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Requirement, Dietary Sources, and Efficiency of Absorption of Major Minerals by Farm Animals: From an Educational Perspective

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ABSTRACT

The necessity of the inclusion of major minerals in the diet of farm animals cannot be overemphasized. The production of the much-needed animal protein can be severely hampered when unrecognized conditions of deficiency, oversupply, or in-balance of minerals exist and interfere with the intensification of livestock production. Here, the purpose of this study was to explain this matter based on an educational perspective. This paper is a literature survey. This paper is important to make farmers understand the requirement, dietary sources, and efficiency of absorption of major minerals by farm animals. For the best production of any livestock, the requirement for each mineral must be known. Lack of adequate minerals in the diet of farm animals is associated with late maturity, prolonged breeding period, reproductive disorders, poor growth, anemia, and a high rate of mortality.

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1. INTRODUCTION

Minerals are elemental nutrients required in small amounts or minute traces. They are essential components of the body of an animal. According to Patra and Lalhriatpuii (2020), all body cells, tissues, and fluids contain minerals in variable amounts and different chemical farms. Minerals have many functions relating directly or indirectly to animal growth. They contribute to the rigidity of bones and teeth and are an important part of the protein and lipid fraction of the animal. In addition, they preserve cellular integrity by osmotic pressures and are a component of many enzyme systems, which catalyze metabolic reactions in biological systems (Guindani *et al.*, 2022). Deficiency, excess, or a lack of any of the mineral elements in an animal 's diet, leads to well -defined symptoms . This paper looked at the requirement and dietary sources of the major minerals by farm animals in Nigeria from an educational perspective from a literature survey.

2. METHOD

This paper is a literature survey. This paper analyzed data based on articles published in several journals. Detailed information on how to get data for the literature survey is explained elsewhere (Azizah *et al*., 2021).

3. RESULTS AND DISCUSSION

3.1. Requirement and Utilization of Major Minerals by Farm Animals

The major mineral ions required in animal nutrition are Phosphorus P) and Calcium (Ca). Magnesium (Mg), Sodium (Na), Sulphur ($) and Potassium (K) Some levels of these minerals occur naturally in most feedstuff. In addition, they are added as supplements to feeds to balance dietary requirements (Humer *et al*., 2018). The requirement for a mineral may be defined as the amount of that mineral that must be supplied in the diet to meet the needs of a normal healthy animal given a completely adequate diet Lack of adequate minerals in the diet of farm animals has been associated with late maturity, prolonged breeding period, reproductive disorders, poor growth, anemia, and high rate of mortality (Christian & Smith, 2018). For the various life processes, not only must there be sufficient supplies of the various essential minerals but also, they must not be in excess. The mineral needs of farm livestock vary widely. The relative requirements of each type of stock depend to a greater extent on the relative magnitude of the digestive organs and chiefly on the nature of its product. The goat for instance has an outstanding mineral requirement due to its small body size, which has a high metabolic rate, a large digestive system, and produces milk richer in minerals than cows and greater in volume than sheep. Therefore, feeding adequate minerals for other stock is liable to be deficient for the goat. The requirement by goats weighing 45kg to be 6.69g and 3.269 for calcium and phosphorus respectively.

These requirements are somewhat higher than those for sheep but provide about one-third of calcium and half of phosphorus. Requirements of the various minerals by cattle are well documented as shown in **Table 1.** Available evidence showed that differences exist in the utilization of minerals by various classes within a species of ruminants. The calcium and phosphorus are utilized by three classes of WAD Goats viz, the adult castrated buck, the adult female goat, and the young male goat obtained different values for each class of goat. He observed that the adult castrated bucks weighing 16 kg required daily for maintenance and growth of 4.09 and 2.77 g of calcium and phosphorus respectively. For the adult female WAD goat, he obtained 3.90 g per day and 2.40g per day as the calcium and phosphorus requirements for the maintenance and growth while the young goat weighing an average of

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10kg required daily, 0.37g and 0.31g of calcium and phosphorus for growth and maintenance While an adequate supply of calcium and phosphorus is essential, they are more efficient when they are present in a certain ratio.

Table 1. Mineral requirements of beef cows.

