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Importance of Microminerals in Bovine Reproduction

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Reproduction is an important consideration in the economics of cattle production. A healthy calf each year is the usual goal of reproduction. Reproduction ensures meat and milk production together with herd replacement. Micronutrients are essential in immunological function, oxidative metabolism, and energy metabolism in ruminants. Microminerals affect animal reproductive physiology, causing imbalances that decrease efficiency and financial losses in the dairy business. Reproductive efficiency significantly impacts profitability in ruminants. Trace minerals like zinc, copper, manganese, and selenium play important roles in antioxidant enzymes and proteins. Most roughages, greens, concentrates, and commercial feeds in the Indian market lack trace minerals, necessitating adequate supplementation. Correcting mineral imbalances can improve reproductive performance and health without incurring additional costs. Hence, there is a need to map the diverse nutrient status in soil, fodder, and animals to supplement area-specific minerals.

Introduction

High levels of production necessitate precise metabolic management and coordination of major physiological systems to balance productivity, health, and reproduction. Effective dietary management in dairy cows, especially during the transition from late pregnancy to early lactation, is crucial for achieving milk supply demands while maintaining health and reproductive potential. Twenty-two factors have been identified to enhance reproductive performance in farm animals. Copper, cobalt, manganese, selenium, iodine, zinc, iron, chromium, and molybdenum are essential minerals, whereas others have limited practical applications. Minerals are important for reproductive performance in livestock because their supplementation improves reproduction and improves conception (Rabiee *et al*., 2010). The ovarian activity of ruminants is influenced by mineral deficiency. They are also involved in the synthesis of hormones that are important for reproduction. Their deficiency affects steroid hormone production. Trace element deficiency may be linked to problems such as retained foetal membranes (Kumar *et al*., 2005), abortion (Mee *et al*., 2004) and weak calf syndrome (Logan *et al*., 1990) Micro minerals are involved in several biological processes, such as a component of metallo-enzymes and enzyme co-factor. In male animals, it may change spermatogenesis and reduce libido. Different types of functions are performed by minerals (Grewal *et al*., 2011). (Fig.1)

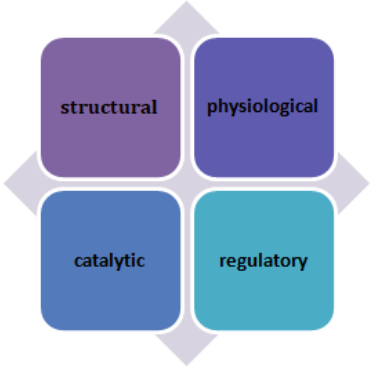

Fig. 1

Copper

Copper has an important role as a cofactor in various enzyme systems. Cytochrome oxidase is a cupro-enzyme required for

electron transport in mitochondria and energy metabolism in ATP-dependent biosynthetic activities. An important sign related to reproduction in cattle is a decline in fertility. Steroidal metabolic changes can affect reproductive behaviour, including nymphomania in ewes. Copper and cobalt deficiency can cause delayed puberty, repeated breeding, low conception, early embryonic mortality, and increased placental retention. Copper treatment has been shown to boost conception rates in ruminants. Copper levels in the diet can range from 4 to over 10 ppm.

Selenium

Selenium, together with vitamin C, plays a crucial role in regulating redox regulation and anti-oxidant action, promoting membrane integrity, and protecting against DNA damage. Selenium deficiency can increase the risk of perinatal metritis and placental retention in dairy calves (Spears, 2008). Selenium deficiency can cause early fetal deaths and stillbirths. Selenium deficiency can also disrupt testosterone and sperm production, leading to male infertility. In male animals, it can cause impaired spermatozoon motility due to the fragile intermediate component.

