EFFECT OF SUPPLEMENTATION OF MINERALS ON THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF LACTATING CATTLE AND BUFFALO

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ABSTRACT: A significant part of a complete dairy feeding program is the mineral-vitamin component. Physiologically, minerals are involved in reproduction, lactation, cow/calf health during pregnancy and cow recovery after calving and general herd health. Highly productive dairy animals have much greater needs for minerals and vitamins than low-producing.Concentrations of minerals and vitamins in feeds can be extremely variable. Dairy animals commonly need 3 vitamins and 17 mineral for their optimal productivity. Even the deficiency of any of these can result in health, reproduction and milk production problems. The antioxidant, vitamin E and carotene are beneficial in reducing mastitis. Vitamins (D, E, C and carotene) and minerals (Cu, Zn, and Se) are needed for enhanced immune response.Almost all the members of B.comlex group, C vitamin $K_2$are synthesized in rumen but ruminant diet should contain sufficient cobalt for B_{12} synthesis. Vitamin A is neither synthesized in the body nor contributed by bacteria and it is the only vitamin, which may be deficient supply under many conditions. Therefore its supply seems to be critical.Vitamin E content of forage is highly variable and is effective in reducing gossypol toxicity. Generally it is assumed that the dairy animals with functional rumen do not develop deficiency. Different research reports suggest the need for supplemental biotin, thiamin and niacin for dairy cattle. Pre-partum anionic diets should be supplemented to avoid Milk fever. High phosphorus diets do not improve milk production or reproduction but there is environmental concern from use of excess P. Manganese has its role in ovulation and fertility of dairy animals. Grazing dairy animals should have access to high quality free-choice mineral mixtures. Mineral and Vitamin supplementation should especially be managed before the periods of increased trace mineral demand such as calving, joining, dry-off and growth.

Keywords: Mineral mixture, micro minerals, milk fever, macro minerals, milk yield.

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INTRODUCTION

Minerals and vitamins are very important nutritional factors having direct impacts on the production, reproduction and general health of the dairy animals and their deficiency results in poor performance and reproductive problems in livestock. A proportion of minerals and vitamins is contributed by the daily fodder and forages but as plants matures, mineral and vitamin concentrations decline due to natural dilution process and translocation of nutrients to the root system. As a result, mineral imbalance and deficiency exist widely in dairy animals and the severity of the deficiency depends upon the type of diet, age, physiological status of the animals and the agro-climatic condition of the region (Garg *et al*., 2007). In India, buffaloes often do not receive mineral supplements, exceptcommon salt (Garg *et al*., 2005). For vitamin and mineral mixture supplementation, it is necessary to know the availability of minerals and vitamins from feeds and fodder fed to animals. This article discusses vitamin and mineral mixture requirements and supplementation of dairy animals and from this discussion an indication of the possible consequences of different physiological changes can be obtained, and the need to change management practices assessed.

Mineral Feeding: Mineral requirements and toxic levels and vitamin requirements suggested by the National Research Council (NRC) for lactating dairy cows are presented in Table1. In General, there are two sources of minerals including natural feeds (fodder, forages and grains) and additional mineral supplementation to balance

the minerals present in the dairy feed. The major minerals (macrominerals) required by the lactating animals include calcium, phosphorus, potassium, magnesium, sodium, sulfur, and chlorine. Other trace minerals required in much smaller or trace amounts (microminerals) include iodine, iron, cobalt, copper, manganese, zinc, and selenium (McDowell, 2002). Whether the requirement for a mineral is large (measured as a percent of dry matter) or small (measured in ppm), the optimum level of these minerals must be fed to achieve optimum performance and herd healthof dairy animals Grant (1992).

Biological Availability of Mineral Sources: In ration formulation of dairy animals the mineral content of a feed or mineral supplementation is of little value unless the availability, or digestibility, of the minerals is well known. Biological availability tells how well a mineral is digested and used by the animal to promote healthy production (Grant, 1992). As the availability of mineral decreases, the amount of that mineral needed to meet the cow's requirement obviously will increase (NRC, 1980).

Table I. Relative availabilities of calcium, phosphorus, magnesium and sulfur from common feed sources.

Relative Avaialbility	Source			
	Calcium	Phosphorus	Magnesium	Sulfur
High	Steamed bone meal Monocalcium phosphate Dicalcium phosphate Calcium chloride	Monocalcium phosphate Monosodium phosphate ammonium phospahte dicalcium phosphate	Magnesium oxide Magnesium Sulfate Magnesium carbonate	Calcium sulfate Sodium sulfate Potasium sulfate Magnesium Sulfate
Medium	Calcium carbonate lime stone	Steamed bone meal Deflourinated phorphus Sodium triployphosphate	Magnesium chloride	
Low	Forages	Low flourine rock phosphate Soft rock phosphate	Dolomitic limestone Forage, Grain	Elemental sulfur

Source: (Grant, 1992).

Bone meal and dicalcium phosphate have the highest calcium availability as shown in Table 1. Limestone is intermediate, and forages tend to have lower availabilities, but are not necessarily poor sources of calcium (Weiss, 2004). Most common sources of phosphorus are quite available except for the rock phosphates, which are low. Calcium requirements are based on an average calcium availability of 38 percent. Average calcium availabilities are 51 percent for most mineral supplements, 43 percent for grains, and 35 percent for forages (NRC, 1989). One exception may be the older, high producing cow fed alfalfa as the sole forage. In this case, increase the dietary calcium level to between .90 and 1.0 percent of ration dry matter (Lippolis, 2011).

