Effect of supplementing chelated trace minerals and coated vitamins on the incidences of sub-clinical and clinical mastitis in dairy cows

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Abstract

Fifty high yielding HF crossbred cows (>15kg/animal/day) having history of clinical and sub-clinical mastitis in previous lactation were selected from 36 farms in Banaskantha district of Gujarat. Twenty five cows from 18 farms served as control group, and remaining 25 in experimental group were fed daily 10 g supplement per cow, containing chelated copper, zinc, chromium, vitamins E and A along with iodine for 4 weeks prior to calving. After calving, milk samples were collected on 15th and 45th day for analysis of somatic cell counts (SCC), sodium content, pH and electrical conductivity. The farmers were provided with Mastect strips for routine check up for sub-clinical mastitis.

Out of 25 animals under the experimental group at different farms, only 4 showed positive signs for sub-clinical and clinical mastitis with Mastect strip test, which was confirmed by California Mastitis Test (CMT) and SCC in milk (3.97 x10^5 cells/ml milk). However in control group, out of 25, 22 cows were affected with sub-clinical mastitis as indicated by positive CMT and SCC (4.21 x10^5 cells/ml milk) in milk, which was later aggravated to clinical mastitis. The pH, electrical conductivity, SCC and sodium content in milk were significantly higher (P<0.01) in animals affected with sub-clinical mastitis than the normal animals. In experimental group, SCC in 21 animals was within the normal range (1.41- 1.46 x 10^5 cells/ml milk) and no signs of sub-clinical or clinical mastitis were observed. From the present study, it could be concluded that feeding certain chelated trace minerals and coated vitamins for 4 weeks prior to calving, can help in significantly reducing the incidences of sub-clinical and clinical mastitis in crossbred cows under field conditions.

Key words: crossbred cow, somatic cell counts, vitamin E

Introduction

Mastitis is a serious infectious disease of dairy animals causing enormous economic losses due to reduction in milk yield, as well as lowering its quality and nutritive value. Sub-clinical mastitis (SCM) is 30-40 times more prevalent than clinical mastitis (CM) and causes heavy economic loss in dairy animals, especially in crossbred cows. In addition to causing colossal economic losses to milk producers, the disease is important from consumers’ and processors’ point of view (Wheelock et al 1996). The milk from an affected animal may harbor the organisms potentially pathogenic for humans (Sharma et al 2006). Mastitis affects the milk quality in terms of decrease in milk protein, fat, lactose contents and increase in somatic cell counts (SCC). Dairy animals are most susceptible to mastitis during 2 weeks prior to calving and 2 weeks post-calving. Amongst others, proper feeding of dry pregnant cows with appropriate vitamins and minerals can significantly improve immune function, as their deficiencies can result in immune-depression (Suttle and Jones 1989; Weiss and Spears 2006). Rations fed to crossbred cows in India are often deficient in zinc, copper (Garg et al 2008), chromium and vitamins A and E that are primary minerals and vitamins affecting immune function and susceptibility to sub-clinical and clinical mastitis (Drake et al 1992; Harmon and Torre 1997). It has been reported that the amount of certain vitamins and minerals required for optimal immune function is greater than the amount required for growth and reproduction (NRC 2001). Therefore, it becomes utmost desirable to supplement the ration with requisite vitamins and minerals, especially prior to calving to improve immune function of animals. In view of this, the present study was undertaken to investigate efficacy of supplementing certain chelated trace minerals and coated vitamins in reducing the incidences of sub-clinical and clinical mastitis in dairy cows, maintained under field conditions.

Materials and methods

A primary survey was conducted in Banaskantha district of Gujarat, to identify advanced pregnant crossbred cows having history of sub-clinical and mastitis in previous lactation. All the experimental cows were in their second or third lactation. Fifty animals from 36 dairy farms having history of sub-clinical and clinical mastitis in previous lactation were identified for the study. Twenty five animals at 18 farms were taken under the experimental group and fed daily 4 weeks prior to calving with one sachet of 10 g supplement per animal, containing chelated trace minerals (Cu, Zn, Cr), vitamins A and E along with iodine. Twenty five animals at 18 farms were maintained without supplement and served as control. On an average, animals were fed on local grasses (4-5 kg), hybrid napier/sorghum green (10-12 kg) and *ad lib* wheat straw and bajra straw. The compound cattle feed and cottonseed cake was fed based on the level of milk production at the time of milking. Feeds and fodder samples were analyzed for proximate composition (AOAC 1999) and copper (Cu), zinc (Zn) and manganese (Mn) by Inductively Coupled Plasma-Optical Emission Spectrometer (ICP-OES), Perkin Elmer, Optima 3300 RL. The average milk production of crossbred cows identified for the study was 16.20 kg/animal/day with 3.45 per cent fat in milk while in production. All the animals under control and experimental groups were checked for sub-clinical mastitis with Mastect strip test and California Mastitis Test, on weekly basis, post calving. Milk samples were collected from all four quarters of an animal in sterile polyethylene screw capped, wide mouth vials after squirting few streams, on 15th and 45th day after calving, from all the animals under control and experimental groups for estimation of sodium content (Brooks et al 1996) and somatic cell counts (IDF 1984). The pH and electrical conductivity in milk samples were measured on the spot with the help of portable digital pH/conductivity meter (Model Eutech, PCSTEST35-01X441506). The data on milk pH, electric conductivity, SCC and sodium content were subjected to variance for statistical significance as per Snedecor and Cochran (1994) with

SPSS package programme (SPSS 9.00 software for Windows, SPSS Inc., Chicago, IL).

