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# Impact of Area Specific Micronutrient Supplementation in Peri-Parturient Malvi Cows on the Udder Health and Milk Production

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## ABSTRACT

Objective of this experiment was to evaluate the effect of supplementation of area specific micronutrients on udder health, milk yield, and its quality in Malvi cows under field conditions. Eighteen healthy multiparous advanced pregnant Malvi cows, having similar body weights (317.95±5.93kg), parity (3 and 4), and feeding conditions were divided into 2 equal groups in which diet was supplemented with or without a micronutrient. This supplementation study was continued for 2 months during advanced pregnancy and thereafter for 2 months post-calving. Dry matter (DM) intake during the pre- and postpartum remained comparable (P>0.05) between two groups. Udder health, milk pH and somatic cell count improved (P<0.05) in the micronutrients supplemented group. The average milk yield was increased (P<0.05) by 16.42 % in supplemented group. There was no effect of micronutrient supplementation on milk chemical composition (Fat, TS (Total solid), SNF (Solid not fat), lactose and protein) in dairy cows. These findings suggest that supplementation of micronutrient in the ration of peri-parturient Malvi cows not only improved the udder health by reducing the occurrence of mastitis but also increased the milk yield without affecting milk quality.

**KEYWORDS:** Area specific micronutrients, Malvi cows, Mastitis, Milk quality, Milk yield, Udder health

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## INTRODUCTION

Mastitis ranked 1st among the disease in India for dairy industries because it reduces the milk yield, lowers the quality of milk and shorten the productive life of animal thereby leading to heavy economic loss (NAAS, 2013). Subclinical mastitis has been estimated to account for 57.93% (4151.61crores) of total economic loss due to mastitis. Nutrition plays an important role in the control of mastitis. Cows with sub clinical mastitis produce up to 4.6 kg/d less milk compared with healthy herd mates (Green et al., 2006), represent a reservoir of infection for other cows in the herd and are at a greater risk of being culled or developing clinical mastitis (Barlow et al., 2009). Ensuring adequate trace mineral availability is a potential strategy to reduce the effects of mastitis. Trace minerals are critical for proper immune response and play an important role in udder health. Micronutrients remain the most important factor for limiting the transition related disorders and its consequences on general health status due to their cellular roles in immunity, metabolism, growth as well as specific role in free radical control in dairy cows.

Due to lack of awareness in Malwa region of Madhya Pradesh, traditional feeding practices are followed by dairy farmers. The majority of farmers offer straw (wheat straw/masoor straw/gram straw) along with cottonseed cake (un-decorticated) as concentrate without any mineral and vitamin supplementation to lactating animals. The pregnant animals even in an advanced stage of pregnancy fed solely on straw without any concentrate. Few farmers offer a little amount of concentrate/green fodder depending upon the availability. Under such feeding conditions, the availability of antioxidant minerals (Zn, Cu and Se) and vitamins (â carotene and vitamin E) which are having the importance in udder health may greatly be reduced to animals (Weiss et al., 1997; Gangwar et al., 2008). Thus, the incidence of mastitis in cows was high in Madhya Pradesh (Mourya et al., 2020).The present study was therefore, planned to suggest an appropriate area specific micronutrient supplementation for improving udder health and milk production to increase the profit of farmers.

## MATERIALS AND METHODS

### Formulation of area specific micronutrient supplement

Micronutrient availability to the Malvi cows was calculated and compared with the requirements given by NRC (2001) to find out the deficiency or excess of micronutrients. For the preparation of micronutrient supplement, copper sulfate (Cu), zinc sulphate (Zn), and vitamins A and E (commercial preparations) were used. The measured quantity of trace mineral and vitamin was supplemented in the ration of cows of treatment group daily for 120 days (2 months during advanced pregnancy and thereafter for 2 months post-calving).

