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Importance of micro minerals in reproductive performance of livestock

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Abstract

Micro minerals have a great impact on animal's reproductive physiology and its imbalance causes various problems leading to lowered reproductive efficiency and resultant monetary loss to the dairy industry. Adequate micro minerals supplementation is required as most of the roughages, greens, concentrates and even most of commercial feeds available to Indian market are deficient in trace mineral elements. Often correcting an imbalance in mineral levels can sole a nagging problem by improving reproductive performance and health with little additional cost. As terrain and agro climatic area of India is quite diverse, so one therapeutic treatment may not be suitable for other regions. Hence there is a need to map of the various nutrient status in soil, fodder and animal, so that accordingly an area specific mineral may me supplemented.
Key words: Microminerals, Reproduction, Livestock, Reproductive physiology, Anoestrus, Infertility.

Introduction

Dairy animals most commonly suffer with the nutritional deficiencies due high production and deficient feeding ultimately leading to poor reproductive performance. Micro minerals are very essential part of animal's ration which is required only in micro amount and excess feeding of some of these may show toxicity symptoms. For optimum reproductive performance in farm animals, twenty two such elements have been identified. The important one includes copper, cobalt, manganese, selenium iodine, zinc, iron, chromium and molybdenum where as others are of less practical value.

Micro minerals are involved in several biological processes, such as component of metallo-enzymes and enzyme co factors. These works both as activator of enzymes involved in intracellular detoxification mechanism of free radicals and in stabilization of secondary molecules. Some of these are component of hormones and thus directly regulates endocrine activities. Due to its involvement in carbohydrate , protein and nucleic acid metabolism, any change in its level may alter the production of reproductive and other hormones. Its improper level may affect embryonic development, post-partum recovery activities and over all fertility of animal may be impaired. In male animals it may change spermatogenesis and reduce libido. Most of the non conventional feeds are deficient in micro minerals and are likely to accentuate reproductive problems (Parnekar, 2003).In the present paper the importance of microminerals in the reproductive health of ruminants are discussed.

Copper: Copper is a vital component in many enzyme systems as cofactors. Cytochrome oxidase is a cupro-enzyme necessary for electron transport in mitochondria for energy metabolism of ATP dependent biosynthetic reactions . It is required in the body for the production of red blood cells, as it is essential for absorption and transport of iron necessary for haemoglobin synthesis (Tuormaa, 2000). Cu is necessary for production of melanin pigment and interaction of copper and estrogen are also observed (Hidiroglou, 1979). Cu deficiency is associated with high Molybdenum levels as crops grown on 'tert soils' (having high organic matter) have high Mo and low Cu. Mo and Cu interactions further lowers available Cu for absorption.

The important sign related to reproduction in cattle is decline in fertility. Changes in steroidal metabolism may lead to alter reproductive behaviour; such as nymphomania in ewe (Hidiroglou, 1979). Copper along with Cobalt deficiency delayed onset of puberty, repeat breeding, low conception, early embryonic mortality and increased incidence of retention of placenta (Nix, 2002). Reproduction is hampered in a manner of depressed oestrus associated with anemia and increased days open due to inactive ovaries. Low

fertility associate with delayed or depressed oestrus have been reported in cattle graze on copper deficient pastures (Kreplin et al., 1992). In males, copper deficiency leads to decreased libido, lower semen quality, and severe damage of testicular tissue may render the bull sterile (Kreplin, 1992, Nix, 2002).

The normal body requirement of copper in dairy cattle is 10 ppm but additional supplementation of copper is must for quality semen production (Puls, 1994). Copper treatment has been found to improve conception rate (Hunter, 1977).

Selenium: Selenium along with Vitamin E function as preventive and chain breaking anti oxidant, and inactivates peroxidise formed during cell metabolic process. (Hine, 1992). Commonly recorded selenium responsive reproductive disorders of cattle are retained placenta, abortion, still birth, irregular estrous cycle, early embryonic mortality, cystic ovaries, mastitis and metritis which can be reduced by supplementation of selenium (Randhawa and Randhawa, 1994,). In sub clinical selenium deficiency, reproductive performance may be reduced with increased number of services needed per conception, high incidence of mastitis and a retained fetal membrane and this may be explained due to the impaired functioning of neutrofils in selenium deficiency (Goff, 2005). Selenium' beneficial effects of decreasing reproductive problems in dairy animals have been associated with increased glutathione peroxidise activity in blood and tissues. Selenium is readily transmissible through placenta to the foetus whether fed as inorganic or as an organic food Selenium.

Improvement in conception rate at first service following selenium supplementation has been reported (McClure et al., 1986). Prepartum injections of Se for 3 weeks decrease the incidence of retained placenta in Se-deficient animals. However neither vitamin E nor Se was effective alone. Harrison et al., (1984) also recorded that the incidence of cystic ovaries and metritis was significantly reduced in Se administered group as compared to untreated controls .In contrast Hidiroglou (1979) studied on the effect of Se given to ewe and cattle in Se deficient areas and reported no significant influence on rate of ovulation, conception and embryonic loss.

The testes contain high concentration of selenium that is essential for testicular function. Low sperm production and poor sperm quality including impaired motility with flagella defects localised primarily to the mid piece has been a consistent feature in selenium deficient animals. Se supplementation in cattle has been found beneficial in maintaining sperm motility. The percent mobility increased significantly as dietary Se was increased from 0 to 1.0 pp.

Manganese: The precise pathway of specific Mn involvement in reproductive processes remain unknown, some evidence suggests that Mn plays a role in the activity of certain endocrine organs. It is involved as co factor in cholesterol synthesis which is necessary for the synthesis of steroids like progesterone, estrogen and testosterone (Keen and Zidenburg-Cherr, 1990).

