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Role of Micronutrient in Livestock Production

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ARTICLE ID: 100

Abstract:

Mineral Play very important role in Immunity, Production andReproduction of animals. Deficiencies of certain mineral elements may cause reproductive disorders as minerals play an important role in health and reproduction of the livestock. Infertility and reproductive disorders has emerged as major problem in Indian livestock farming. Adequate supplementation of minerals depends on age, stage of pregnancy and lactation. For the formation of structural component of body and proper functioning of enzymes, hormones, vitamins and cells, macro and micro minerals are equally important. Area specific Mineral deficiency and toxicity is very common due to variable soil and climatic condition. So now a day's area specific mineral mixture are prepared by various organization.

Keywords: Major, minor, Mineral, reproduction, infertility, macro, trace.

Introduction

It has been established beyond doubt that micronutrients play important role in livestock production. Mineral supplementation in livestock improves health, enhances growth, reproductive and productive performances.

Role of mineral in livestock

The minerals have been broadly classified depending upon the concentration in the body and amount required in the diet. The minerals required by the animal are classified in to 2 categories, namely macro or major minerals and micro or trace minerals. Normally the trace minerals are present in concentration below 50mg/kg and required in the diet at levels of 100mg/kg feed (Mc Donald et al, 2004).

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1. Major macro minerals are- calcium (Ca), phosphorus (P), magnesium (Mg), potassium (K), and sodium (Na) sulphur (S) and chloride (Cl).

2. The micro minerals important in animal nutrition are zinc (Zn), iodine (I), manganese (Mn) and iron (Fe) copper (Cu),) selenium (Se). In recent literature metals like Chromium, vanadium and nickel are also considered as trace minerals.

Body needs about 80 numbers of minerals for various functions in the body but the above mentioned minerals are critically important for maintainance of health, growth and reproduction. The figure 1 describes the relation between the adequate and inadequate mineral status and health and reproductive performance in animals. The figure also depicts that the subclinical symptoms of mineral deficiency vary often unnoticed as because growth and reproductive performances are not achieved at desired level. Clinical symptoms of mineral deficiency occur at a much later stage.

Factors affecting mineral content in animal diet

There are several factors which affect the mineral availability to the animal. Species of plant, variety of forage, portion of the plant (leaf:stem ratio), quantity of exchangeable minerals in the soil, season and climate of harvesting, level of fertilization, soil pH, and harvest conditions. Mineral content of pastures and grains used for cattle is presented in table 2. Harvesting and storage losses also contribute to mineral variability. Over conditioning or weathering of forages will increase the amount of leaf loss and leaching of nutrients resulting in greater mineral losses. Lush spring pasture is low in Mg and can result in grass tetany in cows. Forages that are very mature are more lignified than young immature plants. Nutrients that are bound in lignin are no longer available for digestion (Bell, 1997).

The trace mineral content of our natural feeds is determined primarily by the mineral availability from the soil and secondly by the actual mineral composition of soil (Smart et al, 1981; Williams, 1977). Factors which influence the mineral composition of the soils are: the origin of the parent rock (Fletcher and Doyle, 1978), glaciation, leaching, surface erosion, evaporation, salinization, the application to the soil of pesticides, fertilizers, trace elements, manures and sludges, and the aerial fallout from industry and transportation (Horvath and Reid, 1980; Williams, 1977). Soil factors, such as acidity, moisture or drainage conditions, temperatures and seasonal effects influence mineral uptake by crops and pastures (Horvath and Reid, 1980).

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The availability of minerals in soil depends upon their effective concentration in soil solution. This concentration is influenced by pH, moisture, organic matter, leaching, and the presence of other elements and the microbial activity of the soil (Burk, 1978; Williams, 1977). Alkaline soils lead to an increased biological availability of some trace elements such as selenium and molybdenum (Williams, 1977). With decreasing soil pH, selenium is less available, but the uptake of some cationic metals such as copper is increased (Burk, 1978; Williams, 1977). Some trace minerals form insoluble complexes with the organic matter in the soil; copper is one of these (Williams, 1977). Soil leaching, erosion and long term cropping leads to a depletion of biologically active trace minerals and other elements in the soil can form complexes with the minerals. An example of this is sulphate which will inhibit the uptake of selenate and selenite from the soil (Burk, 1978). The soil zones and the origin of the soils have little influence on the availability of most trace minerals except selenium. The selenium content is high in plants grown on soils derived from recently exposed sedimentary rock and deficient in plants grown on soils from igneous rock (Burk, 1978). Crop management and climatic conditions also influence the eventual trace mineral level in the feeds. Fertilization and/ or heavy rainfall can result in lush pasture growth and the dilution of some trace minerals (Burk, 1978).