Mineral	for Lactating Cows	for Pregnant Cows	for Growing Cattle
Calcium (%)	0.45	0.30	0.45
Phosphorus (%)	0.20	0.20	0.30
Potassium (%)	0.70	0.60	0.60
Magnesium (%)	0.20	0.12	0.10
Sodium (%)	0.10	0.08	0.08
Copper (ppm)	10.00	10.00	10.00
Selenium (ppm)	0.20	0.20	0.20

The desirable calcium: phosphorus ratio is often defined as one lying between 2:1 and 1:1. To tolerate a wide range of calcium: and phosphorus ratios. Wise *et al*. (1963) reported no significant difference in calf growth rates at ratios between 1:1 and 7:1. Ricketts *et al*. (1970) in their experiment on the effect of three calcium; phosphorus ratios on the performance of growing Holstein Steers, reported that animals receiving an 8:1 calcium/phosphorus ratio diet gained less daily than the 1:1 and 4:1 group. There was no difference in daily gain between the 1:1 and 4:1 group. The 4:1 group showed no adverse effect on average daily gain and feed efficiency. Lofgreen and Klelber (1953) reported the adverse effect of Ca: P ratios between 0. 8:1 and 6.0:1 on phosphorus and calcium absorption in growing lambs. The decrease in the average daily gain of swine when the dietary Ca: P was widened from 1:1 to 2.9:1. When sows were fed a diet containing excess calcium, adverse effects on reproduction occurred and most of their piglets died at birth. Excess calcium had been observed to depress gains by interfering with digestibility and or absorption of nutrients other than phosphorus . This confirmed the findings of Newland *et al*. (1958) who reported that high levels of Ca interfere with zinc metabolism . The Magnesium , Potassium , and Sodium requirement for growing animals have been given as 0.06, 0.2-0.6, and 0.1-0.2% of the dry ratio, respectively . High intakes of macro-element can increase the dilution rate in the rumen with possible effects on voluntary intake . For example , increasing phosphorus intake from 1.5 g/day by a ruminal infusion of phosphorus salts increased the flow of rumen liquor from 10 L/day.

3.2. Dietary Sources of Major Minerals

As stated earlier, animals have two primary sources of inorganic elements: natural feeds or supplementation in form of concentrates. Many feedstuffs provide livestock with an inadequate amount of improper proportions of minerals. Thus, mineral supplements are required to correct mineral deficiencies in animal diets. In the tropics, there's often a shortage of minerals in the diet. This is because many forages, Soils, and pastures are low in mineral content, especially calcium and phosphorus. The natural grassland of the West African region seldom supplies sufficient phosphorus to maintain animals in good health for more than a few weeks at the beginning of the rainy season. For most of the year, they observed that phosphorus levels were extremely low and frequently below safety levels. The southern gamba grass (*Andropogon*, *Tectorum,* Schum) a common constituent of bush fallow in the South and middle belts of Nigeria contained a rather low amount of magnesium and very low amounts of phosphorus. He showed that samples cut every 3 weeks contained 0.39% phosphorus. This value according to him, fell to 0.34% for grass cut every 12 weeks. Non-fertilized forages taken between June (dry season) and November (wet season). They found

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that majority of soil and forage analyses indicated inadequacy concerning requirements. Forage magnesium, sodium, copper, and zinc concentrations were deficient during both seasons while protein and potassium were low only during the dry season. Tropical forages contain low mineral contents especially during the extended dry season because the nutrients are translocated from the plant to the root (Tergas & Blue 1971). That phosphorus deficiency was pronounced and widespread in extensive grazing areas of the tropics. He also observed that phosphorus was a major limiting factor in the unit of ruminant livestock in West Africa. This was supported by Judson and McFarlane, (1998) who stated that phosphorus deficiency is the most widespread and economically important of all mineral disabilities affecting grazing livestock. Dairy cows according to Becker *et al*. (1934) depend upon grains and milling by-products for most of the phosphorus.

Peeler (1972) in his review of the biological availability of major mineral ions in feeds stated that a required nutrient can be of nutritional value only if it is in a form that can be digested, absorbed, and transported to the part of the body where it is utilized for essential functions. The soluble phosphates including sodium phosphate, and phosphoric acid is more biologically available to animals than the phytate form of phosphorus. Lofgreen and Kleiber (1953) found that 91% of the phosphorus in alfalfa hay was utilized by the sheep. For the ruminants, bone meal, and monocalcium phosphate are high sources of calcium while the hay is a low source of calcium (Peeler, 1972). Becker *et al*. (1934) observed that dairy cows depend on roughages as their main natural source of calcium.

