Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(2): 534-536

Received: 23-01-2021
Accepted: 26-02-2021

Praveen Kumar Gupta
M.V.Sc. Animal Nutrition, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh, India

Corresponding Author:
Praveen Kumar Gupta
M.V.Sc. Animal Nutrition, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh, India

Minerals play role in reproduction of animals and their deficiency diseases in animals: A review article

Praveen Kumar Gupta

Abstract
There are several minerals like Calcium-Ca, Phosphorus-P, Selenium-Se, Zinc-Zn, Copper-Cu, Manganese-Mn, Iodine-I, Cobalt-Co, Potassium-K, Chromium-Cr, Salt-NaCl etc. play important role in animal reproduction. Dietary Ca concentration is risk factor for milk fever and milk fever increases the incidence of many periparturient disorders such as dystocia, retained placenta, mastitis, displaced abomasum and ketosis. Deficiency of P leads to decline in fertility rate, feed intake, milk production, ovarian activity, irregular estrous cycles, and increased occurrence of cystic ovaries, delayed sexual maturity and low conception rates. Se supplementation reduces the incidence of retained placentas, cystic ovaries, mastitis and metritis. Se plays role in protecting both the intra- and extracellular lipid membranes against oxidative damage and protects milk lipids from oxidation. Cu and Zn have a significant correlation with reproductive hormones (progesterone and estradiol). Deficiency of iodine affects reproductive capacity, brain development and progeny as well as growth. Na functions in maintaining osmotic balance, in cellular uptake of glucose and in amino acid transport. Chromium improves sensitivity of insulin, resulting in increased uptake of glucose by cells in the body.

Keywords: Minerals, animal reproduction, deficiency diseases

Introduction
Nutritional deficiencies, will not only reduce performance below genetic potential, but also exacerbate detrimental environmental effects. So there is a need to pay particular attention to the interactions between nutrition and reproduction particularly. In general, poor nutrition caused by inadequate, excess or imbalanced nutrient intake may adversely affect the various stages of the reproductive event, going from delayed puberty, reduced ovulation and lower conception rates, through high embryonic and foetal losses to excessively long post-partum anoestrus, poor lactation, high perinatal mortality and poor neonatal performance. Nutritional efforts that maintain a healthy immune system may and proper levels of vitamins and minerals are also very important for successful reproduction. The Deficiencies of minerals and toxicity may cause reproductive disorders in animals because minerals play an important role in health, production and reproduction performance of the livestock [1]. Minerals are major nutrients required after energy and protein and should be given priority in order to optimize reproduction in dairy cattle [2]. Minerals are divided in two main groups i.e. macro minerals and micro minerals. The macro minerals which required in more than 100 ppm in diet and these are calcium, phosphorus, magnesium, potassium, sulphur, sodium and chloride. The second group is trace or micro minerals such as cobalt, copper, iodine, iron, manganese, selenium and zinc which are required in less than 100 ppm in the diet of animals. Micronutrients are involved in various functions like as intracellular detoxification of free radicals, synthesis of reproductive steroids and hormones.

Role of minerals in animal reproduction- (Calcium-Ca, Phosphorus-P, Selenium-Se, Zinc-Zn, Copper-Cu, Manganese- Mn, Iodine-I, Cobalt- Co, Potassium-K, Chromium-Cr, Salt- NaCl etc.)
Calcium plays a very importance role in physiological and structural functions. In periparturient animals hypocalcaemia is major cause of decline in smooth muscle contraction, suppression of dry matter intake, increase in body fat mobilization in the form of non-esterified fatty acids [3], reduction of neutrophil function [3, 4], and thus leads to an increased incidence of periparturient disease [4].

Dietary Ca concentration is not only risk factor for milk fever, the dietary cations, especially K, induce metabolic alkalosis in the prepartum dairy cow and thus reduces the ability of the cow to maintain Ca homeostasis. Milk fever increases the incidence of many periparturient disorders such as dystocia, retained placenta, mastitis, displaced abomasum and ketosis. According to NRC, Ca content should be 0.65% of the total ration on DM basis for high producing cows.