In one study, nitrogen fertilizer increased the copper content of the forage (Mudd, 1970). The stage of plant maturity and method of forage handling influence the availability of trace elements to the animal. In immature pastures, copper is not as available as in dried forages cut at the same stage of maturity (Horvath and Reid, 1980). As the plant matures there is also a gradual decline in the trace mineral content, particularly copper and zinc. The type of cultivar can influence the trace mineral content (Gladstone and Loneragan, 1967). Some plants are known for their selenium and molybdenum concentrating ability, while alfalfa and other legumes do not readily take up selenium (Burk, 1978). The selenium levels varied according to soil zones and the soil type. The selenium values were higher in clay soils than in loam soils. Seasonal effects influenced copper levels. Results from a study in Saskatchewan, Canada indicate that 60% of the alfalfa hay, silage and brome hay analyzed were deficient in copper (less than 10 mg/ kg of dry matter), and 100% were deficient in zinc (less than 40 mg/ kg of dry matter). Copper was also deficient in all the clover silage, barley and oat grain samples. Deficient zinc levels were found in 88% of the barley, 40% of the wheat and 93% of the oat samples (Christensen, 1978).

Factors affecting mineral requirements of animals

The quantity of minerals required depends upon the age, weight, physiological status, species, disease and type and level of production of the animal. Young animals absorb minerals such as Ca more efficiently than older animals, but they have higher mineral requirements. Sheep have different requirements than cattle. For example, in sheep, levels above 25 mg/kg of Cu are considered toxic, while cattle do not reach toxicity levels until 400 mg/kg are present in the diet. As Cu toxicity in sheep is acute, no Cu supplementation is required if adequate amount is in the forage (Bell, 1997).Factors that affect the consumption of mineral mixtures have been summarized by McDowell (2003) is as follows:

a. **Soil fertility and forage type consumed:** Usually, the higher the level of soil fertility, the lower the consumption of minerals. Barrows (1977) reported that for cattle, salt, calcium, phosphorus and magnesium each appeared to be consumed in relation to the content of the particular element in the grass. Several reports have shown that cattle on native range consume more mineral supplement than those cattle on improved pastures. Cattle on low-quality or overgrazed pastures consume more mineral supplements.
b. **Season of year:** Season of the year affects mineral intake (Cunha, 1983), which is often greatest during the winter or dry season when forages stop growing, lose green color and become high in fiber and lignin and low in digestibility and mineral availability. As plants mature, mineral content declines (McDowell, 1985). Mineral supplement intake is lower when forage quality and quantity is optimal. Under drought conditions, mineral supplement intake is increased to counteract the low mineral availability in the forage and the low level of forage intake due to its reduced palatability (Cunha, 1983).
c. **Available energy-protein supplements:** The kind and level of protein-energy supplementation influences mineral supplement intake. Protein and energy supplements that also provide minerals will decrease both the need and desire for free-choice minerals. Weber et al. (1992) reported a wide day-to-day variability in free-choice mineralized salt and protein block consumption by British-bred beef cows.
d. **Individual variation in requirements:** Growth rate, percentage of newborn and milk production influence mineral needs. Added requirements of gestation and lactation increase mineral needs and, thereby, consumption. The higher the level of productivity,

the more important an adequate level of mineral intake. Barrows (1977) reported that mineral consumption tended to decline as cows increased in age. Different breeds and strains of animals vary in their mineral requirements and those of new breeds developed for improved production may be higher requirements.

e. **Salt content of drinking water:** High salt concentration of drinking water decreases mineral supplement intake. If, naturally occurring salt content of water is high, mineral supplements needs to be reformulated with other palatability stimulators such as cottonseed meal and molasses.

f. **Palatability of mineral mixture:** Ruminants have no particular desire for the majority of minerals, with the exception of common salt. Becker et al. (1944) noted that the attitude of cattle toward salt in a mineral supplement is inversely related to the amount of salt present in feeds and water. Common salt, because of its palatability, is a valuable carrier of other minerals. If mixtures contain 30-40% salt or more, they are generally consumed on a free-choice basis in sufficient quantities to supply supplementary needs of other minerals.

g. **Physiological makeup and production function:** Mineral needs of ruminant animals depend greatly on their physiological makeup, age, health, nutritional status and function, such as producing meat, milk or developing a fetus. For example, dairy cows producing greater volumes of milk have higher mineral requirements than dry cows or cows producing low quantities.

h. **Confinement rearing without access to pasture:** Moving of livestock operations into complete confinement without access to pasture has had a profound effect on mineral, as well as vitamin, nutrition (McDowell, 2000). Young, lush, green grasses or legumes are good sources of many minerals. Confinement rearing, including poultry in cages and swine on slatted floors, results in limited animal access to feces (coprophagy), which provide some minerals. Confinement rearing requires producers to pay more attention to higher mineral requirements (Cunha, 1987).

i. **Stress, disease or adverse environmental conditions** Intensified production increases stress and subclinical-level disease conditions because of higher densities of animals. Nutrient levels that are adequate for growth, feed efficiency, gestation and lactation may not be adequate for normal immunity and for maximizing the animal's resistance to disease (Cunha, 1985). Diseases or parasites affecting the gastrointestinal tract reduce intestinal absorption of minerals. If they cause diarrhea or vomiting, this will also decrease intestinal absorption and increase needs.