Eighteen multiparous healthy advanced pregnant Malvi cows (around last 2 months of gestation), identical in body weights (322±8.57kg) and feeding conditions, were selected randomly from a dairy farm in the village Rau and Indore (Madhya Pradesh, India). Body weight was determined based on body length and girth by using Schaeffer's equation (Sastry et al., 1982). Feed samples collected at the start of the experiment were analyzed for dry matter (DM) and trace minerals (Ca, P, Mn, Zn, Cu, Co and Se) with the calculation of availability of carotene and vitamin E using reported values. Trace minerals were estimated by atomic absorption spectrophotometer (AAS Plus; Motras Scientific).

The selected animals were divided into two groups, control and treatment, including nine Malvi cows in each group based on their body weights. The control group was fed as per the practice of farmer, while the ration of cows of the treatment group was supplemented with a micronutrient supplement. This supplementation study was conducted for 2 months during advanced pregnancy and continued for 2 months post-calving. Feed samples collected during the supplementation study were fortnightly analyzed for DM (AOAC, 2005). The average daily milk yield (kg/day) of individual cows was recorded Milk fat, protein, solid not fat (SNF), lactose and total solid were analyzed by Indiz milk analyzer (Smart 305). Udder health indices; pH (Model pHep-HI 70300), Somatic cell count (Dang and Anand, 2007) and Modified California Mastitis Test (MCMT) (Sastry, 1978) were measured fortnightly. The statistical analysis was carried out using statistical package SPSS (20.0).

Table 1. Average minerals and vitamins content of feedstuffs (On DM basis)

| Feedstuffs | Ca (%) | P (%) | Fe (ppm) | Cu (ppm) | Zn (ppm) | Mn (ppm) | Co (ppm) | Se (ppm) | Carotene (ppm) | Vit. E (IU/kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| Wheat straw | 0.37±0.01 | 0.06±0.01 | 464.75±0.17 | 9.37±0.01 | 8.41±0.10 | 31.00±1.08 | 0.11±0.01 | 0.27±0.02 | 1.0 | 0.7 |
| Masoor straw | 1.00±0.02 | 0.06±0.01 | 621.42±0.75 | 6.54±0.03 | 23.53±0.14 | 39.87±1.27 | 0.36±0.01 | 0.21±0.03 | 1.0 | 0.9 |
| Cotton seed cake | 0.39±0.01 | 0.38±0.03 | 216.44±0.86 | 8.26±0.01 | 42.52±0.03 | 25.53±1.40 | 0.39±0.02 | 0.45±0.01 | 0.2 | 12 |
| Wheat bran | 0.17±0.02 | 0.48±0.02 | 251±0.95 | 8.63±0.02 | 67.51±0.02 | 131.90±1.56 | 0.12±0.01 | 0.12±0.05 | 0.1 | 21 |
| Concentrate mixture | 0.76±0.01 | 0.41±0.03 | 882.21±0.64 | 20±0.57 | 34.16±0.54 | 102.59±0.85 | 0.88±0.02 | 0.13±0.01 | Trace | Trace |
| Maize fodder | 0.27±0.03 | 0.21±0.01 | 294.5±0.85 | 8.37±0.01 | 9.84±0.01 | 190.33±1.29 | 0.14±0.01 | 2.0±0.02 | 285 | 80-200 |

## RESULTS AND DISCUSSION

### Average minerals and vitamins content of feedstuffs

The mineral content of the feedstuffs was given in Table 1 which formed the basis for calculation of availability of minerals in different feedstuffs.

### Body weight and dry matter intake of advanced pregnant Malvi cows

The average BW of 18 advanced pregnant cows was 317.95±5.93 kg. The daily DM intakes in those cows from dry roughage, maize fodder, cotton seed cake, wheat bran and concentrate mixture were 5.28±0.05, 0.43±0.15, 0.67±0.23, 0.91±0.16, 0.95±0.16 kg, respectively, with total DM intake of 8.23±0.08 kg/day.