Phosphorus is the second most abundant mineral element in the body. 80 to 85% of P found in the teeth and bones. Deficiency of P leads to decline in fertility rate, feed intake, milk production, ovarian activity, irregular estrous cycles, and increased occurrence of cystic ovaries, delayed sexual maturity and low conception rates. Hypophosphatemia have been a contributing factor for typical periparturient diseases (downer cow syndrome and postparturient hemoglobinuria) of dairy animals. NRC (2001) recommendation for dairy cattle from 0.3 to 0.4% [5]. Increasing the concentration of dietary P above requirement (more than 0.38-0.40%) does not improve reproductive performance. A recent study reported that lowering dietary P from 0.57 to 0.37% did not negatively affect milk production, but did significantly reduce P excretion into environment [6].

Selenium involved in normal spermatogenesis and is an essential component of glutathione peroxidase, thioredoxin reductase and iodothyronine deiodinase and plays role in protecting both the intra- and extracellular lipid membranes against oxidative damage and protects milk lipids from oxidation. Selenium deficiency in pregnant animals will lead to abortion, or calves will be weak and unable to stand or suckle. Se supplementation reduces the incidence of retained placentas, cystic ovaries, mastitis and metritis. Low Se has also been associated with poor uterine involution, and weak or silent heats. Chronic Se toxicity include lameness, sore feet, deformed claws and loss of hairs from tail. Selenium toxicity in pregnant animals will produce abortions, stillbirth, weak and lethargic calves as selenium accumulate in the fetus at the expense of the cow. Selenium and Vitamin E supplements in diets have a protective effect against acute infections mammary gland [7].

Zinc is an essential component of many enzyme systems involved in metabolism of carbohydrate, protein and nucleic acid metabolism, epithelial tissue integrity, cell repair and division, vitamin A and E transport and their utilization. Zn plays a major role in the immune system and certain reproductive hormones. Zn has a role in the repair and maintenance of the uterine lining following parturition and speeding return to normal reproductive function. Zn deficiency in bulls results in poor semen quality and reduced testicular size and libido. Zinc has also been shown to increase plasma β-carotene level which is correlated to improvement in conception rates and embryonic development. Zn deficiency in males reduces testicular development and sperm production. Cu, Cd, Ca and Fe reduce Zn absorption and interfere with its metabolism [8]. Requirement of Zn in diet of dairy cows is 40 ppm [5].

Copper is a necessary component of number of enzymes including superoxide dismutase, lysyl oxidase and thioloxidase. Cu also plays an important role in the immune system. Cu and Zn have a significant correlation with reproductive hormones (progesterone and estradiol). Copper deficiency in cattle is generally due to the presence of dietary antagonists, such as S, Mo and Fe that reduce Cu bioavailability. Deficiencies of Cu have also been associated with retained placenta, embryonic death and decreased conception rates and anestrus [9]. Higher serum Copper levels in dairy cows, had significantly less days to first service, fewer services per conception and fewer days to open. Feeding a total of 10 to 15 ppm Cu in the ration dry matter or supplementing with 10 ppm Cu should meet dairy cattle needs. If rations contain antagonists such as elevated Fe, S, or Mo, replacing 35 percent of supplemental Cu with organic Cu sources improved Cu availability.

Fodders were generally adequate in manganese but concentrate ingredients may be deficient [10]. Legume and grass hays have more Mn than corn or corn silage and Mn is reported to be more available in hay than silage. It is an activator of enzyme systems in the metabolism of carbohydrate, fats, protein and nucleic acids. Manganese is necessary for cholesterol synthesis, which in turn is required for synthesis of the steroids, estrogen, progesterone and testosterone. Deficiency of Mn may be associated with suppression of estrus, cyclic ovaries and reduced conception rate. The maintenance requirement for absorbed Mn was set at 0.002 mg/kg of body weight (1.2 mg/day for an average Holstein cow), the growth requirement was set at 0.7 mg/kg of growth, pregnancy requirement was set at 0.3 mg/d, and the lactation requirement was set at 0.03 mg/kg of milk [5]. Gestating cattle may need up to 50 mg of Mn/Kg of DM because it helps in skeletal cartilage and bone formation of fetus [11].