The proper supplementation of macro and micro minerals according to requirements in the daily diet of lactating animals increases milk production. This is apparent from Table 3 where the animals receiving different levels of minerals supplementation (80, 100, and 120%) as defined by NRC are performing better than control group where the animals are not being supplemented.

Vitamins for Dairy Animals: Vitamins A, D, and E must be furnished in dairy cattle diets, while the water-soluble vitamins and vitamin K are synthesized in apparently adequate amounts by rumen microbes. Special situations prevails where production responses have occurred or metabolic problems corrected from supplementation of certain B vitamins. Because of wide variations in content of vitamins A, D, and E in normal feedstuffs for dairy cattle, particularly harvested forages, and because of the multitude of factors which affect their utilization and bioavailability, it is recommended to supplement dairy cattle diets with an amount equal to the minimum daily requirement of these vitamins. This practice provides inexpensive insurance against reduced productivity or compromised health status of dairy cattle. Of the 14 known vitamins, only two (vitamins A and E) have absolute dietary requirements for dairy cows. Those two vitamins (or their precursors) must be in the diet or cows will become clinically deficient (Weiss, 2005). Adequate vitamin D can be synthesized by skin cells when they are exposed to enough sunlight.

The liver and kidney of the cow can synthesize vitamin C. Ruminal and intestinal bacteria synthesize most, if not all, of the B-vitamins and vitamin K, and under most situations cows probably do not need to consume those vitamins to prevent clinical deficiency (Weiss, 2004, 2005).

Diagnosis of Mineral and Vitamins Deficiencies: Assessing the consequences of mineral deficiencies in dairy animals is difficult. Slightly lowered weight gains, reduced milk production and/or decreased reproduction rates in cows may occur without visible signs of a mineral deficiency (Rasby *et al*., 1997). At the same time, excess mineral consumption may cause reduced cow performance without obvious signs of low-level toxicity.

Producers need sufficient information to establish a "least cost" method of correcting mineral deficiencies (Rasby *et al*., 1997). The transition period, from 3 weeks before to 3 weeks after parturition, is a stressful time for dairy cows (Spears, 2011).A number of minerals and vitamins can affect immune function and health in cattle if they are present in the diet in inadequate amounts (Weiss, 2005). It is well documented that low vitamin E and/or selenium status can increase incidence of mastitis and retained placenta. A deficiency of copper may affect mammary gland health. Copper status in cattle is affected not only by the level of copper in the diet but also by high levels of other minerals, such as sulfur, molybdenum, and iron that reduce the bioavailability of copper. In herds with a history of lameness and hoof lesions, biotin supplementation may improve hoof health. Supplementing dairy cattle with minerals and vitamins at levels well above requirements will not result in further improvements in health and may produce adverse effects on animal health (Spears, 2011). Mineral and vitamins supplementation to dairy animals reduces economic losses caused by the minerals deficiencies. Moreover, it also increases milk production, improves reproductive performance and ultimately enhances the farmer's income.

Table 2: Suggested mineral and vitamin requirements and effectively reestablishes the number of circulating lymphocytes trace element toxicities for lactating dairy animals (dry basis).

Required elements **Suggested value**	**Lactating dairy animals[a]**
Macro elements (%)	
Calcium (Ca)	0.43 - 0.77
Phosphorus (P)	0.25 - 0.49
Magnesium (Mg)	0.20 - 0.25
Potassium (K)	0.90 - 1.00
Sodium (Na)	0.18
Sulfur (S)	0.20 - 0.25
Microelements (mg/kg)	
Cobalt (Co)	0.1
Copper (Cu)	10.0
Iodine (I)	0.6
Iron (Fe)	50.0
Manganese (Mn)	40.0
Selenium (Se)	0.3
Zinc (Zn)	40.0
Vitamins (IU/kg)	
Vitamin A	3200
Vitamin D	1000
Vitamin E	15
Toxic Elements (mg/kg) [b]	
Copper (Cu)	80
Fluorine (F)	30
Molybdenum (Mo)	6
Selenium (Se) [c]	5
Zinc (Zn)	500

[a] National Research Council (1989), [b] National Research Council (1980)
[c] McDowell (1992)

Table-3: Effect of feeding mineral mixture on milk production and composition.

Parameters	**Control without suppl.**	**NRC Requirement %**		
		80	**100**	**120**
Milk yield (kg/day)	08.00	9.32	10.50	11.75
Fat corrected milk at 4%, (kg/day)	09.66	11.49	14.00	16.60
Fat %	05.38	5.55	6.23	6.75
Total solids	15.00	15.00	15.30	16.10

NARC, 2012

Table 4: Vitamin recommendations for dairy animals 1,2.

		Ration levels		
Vitamin	**Unit**	**Recommended**	**Maximum**	**Estimated**
A	A IU/pound	1,450-1,800	30,000	65,250 IU
D	D IU/pound	450	4,500	20,250 IU
E	E IU/pound	7	900	315IU

[1]Data from Dairy NRC (1989).
[2]Research at the University of Nebraska showed no benefits of feeding high levels (1,500,000IU per head daily) to lactating dairy animals.

Conclusions: Meeting the optimum requirements of mineral and vitamin needs of dairy animals is crucial to achieve high levels of milk production, maintaining general herd health and reproductive performance. By knowing a dairy animal's nutrient requirements as well as the amount and biological availability of minerals and vitamins in the feedstuffs being consumed by the cow, producers can understand when supplementation may be beneficial. Cost effective and efficient meeting these requirements through available feedstuffs and strategic supplementation can improve profitability of the dairy enterprise.

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