### Availability and status of micronutrients

The availability of individual micronutrients was calculated on DM basis. Average availability of Ca, P, Fe, Cu, Zn, Mn, Co and Se is 54.31±4.09 and 14.86±0.29 g, 4322±199.44 mg, 75.40±0.63 mg 224.33±14.34, 511±12.76 mg, 2.73±0.21 mg, 2.60±0.40 mg, respectively. It indicated the shortage of Zn (63.5 %) and Cu (2.83 %) as per NRC (2001) requirements while an excess of Se (37.56 %) and other minerals like Ca, P, Mn, Fe, and Co was observed. Likewise, the average availability of vitamin A and E were 50736±43.19 and 113.13±24.79 IU/day, respectively in prepartum cows, which tunes up with the shortage of 74.6 % and 81.2 %, respectively, for vitamin A and E.

Thakur et al. (2016) observed a shortage of Cu and Zn by 2% and 65%, respectively, in the ration of advanced pregnant buffaloes from the Malwa region of Madhya Pradesh. The average daily supply of carotene and vitamin E in animals also remained deficient by 88.4% and 95.7%. While Jain et al. (2012) reported a 54% deficiency of vitamin A, Thakur et al. (2016) observed shortage of vitamin A and vitamin E by 45% and 80%, respectively, in the ration of advanced pregnant buffaloes of Malwa region of Madhya Pradesh. Variation in feeding practices due to the local availability of different feed ingredients remained a major cause of variation in nutrient intake.

### Designing of area specific micronutrient supplement

Micronutrient supplement developed to supply the deficient levels of antioxidant micronutrients includes 1069 mg of zinc sulphate, 8.64 mg of copper sulphate, 2986, IU of vitamin A, and 8626 IU of vitamin E. The level of other minerals estimated in feeds was not deficient, hence avoided to include in the micronutrient supplement.

### Effect of area specific micronutrient supplementation on dry matter intake of Mavi cow

No significant difference was observed in DMI during pre- and post-parturient periods between two groups (Table 2) may be due to otherwise nutritionally appropriate ration of the control group, except micronutrients, while other studies indicated increased DMI in animals supplemented with micronutrients (Saini et al., 2010; Righi, 2016). In corroboration to our study, Dhami, (2022); Singh et al. (2021) also reported that the dietary supplementation of micronutrients did not have any significant effect on voluntary feed intake of animals.

### Effect of area specific micronutrient supplementation on milk yield and its composition

In the present experiment, overall milk yield was higher (P<0.05) in supplemented group as compared with the un-supplemented group (3.41±0.04 kg/head/day) with improved milk production of 0.56 kg/head daily (Table 2). Results of milk yield clearly indicate that micronutrient supplement has potential to increase (P<0.05) milk yield by 16.42%. The overall milk (%) fat, protein, lactose, solid not fat, total solids were comparable and statistically non-significant (P>0.05) between the groups. Tiwari et al. (2012) also recorded around 15.32 to 18.80% increase in milk production in cows fed strategic dietary mineral mixture supplementation in cattle and buffaloes under field condition. Kantwa et al. (2021) also reported a 15.82 % increase in milk yield in buffaloes fed chelated mineral mixture @ 40 g/buffalo/day till 90 days of early lactation period. Similar results were also reported by Sahoo et al. (2017), Singh et al. (2020) and Jadoun et al. (2024).

As per the composition of milk is concerned, no significant difference in milk SNF and lactose was reported due to supplementation of either mineral or vitamin in dairy animals by Singh et al. (2021), However, they observed significantly higher milk fat and protein % in supplemented group. Similar to the present study, no change in milk composition by supplementation of minerals was also reported by Gowda et al. (2004).

The present results indicating that supplementing of area specific micronutrients could increase milk yield of cows due to having impact on the milk production cells in the udder. Their micro and macro element contribute in the working of memory cell to enhance their production (Pal et al., 2020).

