Role of ß carotene / vitamin A in animal reproduction

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Introduction

Reproduction being a luxury function, nutrition plays a primary role for its optimum expression. Apart from energy and protein intake, the micronutrients (vitamins and minerals) are highly essential for better reproductive efficiency. Though these micronutrients are required in very minute quantities, they are considered indispensable for normal cellular metabolism, growth and maintenance including reproduction. The beneficial effects of ß- carotene and vitamin A in controlling various maladies causing reproductive failure have been well documented (Hamit Yildiz et al., 2005). This review is an attempt to highlight the role of ß-carotene and vitamin A in farm animal reproduction.

ß carotene and reproduction

ß-carotene has a specific role in reproduction and is involved in the formation of estradiol-17 b in tertiary follicles and progesterone in corporalutea, maturation and functional integrity of oviduct, uterus and placenta (Kolb and Seehawar, 1998). It has been suggested that ß- carotene is an integral part of luteal cell microsomal membrane, where it plays a role in membrane integrity and is associated with plasma derived low density lipoproteins. For optimum fertility in cows the minimal plasma ß-carotene level should be in the range of 150-300 mg/dL (Schwegert, 2003). Diets deficient in this micronutrient had been shown to affect the reproductive performance of animals due to decreased P4 output, delayed ovulation, low estrus intensity, high incidence of cystic ovarian degeneration, embryonic mortality, abortions etc. (Gaikwad et al, 2001, Noakes et al, 2001). It has been experimentally demonstrated that feeding of maize silage which is known to be low in ß carotene produced very low pregnancy rates in dairy cattle (Lotthammer, 1979).

On the contrary, other studies (Ducker et. al. 1984, Marcek et. al. 1985) have reported that feeding of ß-carotene deficient diets did not produce any adverse effects on growth rates, reproductive performance in terms of pregnancy rate, calving conception interval, number of services per pregnancy etc. The reasons for contradictory findings might be due to inherent difficulties of accurately determining the nutrient requirement and also due to lack of knowledge of the interaction of micronutrients in the body. Perhaps, ß-carotene deficiency occurs at levels well below those normally found in practice and the association between ß-carotene deficiency and fertility is a reflection of some other unspecified deficiency (Ducker et al, 1984).

Vitamin A and Reproduction

Vitamins are not directly involved in reproduction but play an indirect role in proper functioning of reproductive system. Vitamin A regulates vision, growth and reproduction and, affects the overall health of animals (Zile and Cullum, 1983, Chew, 1987). It is highly essential for maintaining the health and integrity of epithelial tissues in the body. Both vitamin A and ß-carotene play a protective role against periparturient diseases by significantly decreasing the lymphocyte proliferation during parturition (Rajiv, 2001). Lack of this vitamin reduces the animal's resistance against invading pathogens and makes it more susceptible to infections. With special reference to reproduction, this micro element effects the ovarian steroidogenesis and directly or indirectly through P4 secretion, influences the uterine environment and early embryo and fetal development.

Clinical signs of infertility related to vitamin A deficiency include delayed onset of puberty in male and female, abortion, birth of weak, blind or in-coordinated calves (Schweigert, 2003; Lanyasunya et al ,2005). Vitamin A deficiency in pregnant sows produced structural and compositional changes in placental glycosaminoglycan (Steele and Froseth, 1980). Rajiv Chawala and Harjit Kour (2004) and Chaudhary and Singh, (2004) reported increased incidence of retained placenta and metritis in animals due to vitamin A deficiency. According to the severity of deficiency and time of occurrence, the type of reproductive problems may vary as anoestrous, repeat breeding, abortion, retained placenta and metritis. (Gerloff and Morrow, 1986).

Deficiency of vitamin A, apart from its adverse

effect on the ovarian cycle, produces degenerative changes in the mucus membrane of the uterus with the result that the nidation is prevented and death and resorption of embryo may take place in the pregnant cow (Van Rensburg, 1957). In view of its conspicuous role being evident on reproduction, supplementation of ß- carotene in cows during dry period has improved the immune status and reduced the reproductive problems during periparturient period (Rajiv Chawala and Harjit Kour, 2004). Most mammals convert ß- carotene into vitamin A in liver or in the lining of intestinal mucosa.

In males vitamin A deficiency provokes testicular atrophy, reduced libido or sexual behaviour. Atrophy of semeniferous tubules and loss of germinal cells results in cessation of spermatogenesis there by decreasing the semen quality (Morrow, 1980). Young bulls affected with vitamin A deficiency have shown cystic pituitary gland (Roberts, 1986).

Recommendations to circumvent ß-carotene and vitamin A deficiency

Supplementation of ß-carotene or vitamin A either through feed or through parental administration produced satisfactory results on various fertility parameters (Mathai et. al, 1974, Schweigert, 2003). Madsen and Davis (1949) fed cows at different levels of carotene ranging from 30-240 mg /kg body weight per day over a number of years and observed improved fertility when cows were fed at a level of 90 mg/ kg. Valyushkin and Kurzeka (1991) found that i/m administration of retinol decreased the incidence of retention of placenta by 16.6 %, fertility increased by 13.45% and service period was shorter by 13 days. It has also been observed that undesired effects of free radicals produced during pregnancy can be prevented by Vitamin A and ß- carotene injections (Nadid Navin and Ebru Beytut, 2005).

Vitamin A can be supplied in the diet as pre formed vitamin A or as carotene. Carotene is converted to vitamin a by the intestinal epithelium cells (Devasena et al, 2007). One mg of carotene provides 400 IU of Vitamin A in dairy cattle ration. The minimum recommended amount of vitamin A in cows is 35000-45000 IU of Vitamin A per day (NRC, 2001). However, a simple unwritten rule is the provision of green succulents adlib to meet the daily requirement vitamin A. Higher demands for vitamin A during pregnancy and lactation may be met by additional dietary supplementation.

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