j. **Mineral interrelationships:** Mineral interrelationships are very important in determining mineral requirements. Minerals and other nutrients, such as vitamins, amino acids and energy, are interrelated to some extent. This means there is a correct level for each nutrient in relation to the level of all other nutrients to obtain the best response. Realistically, until mineral interrelationships are understood, only an approximation of mineral requirements can be made.

k. **Body mineral reserves:** Body storage of minerals from previous intake also affects daily requirements. The body has large stores of some minerals if liberal dietary intakes were previously available (e.g., calcium and phosphorus in osteous tissue) and can store considerable quantities of trace minerals such as copper, selenium and iodine.Optimum mineral allowances are needed to permit animals to achieve their full genetic potential for optimum performance. The higher the allowance, the greater is the extent to which it may compensate for the influencing factors that result in higher true requirements; thus mineral allowances higher than NRC requirements may be needed to allow optimum performance.

Bioavailability of Minerals

Mineral bioavailability refers to the ability of a specific mineral source to supply the mineral for the body function. Certain mineral sources preferred over other due to the increased bioavailability, even though the total mineral content may be low. Generally biological availability is usually expressed on relative basis. One source is selected as a standard and its availability assigned a value of 100. All other sources are then ranked in availability according to the standard source. Availability is highly variable among natural feedstuffs. Mineral interaction, amount of organically bound mineral, presence of compounds such as phytic acid, amount of fertilizer used are the chief factors which determine bioavailability of a mineral from a particular source. Kumar et al (2003) observed that the concentration of Fe, Cu, Co, Zn and Mn in soil and Sorghum were highly correlated and the concentration of Fe, Cu, Zn, Co and Mn in cycling heifers and lactating cycling cows were significantly ($P<0.01$) higher than the non-cycling heifers of either age group.

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Strategic supplementation of deficient minerals through locally available feeds and mineral contents in Chhattisgarh:

Calcium: Rice polish, Wheat bran.

Phosphorus: GNC,Wheat bran,Rice bran, Rice polish

Zinc: Rice bran,Wheat bran,Maize,Rice polish,GNC,MOC

Magnesium: Wheat bran,Crushed maize

Copper: Rice polish,Maize,MOC.

Supplementation of minerals to the pig is not practice however, supplementation of mineral to the pig is essential considering the following facts:-

- The grain typically fed to swine is low in minerals than the requirement.
- Pigs have a faster growth rate.
- Pig reproduce at an early age, at a relatively lower body weight
- Pigs are more prolific breeder and have larger litter size than other livestock.

Experiment revealed that supplementation of area specific mineral mixture as resulted improvement of health , body weight gain and reproductive performance of sows and gilt. It is also observed that mineral supplemented sow furrowed larger and heavier litter size more interesting the litter size bone are found to be of uniform body weight. We have also observed that when supplemental zinc increased to 500ppm, the ratio of lean meat and fat has increased in an appreciable amount without compromising the total body weight gain.

Table 1: Mineral requirement in growing pigs **Table 2:** Min. req. in gilt, boar and lactating sows.

Element	Body weight (Kg)					
	3 to 5	5 to 10	10 to 20	20 to 50	50 to 80	80 to 120
Calcium, percent	0.90	0.80	0.70	0.60	0.50	0.45
Phosphorus (total), percent	0.70	0.65	0.60	0.50	0.45	0.40
Phosphorus (available), percent	0.55	0.40	0.32	0.23	0.19	0.15
Sodium, percent	0.25	0.20	0.15	0.10	0.10	0.10
Chlorine, percent	0.25	0.20	0.15	0.08	0.08	0.08
Potassium, percent	0.30	0.28	0.26	0.23	0.19	0.17
Magnesium, percent	0.04	0.04	0.04	0.04	0.04	0.04
Iron, ppm	100	100	80	60	50	40
Zinc, ppm	100	100	80	60	50	50
Copper, ppm	6	6	5	4	3.5	3
Manganese, ppm	4	4	3	2	2	2
Iodine, ppm	0.14	0.14	0.14	0.14	0.14	0.14
Selenium, ppm	0.30	0.30	0.25	0.15	0.15	0.15

Mineral	Bred gilts	Boars	Lactating gilts and sows
Calcium, percent	0.75	0.75	0.75
Phosphorus (total), percent	0.60	0.60	0.60
Phosphorus (available), percent	0.35	0.35	0.35
Sodium, percent	0.15	0.15	0.20
Chloride, percent	0.12	0.12	0.16
Potassium, percent	0.20	0.20	0.20
Magnesium, percent	0.04	0.04	0.04
Iron, ppm	80	80	80
Zinc, ppm	50	50	50
Copper, ppm	5	5	5
Manganese, ppm	20	20	20
Iodine, ppm	0.14	0.14	0.14
Selenium, ppm	0.15	0.15	0.15

(Source: Swine Nutrition Guide 1997)

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