Results and discussion

Feeds, fodder and animals

The feeds and fodder samples were analysed for chemical composition, Cu, Zn, Mn and values are given in Table 1. Feedstuffs commonly fed to the dairy animals were found to be deficient in Cu and Zn, when compared to critical levels.

Table 1: Average chemical composition and Cu, Zn and Mn content in feedstuffs offered to experimental cows (on DM basis except for DM which is on fresh basis)

Particulars	DM (%)	CP (%)	EE (%)	CF (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)
Bajra straw	90.0	6.78	0.91	29.10	6.12	27.32	48.19
Wheat straw	92.0	3.72	0.95	29.60	6.15	22.10	28.12
Local grasses	27.0	6.12	1.27	29.60	5.73	31.28	45.30
Hybrid napier	18.0	7.85	1.66	27.20	6.78	27.19	52.78
Sorghum green	35.0	6.58	1.67	24.30	8.72	33.54	48.89
Cottonseed cake	92.0	24.80	6.31	24.32	9.15	37.23	17.20
Compound cattle feed	91.0	19.95	2.93	9.89	24.18	49.31	73.29
Critical level*	--	--	--	--	< 8.0	<30.0	<40.0

**McDowell et al (1993)*

Number of animals having history of clinical and sub-clinical mastitis in previous lactation is presented in Table 2. It can be seen from Table 2 that 92% animals were acquired mastitis in early lactation in previous lactation and one teat affected in 64% animals.

Table 2: Identification of trial animals during advanced stage of pregnancy having history of clinical and sub-clinical mastitis in their previous lactation

Particulars	No. of animals	Percentage
Mastitis acquired in early lactation (0-2 months after calving)	46 animals	92 %
Mastitis acquired in late lactation (7 months after calving)	4 animals	8 %
Animals having one or two teat dry	16 animals	32 %
Animals having swelling on teat or flakes in milk or both	22 animals	44 %
Animals recovered after	6 animals	12 %

treatment		
Animals with severity 1 & 2 (less)	10 animals	20 %
Animals with severity 3 (moderate)	22 animals	44 %
Animals with severity 4 & 5 (severe)	18 animals	36 %
Animals with one teat affected	32 animals	64 %
Animals with two teats affected	4 animals	8 %
Animals with four teats affected	14 animals	28 %

Mean pH, electrical conductivity, SCC and sodium content in milk for the control and experimental groups post calving are presented in Table 3.

Effect of feeding supplement on pH and electrical conductivity of milk

The pH testing can be considered as a guide to detect the sub-clinical mastitis as this is economical, easy and rapid to perform in the field at the time of milking. In experimental group, pH of milk from animals (n=4) affected with sub-clinical mastitis was 6.64 and 6.62 on day 15 and 45, respectively, which was significantly higher ($P<0.01$) than that of milk from the normal animals. In normal animals (n=21), pH was 6.32 and 6.18 on 15th and 45th day, respectively. In control group, out of 25, 22 animals were affected with sub-clinical mastitis and showed higher pH than the unaffected animals. In mastitis increased permeability of the gland to blood components viz. sodium and chloride ions leads to increase of milk pH (Kellogg 1990).

In supplemented group, electrical conductivity in normal animals was 6.32 and 6.18 mS/cm on day 15 and 45, which increased to 6.64 and 6.62 mS/cm in infected animals ($P<0.01$). Similar trend was observed in control group animals affected with mastitis (Table 3). Electrical conductivity of milk to detect mastitis is based on the ionic changes which occur during inflammation, since the sodium and chloride concentrations increase in milk (Popovic 2004).

Table 3: Effect of feeding chelated minerals and coated vitamins on different parameters in crossbred cows

Particulars	**Milk pH**		**Electrical conductivity (mS/cm)**		**Mastect strip test**		**SCC ($x10^5$/ml of milk)**		**Sodium content (mg/dl)**	
	Day 15	**Day 45**	**Day 15**	**Day 45**	**Day 15**	**Day 45**	**Day 15**	**Day 45**	**Day 15**	**Day 45**
Control group (n=25)										
Normal animals (n=3)	6.41^{a} ±0.07	6.12^{c} ±0.10	4.32^{c} ±0.09	4.52^{a} ±0.10	N	N	2.35^{a} ±0.26	2.30^{a} ±0.31	55.10^{c} ±6.12	67.02^{c} ±7.87
Cows affected by SCM /CM (n=22)	6.65^{b} ±0.03	6.58^{d} ±0.05	5.18^{d} ±0.06	4.98^{b} ±0.07	S	S	4.21^{b} ±0.12	4.16^{b} ±0.15	141.0^{d} ±12.1	153.9^{d} ±11.51
Experimental group (n=25)										
Normal animals	6.32^{c} ±0.02	6.18^{c} ±0.02	4.38^{c} ±0.04	4.22^{c} ±0.04	N	N	1.46^{c} ±0.06	1.41^{c} ±0.05	53.20^{c} ±4.21	65.57^{c} ±3.52

