www.roavs.com EISSN: 2223-0343
RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Role of zinc in animal nutrition: A review

Reza Soleimani[1*], Omid Pourzargham Faradonbeh[2] and Hossein Bagheri[2]

[1]Department of Animal Science, Chaloos Branch, Islamic Azad University, Chaloos, Iran
[2]Department of Agriculture, Chaloos Branch, Islamic Azad University, Chaloos, Iran

Abstract

Minerals are inorganic substances, present in all body tissues and fluids and their presence is necessary for the maintenance of certain physicochemical processes which are essential to life. Zinc (Zn) is widely distributed throughout the body and plays an essential role in many body processes. A sever deficiency of Zn impairs the productive and reproductive performance of the domestic animals. The aim of this paper is to review the importance of Zn in animals nutrition.

Keywords: Zinc; nutrition; domestic animals

To cite this article: Soleimani R, OP Faradonbeh and H Bagheri, 2011. Role of zinc in animal nutrition: A review. Res. Opin. Anim. Vet. Sci., 1(12), 787-790.

Introduction

Efficiency in feeding has been the major concern in raising poultry, as nutrition and feeding cost 65 to 75% cost of production. It has also been the major means of manipulating poultry production system for profitability. Poultry being the direct competitor of human being for available feed resources warrants judicious use of feeds and their intrinsic factors. Moreover, with the growing concern of the present society on the environment and animal welfare, the attention of the nutritionists has also been diverted towards management of stress, augmenting immunity and minimizing wastage of nutrients that adds to environmental pollution. To overcome those constraints in the process of making poultry farming, a sustainable enterprise, considerable amount of research is being done in the area of poultry nutrition. Areas that have had received attention during the last three decades include optimization of nutrient requirements of different classes and age groups of poultry, partitioning of the requirements, understanding interactions of nutrients and effect of dietary variables, to find out alternative feed resources and their evaluation for efficient utilization in poultry rations, devising suitable processing methods for improving the nutritional value of non-conventional poultry feeds, to find out the effects of exogenous toxins in feeds (like mycotoxins) and to develop suitable methods for their detoxification to improve the utilization of nutrients and safeguard bird's health (Ahmed and Sawar, 2006).

With high density confinement rearing of livestock, an additional important role of nutrition is that animals are not only fed for production or reproductive performances but must also be fed to minimize infectious disease and their concomitant stresses. In context of Indian Poultry Industry, problem of immunosuppression has been felt to be prominent due to various factors *viz.*, managemental conditions, nutritional status, intensive production system, high density rearing and infectious diseases. Therefore, it is highly essential to find ways and means for enhancement of immune response by nutritional manipulation. Substantial information is available in literature to indicate that administration of certain vitamins, minerals, amino acids and their different combinations to mammals and chicken in excess of their supposed requirements enhances their disease resistance. This increased resistance has been attributed to significant stimulation of humoral and cellular immunity and phagocytosis. Since the use of antibiotics has been limited, better use of supplementary immuno-

[*]**Corresponding author:** Reza Soleimani, Department of Animal Science, Chaloos Branch, Islamic Azad University, Chaloos, Iran. Reza_soleymani61@yahoo.com

stimulatory nutrients has to be made in poultry feeding (Basmacioglu et al., 2000). Hence, reports of studies undertaken in this direction have been summarized hereunder (Bartton, 1996).

Interaction of Zn with vitamin E

Low and very high dietary vitamin A decreases body weight gain in broilers. Low dietary vitamin A causes depression in *in vitro* T-Lymphocytes responses and *in vitro* antibody production to defined protein antigens. Excess vitamin A intake also decreases immune responses. Maximum T-cell proliferative responses to antigen have been observed at vitamin A levels considerably above NRC (1984) recommended level. Vitamin A is required for intestinal absorption of Zn in poultry while Zn influences vitamin A utilization by affecting retinol binding protein (RBP) synthesis and release from liver.

Zn for animal

Zn is widely distributed throughout the body and plays an essential role in many body processes. Radioactive Zn given orally or intravenously reached peak concentrations in the liver within a few days, but concentrations in red blood cells, muscle, bone and hair do not peak for several weeks. Zn is present in many enzyme systems which are concerned with the metabolism of feed constituents. For example, Zn is a constituent of carbonic anhydrase, carboxypeptidase A and B, several dehydrogenases, alkaline phosphatase, ribonuclease and DNA polymerase. Zn is required for normal protein synthesis and metabolism, and it is also a component of insulin so that it functions in carbohydrate metabolism. Because Zn plays so many important roles in the body, it is required by all livestock and poultry.

Absorption of Zn occurs throughout the small intestine and usually ranges from 5 to 40% of the intake. Transfer of Zn out of the intestinal mucosal cells to the plasma is regulated by metallothionein. Zn absorption is reduced whenever diets are high in calcium or phytate (Borges et al., 2003).