Iodine is incorporated into the thyroid hormones, which have multiple functions as cell activity regulators. Deficiency of iodine affects reproductive capacity, brain development and progeny as well as growth. Deficiency of iodine leads to delay in puberty, suppressed or irregular estrus, failure of fertilization, early embryonic death, abortion, still birth with weak calves, increased frequency of retained placenta in females and in males, decrease in libido and deterioration of semen quality. Pattanaik *et al*. (2011) [12] reported that 0.1 mg/d extra supplementation of iodine as effective strategy to counteract functional disorders of the thyroid and associated adverse effects induced in goats by feeding of leucaena leaf meal. Inadequate thyroid function reduces conception rate and ovarian activity. So, iodine deficiency impairs reproduction and iodine supplementation has been recommended when necessary to insure that cows consume 15-20 mg of I each day. Subclinical iodine deficiency in breeding females include suppressed estrus, abortions, increased frequency of retained placentas, still births and extended gestation periods. A number of studies have reported beneficial effect of lugol's I in treatment of silent estrus, repeat breeding and conception [13, 14].

Vitamin B_{12} is a water-soluble vitamin produced by rumen microbes. A depletion of cobalt and vitamin B_{12} at parturition through colostrums causes depressed milk production and colostrums yield. Ruminants need Co to meet the vitamin B_{12} requirements of both the ruminal bacteria and the host animal. Cobalt deficiency is associated with an increased incidence of silent heats, a delayed onset of puberty, nonfunctional ovaries, and abortion. Inadequate Co levels in the diet have been correlated with increased early calf mortality. Cobalt requirement in dairy cows varies between 0.10 mg/kg DM [5] and 0.20 mg/kg DM. Recent studies reported that oral Co acetate administration to lactating cows and ewes decreased milk concentrations of fatty acids containing a cis-9 double bond, and inhibition of stearoyl-coenzyme a desaturase activity [15], thus play an important role in mammary lipogenesis in ruminants.

After Ca and P, K is the third most abundant mineral element in the animal body. Ruminants have a higher K requirement than non-ruminants. K is essential for rumen microorganisms. The suboptimal level of K in the ration decreases feed intake in ruminants. The dairy cow's minimum requirement for K is

0.90% to 1.0% of the ration on DM basis [5]. Feeding high levels of K may delay the onset of puberty, delay ovulation, effect corpus luteum development and increase the incidence of anestrous in heifers. In dry period during the last 2 to 3 weeks prepartum can predispose the fresh cow to milk fever, displaced abomasum, uterine problems, and other metabolic disorders. The K requirement in tropical summer is increased as high as 1.9% for high producing cows.

Chromium improves sensitivity of insulin, resulting in increased uptake of glucose and amino acids by cells in the body [16]. Low serum insulin, high glucagon and growth hormone, and high plasma NEFA concentrations in early lactation dairy cows indicates high catabolic activities and negative energy balance [17]. This leads to increased gluconeogenesis and glycogenolysis in the liver and increased mobilization of protein reserves from muscle tissue. Several studies reported insulin resistance begins before parturition and continues during early lactation. At this stage, Cr supplementation (0.5 ppm) may enhance the action of insulin and, consequently decrease NEFA and liver triglyceride concentrations in blood and improve glucose tolerance, which may result in improvement of performance and production during the periparturient period.

Sodium is an essential element for animals but is not required by plants. Na functions in maintaining osmotic balance, in cellular uptake of glucose and in amino acid transport. Lactating dairy animals in the tropics may require more Na due to the hot and humid climatic conditions. The daily salt requirements for dairy cattle are met easily by adding 1 percent salt to concentrate mixture and offering additional salt lick. Thiangtum *et al*. (2011) [18] recommended 1.2 g of Na/kg of DM for dairy cows under tropical conditions. Lactating cows need 2 g salt/kg milk production. Dry cows need 40 g salt daily or 0.3% Na per kg DM. Salt deficiencies can affect the efficiency of digestion and indirectly the reproduction performance of cows.

Conclusion

Dietary nutrients not only affect productivity of animals but also reproductive performance. Mineral requirements of animal depend upon age, species, breed, physiological conditions of animals. Supplementation of minerals to meet normal growth and production requirement is of utmost importance. Mineral requirement for reproduction and immunity have recently been explored in number of studies. However, mineral interactions, toxicities and bioavailability from different sources must be taken into account in dairy animal nutrition. Deficiency or in toxicity have been shown to affect the reproduction on animals. Beneficial role of minerals in resuming the follicular activity and fertility in dairy cattle. Hence in order to avoid the chances of reproductive failure and other reproductive disorders we have to supplement adequate quantities of mineral required by the animal. Thus minerals are help in maintaining growth, health, production and reproduction in animals.