(n=21)										
Cows affected by SCM /CM (n=4)	6.64^{d} ±0.04	6.62^{d} ±0.04	5.14^{d} ±0.06	5.03^{d} ±0.06	S	S	3.97^{d} ±0.21	3.87^{d} ±0.18	136.2^{d} ±14.8	138.1^{d} ±12.3

$^{a,\,b}$ *Means with different superscript in a column differ at P<0.05*
$^{c,\,d}$ *Means with different superscript in a column differ at P<0.01*
N= Normal animals; S= Suspected with sub-clinical mastitis.

Somatic cell counts and sodium content in milk-as an indicator of sub-clinical mastitis

Milk samples from all the animals in control and experimental groups were checked for sub-clinical mastitis (SCM). Out of 50, 26 animals were found to be positive for SCM, which were subjected to somatic cell counts (SCC) for confirmation. Somatic cell counts is indicator of both resistance and susceptibility of dairy cows to mastitis and can be used to monitor the level or occurrence of sub-clinical mastitis in individual cow (Harmon 1994; Torre et al 1996). Increase in SCC indicates inflammatory reaction of udder tissues. In supplemented group, cows detected negative with Mastect strip test and CMT showed SCC of 1.46 (x10^5/ml of milk) and 1.41 (x10^5/ml milk) on 15th and 45th day, respectively. Cows affected with SCM showed SCC of 3.97 (x10^5/ml milk) and 3.87 (x10^5/ml of milk), on 15th and 45th day, respectively which was significantly higher than the normal animals (Table 3). Similarly, cows in control group affected with SCM showed higher SCC than the normal animals. This increase of SCC indicated inflammatory reaction and might be due to shift of leucocytes to the udder after entry of infection in the mammary gland and as a protective mechanism against infection (Kellogg et al 2004; Spears and Weiss 2008).

Antioxidants and trace minerals play important roles in immune function, which in turn can influence health of mammary gland in transition dairy cows (Politis et al 1995). The killing ability of immune cells is shown to be increased by nutritional supplementation with vitamin E and Cr, which have consistently been shown to improve neutrophil function in dairy cows (Persson 1992; Politis et al 1996). Zinc and vitamin A has a critical role in maintaining the health and integrity of skin due to its role in cellular repair and replacement, key to the natural defence mechanism of the mammary gland (Smith et al 1984; Sordillo et al 1997). In addition, it has been reported that Zn supplementation reduces somatic cell count due to its role in keratin formation. Zinc and Cu play important role in removing superoxide radicals (free radicals) from the body. These radicals can disrupt cellular membranes and cause cellular damage leaving the mammary gland more susceptible to infection, scarring, and loss in milk production (Xin et al 1991; Sharma 2007). Supplement containing vitamin E at higher level in the present study might have played a key role in protecting animals from sub-clinical and clinical mastitis.

Major electrolytes in milk are sodium, potassium and chlorides. Sodium and chloride increase during clinical or sub-clinical mastitis, whereas, potassium decreases. These imbalances result into decrease in quality and taste of milk. In supplemented group, sodium content in normal animals was 53.20 and 65.57

mg/dl, on 15th and 45th day, respectively which increased significantly ($P<0.01$) to 136.2 and 138.1 mg/dl in SCM affected animals (Table 3). Similarly, cows in control group affected with SCM showed higher sodium content than the normal animals. Bacterial infection of the udder results into damage to the ductal and secretary epithelium, which leads to increase in permeability of the blood capillaries, thus Na^+ and Cl^- pour into the lumen of the alveolus and in order to maintain osmolarity, K^+ level decrease proportionately (Wheelock et al 1996). The trace minerals and vitamins in the supplement might have helped in preventing damage to ductal and secretary epithelial, due to low sodium content in unaffected animals.

Conclusion

- It is quite apparent from the present study that the colossal loss caused to dairy sector by the increasing incidences of sub-clinical and clinical mastitis could be minimized by supplementing dairy animals with coated vitamins A and E along with specific trace minerals in the form of chelates, for about 4 weeks prior to calving.

Acknowledgements

Financial assistance and necessary facilities provided by the management of National Dairy Development Board, Anand, for undertaking this study, are gratefully acknowledged. Necessary assistance provided by the officers of Banaskantha District Cooperative Milk Producers Union Ltd., Palanpur, Banaskantha, Gujarat, in the identification of dairy farms and animals is gratefully acknowledged.

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Received 1 February 2013; Accepted 3 February 2013; Published 2 April 2013

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