Beef cattle

A severe deficiency of Zn in young calves results in parakeratosis (a condition that resembles mange). The nose and mouth become inflamed with sub-mucosal hemorrhages. The animal also develops an unthrifty appearance, a roughened hair coat and joint stiffness. A mild Zn deficiency in finishing cattle results in lowered weight gains, but they show no clinical signs of a deficiency (Burt, 2004). Excessive salivation is an early sign peculiar to ruminants. It may be caused by reluctance to swallow the large amount of salvia that is normally produced (Do et al., 2005). Many recent studies have shown Zn to be essential to maximum immune function in stressed feedlot cattle. Texas researchers reported that when steer calves were challenged with virulent infectious bovine rhinotrachetis (IBR) virus, serum Zn levels decreased significantly. The same author showed that during a natural outbreak of bovine respiratory disease, serum Zn levels were lowest at the time of peak morbidity. Substantial losses in immune capacity can occur due to inadequate Zn intakes before typical Zn deficiency symptoms appear (Griffin et al., 1992). A USDA study in Idaho showed that cows and their suckling calves grazing mature dry forage supplemented with Zn resulted in calves gaining 6% more weight (Lott, 1991). The weight gains of the cows were not increased, however. The forage used contained less that 20 ppm Zn. Some foreign scientists have reported signs of Zn deficiency in cattle grazing forages containing 20 to 30 ppm Zn. Florida researchers have reported Zn deficiencies in four regions of the state (Nairn and Watson 1972). One must keep in mind that forages may differ in Zn level and availability and that the stage of maturity may also affect Zn availability. The Zn requirement for normal beef cattle appears to be between 20 and 40 ppm in the total diet. However, this requirement probably doubles during time of stress. Excess calcium in the diet may also increase the Zn requirement. The pig, for example, may need at least twice as much Zn if excess calcium is consumed in the diet. Zn toxicity is seldom a problem. However, high levels of Zn caused harmful effects in beef cattle fed 900 ppm, which results in reduced gains and feed utilization (Windisch et al., 2008).

Dairy cattle

Lowered feed intake is one of the first changes observed in a Zn deficiency. The cattle grow slower due to a decreased feed intake and less efficient feed utilization. Other symptoms in a severe Zn deficiency are skin parakeratosis (usually most severe on the legs, neck and head), hair loss, unthrifty appearance, stiffness of joints, teeth gnashing, retarded testicular growth and excessive salivation. Reduced reproductive performance has been observed in both males and females fed Zn deficient diets (Zeinali et al., 2011). Another effect of Zn deficiency is a failure of wounds to heal normally. In most cases, when a Zn deficient animal is given Zn, there is a dramatic and quick recovery. Improvements are observed within 24 hours after supplementation. The estimated Zn requirement for dairy cattle is 40 ppm in the diet (Zeinali et al., 2011). There may be certain conditions or an interrelationship with other nutrients that might increase Zn needs. For example, a small percentage of Dutch-Friesian calves are born with an apparently inherited defect that causes a very severe Zn deficiency which can be temporarily corrected by very high amounts of Zn. Whether this means there are genetic differences affecting Zn needs is not well established. A review of the various experiments conducted on the Zn requirements of dairy cattle and the levels needed in each one indicate there is considerable variation in the requirements obtained. However, factors other than genetics are also involved. Growing cattle fed 900 ppm Zn exhibited decreased weight gains and decreased feed efficiency. Based on these and other studies, the 1980 NRC publication, mineral tolerance of domestic animals suggest that 1,000 ppm Zn in the diet is the point at which adverse physiological effects are observed (Nairn, 1972). Regardless of the level of Zn fed previously, cattle fed a severe Zn deficient diet may develop a deficiency within a few weeks. In other words, body stores of Zn do not last very long. The average Zn content of milk is about 4ppm, but there is considerable difference among cows in the level of Zn in their milk. Milk Zn concentrations will decrease rapidly in response to a dietary deficiency (Windisch et al., 2008).

