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Vitamin E and Selenium in Dairy Cattle Reproduction

R. Kumar, K. Sethy* R. P. Kharade and O. S. Andure
Department of Animal Nutrition, C.V.Sc and AH, Odisha University of Agriculture and Technology, Bhubaneswar, 751003, Odisha
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Introduction

Livestock is a key sector in Indian economy. Livelihood of rural India heavily depends on it. For a profitable dairy farming, reproductive efficiency is highly essential. Metabolic changes around the calving in dairy animals may raise reactive oxygen species (ROS) in the body. Vitamin E and selenium are essential micronutrients that play significant roles in the health and reproductive performance of cattle. Vitamin E and selenium supplementation enhanced the fertility, pregnancy rates, and overall reproductive health. Vitamin E functions as a potent antioxidant, protecting cellular membranes, while selenium (Se) as a component of the enzyme glutathione peroxidase, aids in mitigating oxidative stress and maintaining immune function. Deficiencies in these nutrients have been linked to reproductive disorders such as retained placenta, metritis, and reduced conception rates. Conversely, adequate supplementation has been associated with, enhanced ovarian function, and increased rates of conception and calving.

Stress in periparturient cows

During the transition period due negative nutrient balance, dairy cattle go through several physiological changes. These changes may cause various disease conditions in dairy cattle. Due to the high energy demands associated with the onset of lactation, dairy cattle utilize more oxygen at the cellular level to meet their energy needs, which may result in a negative energy balance. In order to fulfil their energy needs, dairy cattle utilize their adipose tissues. The excessive mobilization of lipids may lead to an increase in ROS generation causing various diseases in animals (Celi and Gabai, 2015). Due to lipid mobilization, NEFAs and beta-hydroxybutyrate (BHB) levels increase in the body of animals. This may contribute to oxidative stress and immune system dysfunction in peri parturient dairy cattle. Oxidative stress in dairy animals are also influenced by their body condition score (BCS). Cows with BCS above 3.5/5 are more likely to experience metabolic and oxidative stress during transition period. Lipid peroxidation has been identified as a significant factor for oxidative stress in animals. Excessive BCS loss is also linked to higher production of ROS in animals. Reduced glucose levels following parturition may decrease the effectiveness of polymorphonuclear neutrophils' pathogen-killing oxidative bursts,

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impairing host defence. However, oxidative stress induced inflammation has been linked to metabolic and infectious diseases. Nutritional control could be the most effective method to protect the animals from stress.

Vitamin E

Vitamin E is a fat-soluble vitamin present in the cell membranes, reactive oxygen radicals (ROS) and prevents oxidative damage in synergy with Se. Polyunsaturated fatty acids, which make up the cell membrane of immune cells, are vulnerable to lipid peroxidation caused by ROS. As an essential part of lipid membranes, vitamin E performs a protective role against reactive oxygen attack on lipid membranes. It also easily exchanges and equilibrates between lipoproteins. As a result, vitamin E act as 1st line of defense against lipid peroxidation caused by free radicals. In addition, vitamin E possesses antioxidant qualities that successfully stop mammary cell deterioration brought on by ROS (Kuhn and Sordillo, 2021). Also, vitamin E is a crucial nutrient for various body functions, including growth, reproduction, and immunity. It plays a vital role in disease prevention and tissue protection. Vitamin E levels in plasma decrease during the latter stages of pregnancy, reaching their lowest point at parturition. Elevated level of malondialdehyde (MDA) has been observed in transition period due to various stress in animals.

Vitamin E and Reproduction

Stress during the transitional period causes metabolic disturbances leading to retained placenta (ROP). Vitamin E deficiency during the transition phase causes a comparatively lower feed intake, which causes the placenta to accumulate lipid peroxides and cause ROP. It has been observed that the occurrence of ROP is higher in dairy cattle that have a deficiency in vitamin E and Se. Research showed that giving vitamin E injections for seven days considerably decreased the incidence of ROP in dairy cows (Santos *et al*., 2011).

The duration from calving to the onset of the first estrus was found to be significantly decreased in cows given a daily dosage of 1000 IU of vitamin E. Vitamin E and Se influence cellular functions by managing oxidative stress in ovarian tissues. Vitamin E also stimulates the secretion of follicle-stimulating hormone (FSH), adrenocorticotropic hormone (ACTH), and luteinizing hormone (LH) enhancing reproductive efficacy in animals

Selenium

Antioxidants and immunomodulatory qualities make selenium a vital trace element. The antioxidant enzyme glutathione peroxidase (GPx), which contains selenium, is crucial to the body's defense against free radicals. Two primary sources of Se are naturally occurring plant-based selenium amino acids, such selenomethionine and selenocysteine, and inorganic selenium compounds, like selenite or selenate. It is possible to supplement diets with either organic or inorganic sources of selenium (Se). Even though Se is a micro mineral and its physiological

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requirement is low but deficiency has detrimental effects on the animal's health. The antioxidative defense mechanism in cells and animals is aided by the selenoprotein GPx. It shields immune cells from oxidative stress and removes lipid-damaging peroxides. GPx activity was considerably raised when 0.30 mg Se/kg of DM was supplemented as Nano-Se. Furthermore, in the mammary glands of dairy cattle, Nano-Se supplementation increased the mRNA expression of genes related to thioredoxin reductase, glutathione peroxidase and various selenoproteins. To reduce oxidative stress, selenium (Se) controls multiple key antioxidant genes, including catalase, glutathione peroxidase and super oxide dismutase.

Selenium and Rreproduction

Oxidative stress is a significant factor in various ailments affecting dairy cattle, encompassing metabolic and inflammatory issues such as ketosis, mastitis, and merits. Research indicates a correlation between oxidative stress and reproductive diseases in cattle. Research revealed that an adequate supply of selenium can enhance the antioxidant status, leading to improved health outcomes in dairy cattle. Se deficiency has been linked to infertility, anestrous, ROP, abortions and still birth in dairy cattle. Se supplementation has been associated with increased progesterone levels and aids in its postpartum production. Furthermore, the occurrence of ovarian cysts and metritis was reduced following Se administration. There was also a decrease in the incidence of ROP.

Selenium and Mastitis Control

Oxidative stress alters the expression of genes linked to proinflammatory factors in high-producing cows leading to a higher incidence of mastitis. Lower glutathione peroxidase activity in Se deficient animals decreases the amount of mammary epithelial cells causing mastitis in animals. The incidence of subclinical mastitis was found to be decreased with selenium administration, which was associated with an increase in GSH-Px activity. As per the research, Se improved the mammary glands resistance to infection, hence preventing mastitis.

Conclusion

In the context of Indian livestock, particularly dairy cattle, reproductive efficiency is paramount for both productivity and profitability. This review underscores the critical role of Vitamin E and Selenium in enhancing reproductive health and performance in dairy cattle. Vitamin E and Selenium play crucial roles in enhancing reproductive efficiency and overall health in dairy cattle by mitigating oxidative stress and supporting immune function. Their supplementation during the periparturient period has been shown to reduce the incidence of ROP, metritis, and other reproductive disorders, thereby improving fertility and calving outcomes.

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