Table 2. Effect of micronutrient supplementation on dry matter intake, milk yield (kg/day) Milk pH, Somatic cell count and milk composition (%) of Malvi cow

| Constituent | Control | Treatment | P-value |
|---|---|---|---|
| DM intake, kg/d | 8.38±0.05 | 8.80±0.15 | 0.080 |
| Milk yield, kg/d | 3.41±0.04 | 3.97±0.03 | 0.04* |
| Milk pH | 6.85±0.01 | 6.53±0.03 | 0.012* |
| SCC ($10^5$/ml) | 3.25±0.13 | 2.30±0.07 | 0.02* |
| *Milk composition (%)* | | | |
| Fat | 3.18±0.03 | 4.02±0.027 | 0.717 |
| Lactose | 4.46±0.02 | 4.56±0.02 | 0.263 |
| SNF | 8.42±0.03 | 8.47±0.03 | 0.571 |
| Total protein | 3.48±0.02 | 3.56±0.03 | 0.492 |
| Total solid | 12.25±0.07 | 12.21±0.05 | 0.36 |

SCC-Somatic cell counts; SNF- Solid not fat
*Show significance at 5% level as compared to control group (P<0.05)

**Effect of area specific micronutrient supplementation on udder health indices**

The overall milk pH was significantly (P < 0.05) higher in the supplemented group (6.85 vs. 6.53) in comparison with the un-supplemented group. The MCMT was positive in 6 cows out of 9 cows of the un-supplemented group, while due to supplementation of areas specific micronutrients, it reached up to a level of only 1 case out of total 9 cows in the treatment group. SCC was significantly (P<0.05) lower in cows of the supplemented group than un-supplemented cows, and the numerically same was maintained throughout the study period.

The increased milk pH in the subclinical and clinical mastitis than the normal cases might be a consequence of increased permeability of the blood capillaries during inflammation of the mammary gland, which allows alkaline blood constituents (sodium and bicarbonate ions) to enter the milk and consequently to increase milk pH (Luck and Smith, 1975). The milk pH was significantly (P < 0.05) higher in the unsupplemented group in comparison with supplemented group it indicates reduction in subclinical mastitis in strategic micronutrient supplemented group (Singh et al., 2020), which are in agreement with the present findings. Similarly, Khan et al. (2022) also reported that supplementation of selenium and vitamins E decreased incidence of bovine mastitis by positively impact on immunoregulation and relieve the oxidative and inflammatory status in dairy cattle during the Peri-parturient phase.

Somatic cell count is usually used as an inflammatory indicator to diagnose mastitis. A decrease in SCC count in milk is an indicator of the success of management and hygienic control programme. In the present study, lower SCC in the supplemented group also highlighted the importance of supplementation in the treatment group. A potential factor contributing to the reduction in SCC is the role of Zn keratin formation; the keratin lining of the teat canal entraps bacteria and prevents their upward movement into the mammary gland. High SCC in mastitis-affected milk may adversely affect the quality of fresh and pasteurized liquid milk and reduced its shelf life (Sobhanirad et al. 2010). Zinc may affect mammary gland health status. Micronutrients are part of proteins with specific functions at the immune system level. Zinc is usually bound to metallothionein, whose effects are related to the proliferation, adherence and invasivity of macrophages. Zinc blood concentrations often decrease around calving and when animals go through mastitis. Moreover, animals' requirements vary, and supplementation with zinc around the peripartum period can boost immunity and prevent mastitis.

Considering the immune system and mastitis microorganisms, copper is believed to exhibit antibacterial properties against bacteria isolated from mastitic cows. According to Reyes-Jara et al. (2016) Cu concentration as low as 250 ppm inhibits the growth of common mastitis microorganisms such as Escherichia coli and coagulase negative Staphylococci. Previous researchers also reported a reduction in SCC supplemented with trace minerals, vitamin E, and vitamin A (Nevidita et al., 2017; Maurya et al., 2014).

## CONCLUSION

It may be concluded that the ration of advanced pregnant Malvi cows was deficient in copper and zinc; vitamin A and vitamin E. The supplementation of these micronutrients in the ration of cows improved udder health, milk yield without affecting milk quality.