Sheep

Zn deficiency in lambs results in a lack of appetite, reduced growth, slipping of wool, swelling around the eyes and hooves, excess salivation, general listlessness, impaired growth of testes and cessation of spermatogenesis (Lott, 1991). Loss of appetite is the first sign of a Zn deficiency in growing lambs. Recent studies have shown that lambs switch from meal eaters to nibblers (May and Lott, 1992) as they become Zn deficient. Pair-feeding studies show that many of the signs of a severe Zn deficiency are secondary to a loss in appetite. In a USDA study in New York, ewes were fed a low-Zn diet during the last third of gestation and for the first six weeks of lactation. The Zn deficiency caused a few deaths, a continuous loss in body weight during lactation and development of skin lesions and frothy saliva. The rapid deterioration of the ewes after lambing suggests the Zn stores were depleted by the end of pregnancy and the marginal Zn levels may have contributed to the deaths that occurred. A recent study showed that 7 of 30 ewes fed a low-Zn diet either aborted, reabsorbed or delivered mummified and deformed lambs, while the other 23 ewes delivered lambs that were 20% smaller than the controls (Griffin et al., 1992). Feeding a diet containing only 3 ppm Zn during pregnancy reduced survival of the newborn lambs and caused pregnancy toxemia in the ewes as a result of anorexia. This will lead to impaired fertility in the ram. The requirement of Zn for sheep is 20-33 ppm in the diet. The maximum tolerable level in the diet is 750 ppm. Excess Zn will cause a copper deficiency.

Poultry

The 1984 NRC publication, Nutrient Requirements of Poultry, recommends a level of 40-75 ppm Zn in various poultry diets. Zn deficiency causes growth retardation and abnormal feather development in poultry. Feather fraying occurs near the end of the feather. The severity of the fraying varies from almost no feathers on the wings and tail to only slight defects in the development of some of the barbules and barbicels. The hock joint may become enlarged. The long bones of the legs and wings also become shortened and thickened with a Zn deficiency. Other symptoms include scaling of the skin, especially on the feet, loss of appetite, reduced efficiency of feed utilization, and mortality in severe cases. Zn deficiency in the breeder diet reduces egg production and hatchability. Embryos produced in Zn deficient eggs show a wide variety of skeletal abnormalities in the head, limbs and vertebrae. The hatched chicks also may not stand, eat or drink (Lott, 1991).

References

Ahmed, T. and Sarwar, M. 2006. Dietary electrolyte balance: Implications in heat stressed broilers. *World's Poultry Science Journal*, 63: 638-653.

Alten, O., Alten, I., Oguz, I., Pabuccuoglu, A. and Konyalioglu, S. 2000. Effects of heat stress on grwoth, some blood variables and lipid oxidation in broilers exposed to high temprature at an early age. *British Poultry Science,* 41: 489-493.

Barton, T.L. 1996. Relevance of water quality to broiler and turkey performance. *Poultry Science,* 75:854-856.

Basmacioglu, H., Tokusoglu, O. and Ergul, M. 2004. The effects of oregano and rosemary essential oils or alpha-tocopheryl acetate on performance and lipid oxidation of meat enriched with n-3 PUFAs in broilers. *South African Journal of Animal Science,* 34: 197 -210.

Belay, T. and Teeter, R.G. 1993. Broiler water balance and thermobalance during thermoneutral and high ambient temperature exposure. *Poultry Science,* 72:116-124.

Belay, T., Bartels, K.E., Wiernusz, C.J. and Teeter, R.G., 1993. A detailed colostomy procedure and its application to quantify water and nitrogen balance and urine contribution to thermobalance in broilers exposed to thermoneutral and heat-distressed environments. *Poultry Science,* 72:106-115.

Borges, S.A., Fischer da Silva, A.V., Ariki, J., Hooge, D.M., and Cummings, K.R. 2003. Dietary electrolyte balance for broiler chickens under moderately high ambiant temperatures and relative humidities. *Poultry Science,* 82: 301-308.

Burt, S. 2004. Essential oils: Their antibacterial properties and potential applications in food—A review. *International Journal of Food Microbiology,* 94:223–253

Do, J.C., Choi, I.H., and Nahm, K.H. 2005. Effects of chemically amended litter on broiler performances, atmospheric concentration, and phosphorus solubility in litter. *Poultry Science, 84*: 679-686.

Griffin, H.D., Guo, K., Windsor, D. and Butterwith, S.C. 1992. Adipose tissue lipogenesis and fat deposition in leaner broiler chickens. *Journal of Nutrition,* 122: 363-368.

Lott, B.D. 1991. The effect of feed intake on body temperature and water consumption of male broilers during heat exposure. *Poultry Science*, 70:756-759.

May, J.D., and Lott, B.D. 1992. Feed and water consumption patters of broilers at high environmental temperatures. Poultry Science, 71:331-336.

Nairn, M.E., and Watson, A.R.A. 1972. Leg weakness of poultry: A clinical and pathological characterization. *Australian Veterinary Journal,* 48:645–656.

Windisch, W., Schedle, K., Plitzner, C. and Kroismayr, A. 2008. Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science,* 86: E140-148.

Zeinali, A., Kermanshahi, H., Riasi, A., Farhangfar, H., Sarir, H. and Ziaie, H., 2011. Effects of sodium selenite and turmeric powder on thyroid hormones and plasma lipids of broiler chickens reared under heat stress condition. *Global Veterinaria,* 6: 237-240.