References

1. Sharma MC, Joshi C, Das G, Hussain K. Mineral nutrition and reproductive performance of the dairy animals: a review. Indian Journal Animal Science 2007;77:599-608.
2. Bindari YR, Shrestha S, Shrestha N, Gaire TN. Effects of nutrition on reproduction-a review. Advances in Applied Science Research 2013;4:421-429.
3. Martinez N, Sinedino LDP, Bisinotto RS, Ribeiro ES, Gomes GC, Lima FS, *et al*. Effect of induced subclinical hypocalcaemia on physiological responses and neutrophil function in dairy cows. J Dairy Sci 2014;97:874-887.
4. Martinez N, Risco CA, Lima FS, Bisinotto RS, Greco LF, Ribeiro ES, *et al*. Evaluation of peripartal calcium status, energetic profile, and neutrophil function in dairy cows at low or high risk of developing uterine disease. J Dairy Sci 2012;95:7158-7172.
5. National Research Council. Nutrient requirements of dairy cattle, seventh revised ed. National Academic Press. Washington, DC. USA 2001.
6. Wang C, Liu Z, Wang D, Liu J, Liu H, Wu Z. Effect of dietary phosphorus content on milk production and phosphorus excretion in dairy cows. J Anim. Sci. Biotechnol 2014;5:23.
7. Ata N, Zaki MS. New approaches in control of mastitis in dairy animals. Life Sci. J 2014;11:275-277.
8. Patterson HH, Adams DC, Klopfenstein TJ, Clark RT, Teichert B. Supplementation to meet metabolizable protein requirements of primiparous beef heifers: II. Pregnancy and Economics Journal of Animal Science 2003;81:503-570.
9. Mudgal V, Gupta VK, Pankaj PK, Srivastava S, Ganai AA. Effect of copper supplementation on the onset of estrus in anestrous buffalo cows and heifers. Buffalo Bull 2014;33(1):1-5.
10. Bhanderi BM, Garg MR, Sherasia PL. Mineral status of feeds, fodders and dairy animals in Jalgaon district of Maharastra state. Sch. J Agric. Vet. Sci 2014;1(4A):222-226.
11. Schefers J. Fetal and perinatal mortalities associated with manganese deficiency. Minnesota Dairy Health Conference 2011. http://purl.umn.edu/118917 (accessed 28 April 2015), University of Minnesota Digital Conservancy, MN, USA.
12. Pattanaik AK, Khan SA, Goswami TK. Iodine supplementation to a diet containing *Leucaena leucocephala* leaf meal: consequences on nutrient metabolism, clinical chemistry and immunity of goats. Anim. Prod. Sci 2011;51:541-548.
13. Pandey P, Pandey A, Sinha AK, Singh B. Studies on the effect of lugol's iodine on reproductive efficiency of dairy cattle. Annu. Rev. Res. Biol 2011;1(2): 33-36.
14. Elsheikh AS, Ahmed FO. Treatment of repeat breeding in dairy cows with lugol's iodine. IOSR J Agri. Vet. Sci 2014;7(4):22-26.
15. Frutos P, Toral PG, Ramos-Morales E, Shingfield KJ, Belenguer A, Hervas G. Oral administration of cobalt acetate alters milk fatty acid composition, consistent with an inhibition of stearoyl-coenzyme A desaturase in lactating ewes. J Dairy Sci 2014;97(2):1036-1046.
16. Kumar M, Kaur H, Deka RS, Mani V, Tyagi AK, Chandra G. Dietary Inorganic Chromium in Summer-Exposed Buffalo Calves (*Bubalus bubalis*): Effects on Biomarkers of Heat Stress, Immune Status, and Endocrine Variables. Biol. Trace Elem. Res 2015. DOI 10.1007/s12011-0150272-0.
17. Deka RS, Mani V, Kumar M, Zade SS, Upadhaya RC, Kaur H. Effect of Additional Chromium Supplementation on Health Status, Metabolic Responses, and Performance Traits in Periparturient Murrah Buffaloes (*Bubalus bubalis*). Biol. Trace Elem. Res 2014. DOI 10.1007/s12011-014-0173-7.
18. Thiangtum W, Yawongsa A, Schonewille JT, Rukkwamsuk T, Yuangklang C, Verstegen MW, *et al*. An attempt to define the sodium requirement of lactating dairy cows in a tropical environment. J Sci. Food Agri 2011;13:2333-2337.