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## REFERENCES

AOAC. 2005. Official Methods of Analysis, 15th Edn. Association of Official Analytical Chemists, Washington D.C.

Barlow, J.W., White, L. J., Zadoks, R. N. and Schukken, Y. H. 2009. A mathematical model demonstrating indirect and overall effects of lactation therapy targeting subclinical mastitis in dairy herds. Preventive Veterinary Medicine. 90: 31-42.

Dang, A. K. and Anand, S. K. 2007. Effect of milking systems on the milk somatic cell counts and composition. Livestock. Research. Rural Development. 19(6): 1-9.

Dhami, J., Chavda, M.R., Vala, K.B., Rava, R.J., Karangiya, L.V.K., Chaudhary, J.K., Parmar, K.H. and Savaliya, B. D. 2022. Peripartum supplementation of nutrients in Gir cows improves the feed intake, blood metabolic profile and postpartum fertility. Indian Journal of Animal Sciences. 92(12): 1434-1439.

Gangwar, P., Upadhyay, A.K., Gangwal, M.K. and Rajput, M.K.S. 2008. Relationship of mineral and vitamin supplementation with mastitis. Veterinary World. 1(4):103-104.

Gowda, N.K.S., Prasad, C.S. and Ramana, J.V. 2004. Effect of supplementation of micronutrients through different sources on the production performance in crossbred dairy cows. Indian Journal of Animal Sciences. 74 (6): 653-657.

Green, L.E., Schukken, Y.H. and Green, M.J. 2006. On distinguishing cause and consequence: Do high somatic cell counts lead to lower milk yield or does high milk yield lead to lower somatic cell count. Preventive Veterinary Medicine. 76: 74-89.

Jain, R.K., Saksule, C.M., Dhakad, R.K. and Mudgal, V. 2012. Nutritional status of cows and buffaloes during advanced pregnancy. Indian Journal of Animal Nutrition. 29(3):246-250.

Jadoun, Y.S., Singh, J., Hundal, J.S., Kasrija, R., Kansal, S.K., Sharma, R.K. and Kaur, N. 2023. Effect of Mineral Mixture Supplementation on Productive and Reproductive Performance of Buffaloes under Farmer FIRST Project. Indian Journal of Animal Nutrition, 40(3):283-287.

Kantwa, S.C., Ram Pratap, S., Yogendra, S.S., Meena, K. and Samota, S.D. 2021. Effect of chelated mineral supplementation on productive and reproductive performance of lactating buffalo. Indian Journal of Animal Sciences. 91 (12): 1073-1076.

Khan, M. Z., Ma, Y., Xiao, J., Chen, T., Ma, J., Liu, S. and Cao, Z. 2022. Role of Selenium and Vitamins E and B9 in the Alleviation of Bovine Mastitis during the Periparturient Period. Antioxidants. 11(4): 657.

Luck, H. and Smith, A. 1975. Relationship between constituent concentrations and the pH value of mammary gland secretions. Australian Journal of Dairy Technology. 7:27.

Maurya, P.K., Aggarwal, S.S.V., Chandra, G., Singh, A.K. and Chaudhari, B.K. 2014. Effect of vitamin E and zinc on cellular antioxidant enzymes in Karanfries cows during transition period. Indian Journal Animal Research. 48: 109-119

Mourya, A., Shukla, P. C., Gupta, D. K., Sharma, R. K., Nayak, A., Singh, B. and Pradhan, S. 2020. Prevalence of subclinical mastitis in cows in and around Jabalpur. Madhya Pradesh. Journal of Entomology and Zoology Studies. 8(4): 40-44.

NAAS. 2013. Mastitis management in dairy animals. Policy Paper No. 61, National Academy of Agricultural Sciences, New Delhi: 12p

Nevidita, P., Joydip, M., Ujjwal, B., Jana, P. S. and Chanchal, G. 2017. Effect of peripartum micronutrient supplementation on postpartum udder health in high-yielding crossbred cattle. Indian Journal of Animal Sciences. 87(9): 1095-1096.