Manganese

Manganese acts as a cofactor in cholesterol synthesis, which is important for the production of steroids such as progesterone, estrogen, and testosterone (Keen and Zidenburg-Cherr, 1990). Deficiency of Mn leads to low fertility in both males and females. According to Wilson et al. (1966), manganese deficiency can be influenced by dietary calcium and phosphorus levels. Manganese insufficiency is primarily associated with infertility, congenital limb malformation, and slow growth in calves. Manganese deficiency can lead to suppressed or quiet estrus, abnormal estrous cycles, cystic ovary, delayed ovulation, increased embryonic mortality, and lower conception rates. Manganese supplementation can reduce postpartum anoestrus and increase conception rates in dairy cows (Krolak, 1968). Manganese deficiency in males can result in diminished libido, spermatozoa motility, and ejaculate sperm count (Satish Kumar *et al*., 2003).

Magnesium

Magnesium does not directly affect animal reproduction due to its antagonistic relationship with calcium in the body. However, disturbances in Ca-P-Mg homeostasis can impair reproduction. Magnesium shortage can lead to impaired reproductive efficiency and hunger (Sathish Kumar *et al*., 2003).

Cobalt

Cobalt is a key component of vitamin B12. Vitamin B12 (cyanocobalamin) contains about 4.5% elemental cobalt in its molecular weight. Cobalt's significance in cell division, development, and reproduction stems from its requirement for thymine synthesis, which is necessary for DNA synthesis. Severe cobalt deficiency can cause infertility. Cobalt deficiency can cause delayed uterine involution, abnormal estrous cycles, and lower conception rates (Satish Kumar *et al*., 2003). Lactating cows require 0.1 ppm of cobalt in their diet through dry matter intake.

Chromium

Cr, commonly known as glucose tolerance factor (GTF), contains Cr+3, nicotinic acid, glutamic acid, glycine, and cystine, which can enhance insulin's impact on tissue. It is essential for glucose and carbohydrate metabolism. It is found in high quantity in nuclear proteins. Therefore, it is necessary for gametogenesis and proper fetal development. Chromium helps to prevent early embryonic mortality by secreting pregnancy-specific proteins from the uterine endometrium. It also affects follicular maturation and LH secretion.

It can lead to lower sperm count and decreased fertility and influences foetal growth and development.

Iodine

Iodine is a component of thyroid hormones. Thyroid hormones regulate energy metabolism and are essential for growth and development in young animals. Ruminants have modest iodine needs (about 0.5 ppm). Inadequate iodine during pregnancy can result in kids with goitre (enlarged thyroid gland). Iodine shortage can lead to miscarriage, hairlessness, blindness, weakness, or even death. Adult females with iodine deficiency experience irregular cycling, low conception rates, and retained placenta.

Molybdenum

Molybdenum and copper are linked in ruminant bodily systems. In the presence of another harmful substance, a lower level of one is typically observed. Proper balance of copper and molybdenum in soil and plants is crucial for optimal absorption in ruminants (Randhawa and Randhawa, 1994). Molybdenum deficiency can lead to diminished libido, spermatogenesis, and infertility in males, as well as delayed puberty, lower conception rate, and anoestrus in females.

Zinc

Zinc is necessary for sexual maturity, reproductive capacity, and the commencement of oestrus. Zinc deficits can lead to abortion, fetal mummification, reduced birth weight, and extended labour due to its role in the uterine lining. Zinc concentrations in animal plasma range from 0.1 to 0.2 mg/100 ml, with variations depending on species and age. It has been postulated that zinc prevents the destruction of spermatozoa DNA by inhibiting the DNAase activity. Zn has a crucial role in repairing and maintaining the uterine lining after parturition, allowing for an early return to normal reproductive functions and estrus (Amin *et al*., 2016)

Conclusion

Minerals play a crucial role in bovine reproduction, influencing various physiological processes essential for fertility and successful breeding. Minerals like zinc, selenium, iron, and iodine, are vital for maintaining optimal reproductive health in cattle. These minerals support hormonal balance, enhance antioxidant defences, and ensure proper cellular function, all of which are critical for reproductive success. Hence trace elements affect both the health and production performance of animals.

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