Deficiency cause poor fertility problem in both male and female.Wilson (1966) suggested that Mn deficiency was dependent on conditioning factors especially the calcium and phosphorus content of the ration. The principal disorder of Mn deficiency is infertility, congenital limb deformity and poor growth rate in calves. Deficiency of Mn. may be associated with suppression of estrus, silent estrus, irregular estrous cycle, cystic ovary, poor follicular developments with delayed ovulation, increase in embryonic mortality and reduced conception rate (Kreplin, 1992,Corrah, 1996). Even Mn deficient goats were observed to exhibit no apparent sign of estrous despite normal ovulation (Groppel and Anke, 1971). Manganase supplementation has proven to be effective in shortening the postpartum anoestrus and increasing conception rates in dairy cows (Krolak, 1968). In males the dietary deficiencies of Mn, leads to absences of libido, decreased motility of spermatozoa and reduced number of sperms in ejaculate (Satish Kumar, 2003).

Zinc: Zn deficiencies have been associated with abortion, fetal mummification, lower birth wt and prolonged labour as Zn plays important role in uterine lining (Nix, 2002). The effect on prostaglandin synthesis suggests that Zn deficiency have profound effect on reproductive cycle and pregnancy. Delayed puberty and lower conception rates, failure of implantation and reduction of litter size are also found in association with the zinc deficiency in feed (Kreplin ,1992). Zinc has a significant role in repair and maintenance of uterine lining following parturition and early return of post partum estrus (Green et al., 1998). Zn deficient animals have been shown to have lower concentrations of FSH and LH chiefly in males (Boland, 2003). Zinc deficiency in male cause atrophy of semeniferous tubule and inefficient testicular development in young ones, leading to reduced testicular size, lack of libido and can adversely affect spermatogenesis (Mass, 1987, Satish Kumar, 2003).

Iodine: It is normally present in the diet as iodide and is necessary for syntheses of thyroid hormone, which regulates energy metabolism. Iodine is important for

the development of fetus and maintenance of general basal metabolic rate. The thyroid gland is involved in stimulation of anterior pituitary gonadotrophin secretion. The effect of iodine on secretion of thyrotropin-releasing factor, which in turn stimulates prolactin secretion, can also have effect on length of estrus cycle (Khillare, et al., 2007).

The reproductive disorders due to iodine deficiency are thought to be steroid dysfunction. Iodine deficiency may cause the birth of weak, premature or dead calves affected with goitre. Iodine deficiency in herds, leads to impaired fertility and an abnormally high abortion rate (Hetzel, 1990). Incidence of retained placenta and post partum genital infections is also high (Hemken, 1960). There is a significant relation between serum protein bound iodine (PBI) and reproduction. Improved reproductive performance was associated with higher PBI and number of services required as well as time interval between first breeding and conception. Sub normal serum protein bound Iodine (PBI) has been found to be associated with infertility in cows and buffalo (Dabas et al., 1987).

Anovulatory estrus observed in cows maintained on iodine deficient diet was attributed to disorder of the thyroid and pituitary function which was reversed by supplementation of iodine to the ration. Recently plasma inorganic iodine (PII) has been found to give an accurate indication of current iodine status. Normal plasma inorganic iodine in cows should be 100-300ng/ml.

Chromium: Naturally occurring chromium is crucial for carbohydrate metabolism (Tuormaa, 2000). It is present in high concentration in nuclear proteins thus it is necessary for gametogenisis and healthy fetal growth.

Chromium plays an important role in the secretion of pregnancy specific proteins from the uterine endometrium which is helpful in preventing early embryonic death. Chromium exerts a significant influence on follicular maturation and LH release. It can possibly lead to lower sperm count and decreased fertility and influences foetal growth and development (Tuormaa, 2000).

Iron: It is required for the synthesis of haemoglobin and myoglobin as well as many enzymes and cytochrome enzymes of electron transport chain. Iron functions in transport of oxygen to tissues, maintenance of oxidative enzyme system and is concerned with ferretin formation (Khillare, et al .,2007).

Deficiency in adult animals is rare due to its ubiquitous presence in the feed stuffs. The reproductive performance of Iron deficient animals may be badly affected due to anaemia, reduced appetite and lower body condition. A deficient animal becomes repeat breeders and require increased number of inseminations per conception and occasionally may abort.

Molybdenum: Mo is interdependent with Cu with reference to body system of ruminants. Generally lower level of one occurs in presence toxic level of another. Therefore proper balance of Cu and Mo in soil and plant is essential for normal absorption of each other in ruminents (Randhawa and Randhawa, 1994). Molybdenum deficiency decreases libido, reduced spermatogenesis and causes sterility in males and is responsible for delayed puberty, reduced conception rate and anoestrus in females (Satish Kumar, 2003).

Cobalt: Cobalt is an important component of vitamin B12. Approximately 4.5% of molecular weight of vitamin B12 (cynocobalamin) is composed of elemental cobalt. The need of cobalt for thymine synthesis, which is required for DNA synthesis, explains the biological role of cobalt for cell division, growth and reproduction.

Infertility is likely to arise as a secondary consequence of debilitating condition such as severe cobalt deprivation (Judson et al., 1997). Sign of cobalt deficiency include delayed uterine involution, irregular estrous cycle and decreased conception rate (Pulls, 1994, Satish Kumar, 2003). Dietary cobalt requirement for lactating cow is 0.1 ppm of the ration dry matter intake.

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