 0.01$) in the pH values were observed between these three groups, Group II and Group IV. The reason for increase of pH in mastitis affected milk could be due to higher levels of citrate and bicarbonate as suggested by Harmon *et al.* (1994) [11] and Lietner *et al.* (2004) [12] or may be due to lowered acidity as a result of reduction in lactose content in mastitis milk as suggested by Horvarth *et al.* (1980) [13].

Highly significant difference ($P \leq 0.01$) in the Electrical conductivity (mS/cm) values were observed on day 0 between control and treatment groups (Table 2). The results of the present study correlated with Diaz *et al.* (2012) [14] and Roukbi *et al.* (2015) [15]. There was no significant difference in the electrical conductivity (mS/cm) values on day 4 between Group II and Group V but highly significant difference ($P \leq 0.01$) was observed when compared to rest of the groups. The reason for significant increase in electrical conductivity in mastitis milk may be due to increase in sodium ion concentration which resulted in increased permeability of mammary epithelium by the pathogens and their toxins and thereby transfer blood components to milk (Merin *et al*., 2004) [16] and (Romero *et al.*, 2012) [17].

The comparison of Mean ± S.E values of electrical conductivity (mS/cm) in the treatment groups after 8 days of treatment trial showed reduction in electrical conductivity (mS/cm) values in all the treatment groups but there was no statistical difference in the electrical conductivity (mS/cm) between Group III and control group (Table 2).

In the present study *Staphylococcus sp* (40 per cent) was the predominant organism isolated from clinical mastitis cases. Similar high prevalence of *Staphylococcus sp* in caprine clinical mastitis were recorded in Bangladesh by Sarkar and Samad, 2011 [18] (38.98 per cent) and Islam *et al.* (2011) [4] (26.67 per cent). The most predominant pathogen to cause caprine mastitis globally is *Staphylococcus aureus* and high prevalence of this organism may be due to re-infection of mammary glands and teat lesions with unhygienic milking operation especially where hand milking is practised, poor management and hygiene or due to transmission of these contagious organisms during unhygienic milking procedures as stated by Majic *et al.* (1993) [19] and Menzies and Ramanoon (2001) [20]. Environmental pathogens include *Bacillus sp*, *E.coli*, and *Klebsiella sp* which accounted 20 per cent, 15 per cent and 15 per cent respectively in the present study and their occurrence could be associated to unhygienic practices in goat rearing as stated by Burriel (1997) [21].

Conclusion

Based on the findings of physical and chemical characteristics of milk (pH and electrical conductivity), the mastitis affected does which received antibiotic plus antioxidant (Group III and V) showed a better recovery rate when compared to groups which received antibiotic alone (Group II and Group IV). Among the antibiotic plus antioxidant group, Group III (Enrofloxacin with Vitamin E and Selenium) had a better recovery rate than Group V (Gentamicin with Vitamin E and Selenium). The order of recovery rate in mastitis affected does from highest to lowest were as follows: Group III (Enrofloxacin with Vitamin E and Selenium), Group V (Gentamicin with Vitamin E and Selenium), Group II (Enrofloxacin) and Group IV (Gentamicin).

References

1. Park YW. Goat milk: composition, characteristics. In: Pond WG, Bell N, editors. Encyclopedia of Animal Science. 2nd ed. Boca Raton (FL): CRC Press; c2010. Chapter 2. In press.
2. Schalm OW, Carroll EJ, Jain NC. Bovine mastitis. Philadelphia (USA): Lea and Febiger; c1971.
3. Cheng WN, Han SG. Bovine mastitis: risk factors, therapeutic strategies and alternative treatments—a review. Asian-Australas J Anim Sci. 2020;33:1699-1713. doi: 10.5713/AJAS.20.0156.
4. Islam MA, Samad MA, Anisur Rahman AKM. Bacterial pathogens and risk factors associated with mastitis in Black Bengal goats in Bangladesh. Bangladesh J Vet Med. 2011;9(2):155-159.
5. Danmallam FA, Pimenov NV. Study on prevalence, clinical presentation, and associated bacterial pathogens of goat mastitis in Bauchi, Plateau and Edo States, Nigeria. Vet World. 2019;12:638.
6. Mavangira V, Angelos JA, Samitz EM, Rowe JD, Byrne BA. Gangrenous mastitis caused by *Bacillus* species in six goats. J Am Vet Med Assoc. 2013;242:836-843.
7. Jesse FFA, Bitrus AA, Abba Y, Sadiq MA, Chung ELT, Hambali IU, *et al*. Severe case of bilateral gangrenous mastitis in a doe: a case report on clinical management. Int J Livest Res. 2016;6:55-59.
8. Khodke MV, Bonde S, Ambade AB. Enzymatic changes in goat milk and udder health status. Indian J Field Veterinarians. 2009;4:17-19.
9. Hassan HJ. Variations in milk composition of some farm animals caused by subclinical mastitis in Aldiwania province. Basrah J Vet Res. 2013;12(2):17-24.
10. Mohanty BK, Rath PK, Panda SK, Mishra BP. Pathological evaluation of mastitis in goats and changes in milk composition. Indian J Small Ruminants. 2022;28:154-160.
11. Harmon RJ, Eberhart RJ, Jasper DE, Langlois BE, Wilson RA. Microbiological procedures for the diagnosis of bovine udder infection. Madison (WI): National Mastitis Council; c1990.
12. Leitner G, Merin U, Silanikove N. Changes in milk composition as affected by subclinical mastitis in goats. J Dairy Sci. 2004;87:1719-1726.
13. Horvath GA, Mohammed IH, Varga J, Szermeredi G, Quarini L. Effect of subclinical mastitis on milk composition. Magyar Allatorvosok Lapja. 1980;35(9):615-619.
14. Diaz JR, Romero G, Muelas R, Alejandro M, Peris C. Effect of intramammary infection on milk electrical conductivity in Murciano-Granadina goats. J Dairy Sci. 2012;95:718-726.
15. Roukbi M, Omar AN, Salam Z, Dibeh K. Investigation of subclinical mastitis cases in GCSARD Damascus goats from Humeimeh research station. Net J Agric Sci. 2015;3(1):5-13.
16. Merin U, Silanikove N, Shapiro F, Bernstein S, Leitner G. Changes in milk composition as affected by sub-clinical mastitis in sheep and goats. S Afr J Anim Sci. 2004;34:188-191.
17. Romero G, Pantoja JCF, Sendra E, Peris C, Diaz JR. Analysis of the electrical conductivity in milking fractions as a means for detecting and characterizing mastitis in goats. Small Rumin Res. 2012;107:157-163.

18. Sarker H, Samad MA. Udder-half-wise comparative prevalence of clinical and sub-clinical mastitis in lactating goats with their bacterial pathogens and antibiotic sensitivity patterns in Bangladesh. Bangladesh J Vet Med. 2011;9:137-143.
19. Majic B, Jovanovic BV, Ljubic Z, Kukovics S. Typical problems encountered in Croatia in the operation of goats milking machines. In: Proceedings of the 5th International Symposium on Machine Milking of Small Ruminants. Budapest, Hungary; c1993. p. 377-379.
20. Menzies PI, Ramanoon SZ. Mastitis of sheep and goats. Vet Clin North Am Food Anim Pract. 2001;17:332-352.
21. Burriel AR. Resistance of coagulase-negative staphylococci isolated from sheep to various antimicrobial agents. Res Vet Sci. 1997;63:189-190.

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