NRC. 2001.Nutrient requirements of Dairy cattle: 7th Edn., Life science Institute National Acedemic press. Washington D.C. pp 105-146.

Pal, K., Maji, C., Das, M.K., Banerjee, S., Saren, S. and Tudu, B. 2020. Effects of area specific mineral mixture (ASMM) supplementation on production and reproductive parameters of crossbred and desi cows: a field study. Research Biotica. 2(2): 55-60.

Reyes-Jara, A., Cordero, N., Aguirre, J., Troncoso, M. and Figueroa, G. 2016. Antibacterial effect of copper on microorganisms isolated from bovine mastitis. Frontiers in Microbiology. 7: 626.

Righi, F., Simoni, M., Malacarne, M., Summer, A., Costantini, E. and Quarantelli, A. 2016. Feeding a free choice energetic mineral-vitamin supplement to dry and transition cows: effects on health and early lactation performance. Large Animal Review. 22(4): 161-170.

Saini, N, Singh, N and Kiradoo B D. 2010. Effect of supplementation on intake of minerals, milk yield and blood biochemical profile in lactating camels under traditional and semi-intensive system. Indian Journal of Animal Sciences. 80 (7): 666-670.

Sastry, N. S. R., Thomas, C. K. and Singh, R. A. 1982. Farm Animal management and Poultry Production, 2nd Edn. Vikas Publishing House Pvt. Ltd., New Delhi.

Sahoo, B., Kumar, R., Garg, A.K., Mohanta, R.K., Agarwal, A. and Sharma, A.K. 2017. Effect of supplementing area specific mineral mixture on productive performance of crossbred cows. Indian Journal of Animal Nutrition, 34(4): 414-419.

Singh, D.K., Sahu, S.P. and Teufel, N. 2020. Mineral mixture feeding enhances dairy animals productivity: A study of Bihar, India. Indian Journal of Animal Nutrition, 37(1): 26-30.

Singh, H. P., Jain, R. K., Tiwari, D., Mehta, M. K. and Mudgal, V. 2021. Strategic supplementation of antioxidant micronutrients in peri-parturient Murrah buffaloes helps augment the udder health and milk production. Biological Trace Element Research. 199(6): 2182-2190.

Singh, N. M., Tripathi, A. K., Saikia, R., Medhi, K., Gogoi, S. H., Gogoi, P. and Hojai, N. 2020. Effect of area specific mineral mixture supplementation on milk yield and reproductive traits of crossbred dairy cattle under sub-tropical region of north eastern India. International Journal of Chemical Studies. 8(6): 2239-2243.

Snedecor, G. W. and Cochran, W. G. 1994. Statistical Methods.7th Edn., Oxford and IBH Publishing Co., New Delhi, pp 312-317.

Sobhanirad, S., Carlson, D. and Kashani, R.B. 2010. Effect of zinc methionine or zinc sulfate supplementation on milk production and composition of milk in lactating dairy cows. Biological Trace Element Research. 136: 48-54

Thakur, D., Jain, R.K. and Aich, R. 2016. Effect of strategic nutrient supplementation on health, reproductive and productive status of buffaloes in the Malwa region of Madhya Pradesh. Buffalo Bulletin. 35(2): 225-235.

Tiwari, S.K., Kumar, A., Tiwari, D.P., Mondal, B.C. and Saxena, P.C. 2012. Response to strategic dietary mineral mixture supplementation in cattle and buffaloes under field condition (Hill region) of Nainital district of Uttarakhand. Indian Journal of Animal Sciences. 82(11): 1381-1385,

Weiss, W.P., Hogan, J.S., Todhunter, D.A. and Smith, K.L. 1997. Effect of vitamin E supplementation in diets with a low concentration of selenium on mammary gland health of dairy cows. Journal of Dairy Science. 80:1728-1737.