The most important source of minerals for beef cows comes from the pasture and forages they are grazing since these feeds contribute the highest percentage of the diet. These feeds are, in fact, good sources of most of the required minerals. An important factor that limits the availability of calcium and phosphorus in tropical forage crops is the crude fiber content of the crops. It is found that the crude fiber content generally ranges from 25% for young forages (at 3 weeks old) to 40% for mature forages at 25 weeks old. The absorption of Ca and P from feed can be reduced by high fiber content. Goats, however, with their wide browsing habits may often avoid mineral deficiencies that affect other species. Magnesium deficiency is rare in West Africa. The availability of magnesium in forages ranges from 10% to 25% and that in grains and concentrates from 30% to 40% (Peeler, 1972). Protein concentrates of plant origin like cottonseed, palm kernel, groundnut, and coconut meals are rich in magnesium with values ranging from 0.3 to 0.6% (Judson & McFarlane, 1998). Animals consuming high grain diets often do not ingest enough potassium (Telle *et al*. 1964). However, the potassium intake of ruminants is greatly increased when they consume a large quantity of hay or pasture. Animals under intensive management get most or all these minerals included in their concentrate ration.

3.3. Factors Enhancing the Efficiency of Absorption of the Major Minerals

The absorption of minerals is dependent upon many factors including the level of the element ingested, age of the animal, pH of the intestinal contents, state of the animal concerning deficiency of adequacy of the element, and the presence of other antagonistic minerals or nutrients. The solubility of minerals is another important factor affecting absorption. For example, the absorption of calcium and phosphorus is dependent upon their solubility at the point of contact with the absorbing membrane. Ben Ghedalla *et al*. (1975) noted that a rise in pH as the digesta advanced along the intestine of the sheep was accompanied by a decrease in the solubility of the minerals, hence a reduction in its absorbability. The level of dietary calcium influences calcium absorption as high dietary levels depresses absorption efficiency (this does not follow for phosphorus). At a given intake,

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therefore, absorption of dietary calcium depends on the net requirements of the animal and at a given net requirement, the coefficient of absorption varies inversely with feed calcium. Therefore, to meet the calcium requirement, the diet must contain sufficient calcium in a form that can be absorbed. The coefficient of absorption of calcium in cattle and sheep is 0.68. The calcium from milk is known to be efficiently absorbed by unweaned lamb, but the precise proportion absorbed was not known. The absorption of calcium varies with age. As age increased calcium absorption decreased. The estimates for phosphorus absorption in sheep were 0.73 for lambs up to 1 year of age and 0.60 for more mature sheep.

Milk-fed lambs were observed to have a coefficient of absorption of phosphorus in milk to be greater than 0.95. As can be seen from the estimate for phosphorus, there is a significant linear relationship within each age class between absorption and intake. Using the tracer technique, the coefficient of absorption of dietary magnesium has been obtained. In calves and lambs receiving milk diets, the coefficient of absorption of dietary magnesium is high at a very young but falls away rapidly with age. Values ranging from 0.20 to 0.70 were adopted as the coefficient of Magnesium absorption for various cattle with different live weights. The absorption of several minerals is dependent on the levels of the other elements present in the diet. A great excess of dietary calcium and phosphorus interferes with the absorption of the other. A magnesium deficiency is also observed to increase the elimination of potassium.

3.4. The Educational Purpose of Diet for Animal

Diet is important for animals. Farmers need information about the importance of diet. Therefore, we need to provide education to farmers. Mineral needs of each animal vary. For the best livestock production, the requirements of each mineral must be known. Lack of sufficient minerals in the diet of farm animals is associated with late maturity, prolonged breeding period, impaired reproduction, poor growth, anemia, and high mortality rates, especially in young animals (Adeloye & Akinsoyinu, 1984).

4. CONCLUSION

The mineral could either be obtained from concentrates or natural feeds. Once the feed is taken in or ingested, it needs to be absorbed to be useful to the animal. Certain factors, such as level of element ingested, age of the animal, pH of intestinal contents, state of animal concerning deficiency or adequacy of the element, and presence of either antagonistic minerals or nutrients, affect the absorption of any mineral.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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