

Roles of Fat-Soluble Vitamins in Reproduction of Dairy Cattle

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Abstract

Reproductive success in cattle is a key factor for profitability in livestock farming. From breeding to calving, each stage requires optimal health and nutrition to ensure both the dam (mother cow) and the offspring remain healthy. Among the nutritional factors influencing cattle reproduction, vitamins play essential roles in maintaining fertility, pregnancy, fetal development, and postpartum recovery. Deficiency of fat-soluble vitamins like vitamin A, D and E may lead to various reproductive problems in dairy cattle. This article provides important information on crucial functions of various fat-soluble vitamins in cattle reproduction, their sources, and the importance of supplementation when natural supplies are inadequate.

Introduction

Vitamins play a vital role in the overall health and productivity of dairy cattle, particularly in relation to reproduction. Successful reproduction is essential for maintaining a productive herd, as it directly impacts milk production, calving intervals, and herd growth. Dairy cattle rely on a balanced diet that provides essential nutrients, including vitamins, to ensure optimal reproductive performance. Deficiencies of fat-soluble vitamins can lead to reproductive issues such as irregular estrous cycles, poor conception rates, and complications during pregnancy and calving. Understanding the specific roles of vitamins in dairy cattle reproduction is crucial for farmers and livestock managers looking to improve fertility, increase productivity, and ensure the well-being of their herds. This article explores the importance of various fat-soluble vitamins in dairy cattle reproduction and the benefits of maintaining proper levels for overall herd health.

Vitamin A: Essential for embryonic development and fertility

Vitamin A is one of the most important vitamins in dairy cattle reproduction. It plays a critical role in maintaining the healthy reproduction in animals.

a) Role in female reproduction

In female cattle, vitamin A is involved in the synthesis of reproductive hormones and



the maintenance of epithelial tissues, such as the uterine lining. This vitamin is crucial for the development and maturation of ovarian follicles, where eggs are produced. Deficiency in vitamin A can lead to irregular estrous cycles, delayed ovulation, or complete cessation of reproductive cycles. Moreover, vitamin A deficiency may cause early embryonic death due to poor uterine conditions, which reduces the chances of successful implantation and fetal development (Schweigert, 2001). Vitamin A also supports the development of the placenta and aids in the growth of the fetus, ensuring that calves are born healthy and robust. Calves born to vitamin A-deficient dams often suffer from weakness, respiratory problems, and impaired vision.

Reduced conception rates in dairy cows can be caused by a shortage in beta-carotene, a natural precursor of vitamin A. Due to higher rates of abortion, retained placenta, and the birth of frail, dead, or blind calves, it is believed that the majority of reproductive issues in dairy cattle occur late in pregnancy. Reproductive efficiency can be negatively impacted by prolonged feeding of low-carotene diets, which can also have detrimental effects on pituitary, ovarian, and other organ functions.

b) Role in Male Reproduction

In bulls, vitamin A is equally important. It is required for spermatogenesis, the process by which sperm cells are produced in the testes. Bulls that are deficient in vitamin A may produce fewer sperm, with impaired motility and structure, which leads to reduced fertility. Adequate vitamin A intake ensures that bulls maintain a high-quality semen production, increasing the chances of successful conception. Depending on the degree of the insufficiency, spermatogenesis in males with vitamin A deficiency either decreases or stops. This is linked to the degradation of the testicular germinal epithelium. Bulls given vitamin A-deficient diets exhibit delayed puberty, decreased libido, and decreased spermatogenesis.

c) Sources and Supplementation

Green forages such as alfalfa and fresh pasture grasses are excellent natural sources of vitamin A in the form of beta-carotene, which is converted to vitamin A in the body. However, during summer or periods of drought, when green forage availability declines, vitamin A supplementation becomes necessary to maintain reproductive health.

2. Vitamin D: Supporting calcium metabolism and fetal bone formation

Vitamin D is most widely known for its role in calcium and phosphorus metabolism, two minerals that are essential for bone health. In cattle reproduction, vitamin D is particularly important during gestation, as it ensures the proper formation of the fetal skeleton and helps prevent metabolic disorders in the dam.

During pregnancy, vitamin D helps regulate calcium absorption from the diet, which is



critical for the mineralization of the fetal skeleton. Cows with adequate levels of vitamin D are more likely to give birth to healthy calves with strong bones. Calves with weak bones are also more prone to fractures during the birthing process or shortly after birth (Thompson *et al.*, 2007). Moreover, vitamin D plays a role in preventing milk fever associated with muscle weakness, poor uterine contractions, and difficulty standing after calving, all of which can impede the reproductive process and reduce overall herd fertility.

b) Sources and Supplementation

Cattle typically synthesize vitamin D when exposed to sunlight, as ultraviolet rays trigger the production of this vitamin in the skin. Sun-cured hay and certain feedstuffs also provide vitamin D. However, cattle housed indoors for extended periods, or those raised in regions with limited sunlight, may not produce enough vitamin D. In such cases, vitamin D supplementation is necessary to prevent deficiencies that could affect both the dam and the fetus. Many commercial feeds and mineral supplements are fortified with vitamin D to ensure adequate intake.

3. Vitamin E: Protecting reproductive tissues from oxidative stress

Vitamin E is a potent antioxidant that protects cells from oxidative damage caused by free radicals. This function is especially important for reproductive tissues, which are highly sensitive to oxidative stress, particularly during pregnancy and lactation. Vitamin E works in conjunction with the mineral selenium to support reproductive health and immune function in cattle.

a) Role in Female Reproduction

In cows, vitamin E helps maintain the integrity of the reproductive tract, particularly the uterus and mammary glands. A deficiency in vitamin E can lead to reproductive disorders such as retained placenta, metritis (uterine infection), and mastitis (infection of the mammary glands). Retained placenta is a condition in which the placenta fails to be expelled from the uterus after calving, increasing the risk of uterine infections that can impair future fertility (Weiss, 1998).

Additionally, vitamin E reduces the risk of oxidative damage to the developing fetus during pregnancy. Adequate vitamin E levels ensure that the placenta functions properly, allowing for the efficient exchange of nutrients and waste between the dam and the fetus. In cows with metritis, supplementing with selenium and vitamin E decreases the risk of cystic ovaries, retained placenta, metritis and the duration of uterine involution.

b) Role in Male Reproduction

In bulls, vitamin E protects sperm cells from oxidative damage, which can impair sperm motility and viability. This antioxidant function ensures that sperm membranes remain intact,



increasing the likelihood of successful fertilization. Studies have shown that vitamin E supplementation in bulls can improve semen quality and enhance fertility (Hogan et al., 1992).

c) Sources and Supplementation

Vitamin E is naturally present in fresh green forage, but its levels decline significantly in stored feeds such as silage and hay. During periods when fresh forage is unavailable, cattle may require vitamin E supplementation to maintain reproductive health. This is particularly important for pregnant and lactating cows, which have higher vitamin E requirements.

Conclusion

Vitamins are vital components in the reproductive health of dairy cattle, directly influencing fertility, pregnancy outcomes, and overall herd productivity. Proper intake of fat-soluble vitamins such as A, D and E helps to regulate reproductive cycles, improve conception rates, and support healthy fetal development and calving. Deficiencies in these essential nutrients can lead to a range of reproductive issues, from irregular estrous cycles to complications in pregnancy and weak calves.

References

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