# Nutrition in Relation to Diseases and Heat stress in Poultry

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Abstract

Different diseases conditions and stress factors are responsible for high morbidity and mortality of present day poultry. Nutritional strategy and proper feed formulation with specific dietary regimen can combat this up to a certain extent. The incidence of various infectious diseases, nervous disorders and metabolic disorders can be minimized through proper feed regimen. There is a stiff competition and restrictions in the global market of poultry products which can be addressed with proper management of emerging and important diseases with economic productions and quality poultry products free of elements detrimental to human health. Researchers have made efforts to prevent such damage to poultry and poultry product through dietary manipulations. Heat stress can lead to a reduction in the defense mechanisms of birds or to a relative state of immunosuppression. The health status of the poultry is facing new challenges today which can be suitably addressed by the right scientific and advanced nutritional manoeuvres and make the poultry farming more profitable and presentable in the global market.

Key words: Poultry, Nutrition, Infectious Disease, Nervous disorder, Metabolic disorder, Heat stress.

## Introduction

Birds frequently suffer with the chronic disease condition or repeated stress, as a result, there is redistribution of body resources including energy and protein at the cost of decreased growth, reproduction and health (Beck, 1991).

Nutrition plays a fundamental role in determining the health and performance of birds and a correctly balanced diet is essential to avoid disease associated with a deficiency or toxicity of a particular nutrient. Furthermore, disease and nutrition are closely interlinked regarding a number of clinical conditions which arise independently of errors in the diet, but in which dietary modification forms an important part of the poultry management practice. Nutrition mana-gement of birds involves assessment of the nutritional requirements for various life stages and operational tasks, and formulations of complete and balanced economic diets and/or therapeutic diets for different physiological and pathological conditions. Poor managemental conditions with respect to supply of nutrients may lead to starvation and infectious diseases in birds (Dohms, 1990). Different nutritional strategies should be followed to eliminate all avoidable form of stressors and minimize unavoidable stressors under control.

## Nutrition and Disease Interaction

### Infectious Diseases

Coccidiosis causes a great economic loss in the poultry industry due to high rate of morbidity, mortality, sub optimal growth, feed conversion efficiency and loss of egg production (Williams, 2005). Different vitamins and proteins contribute a lot in prevention of incidence of coccidiosis. It has been shown that chickens infected with oocysts of coccidian receiving ten times more vitamin A than the minimum requirement, gain their appetite faster and also grow faster. Vitamin-A reserve in the body is less in infected birds as compared to healthy birds. It is reported that during a severe attack of Coccidiosis, administration of 60 I.U. Vitamin A per chicken per day almost completely prevents mortality.

An interrelationship between vitamin K content of the diet and coccidiosis has also been reported. As much as 8 mg of vitamin K per kg of diet was needed at times for maximum growth and feed efficiency in infected birds, while Vitamin K needs were much lower (1.2 mg/kg diet) under normal conditions. Water medication is generally preferred over feed medication for treatment. Antibiotics and increased levels of vitamins A and K are sometimes used in the ration to improve rate of recovery and prevent secondary infections.

The level of protein content of the diet is a contributing factor in the incidence of coccidiosis. Higher levels of dietary protein favour establishment of occysts of coccidian. Similarly, low calcium diets are also reported to decrease the incidence of the disease. These observations have been explained on the basis of the effect of protein and calcium levels of the diet on the activity of trypsin enzyme in the intestine. Since trypsin has been found to be essential for the establishment of coccidiosis infection, it is proposed that the effect of low protein diets in decreasing the severity of coccidiosis is due to the effect of these diets on intestinal trypsin activity. Betaine and other pronutrients are used as coccidiostats for amelioration of the symptoms. (Bedford, 2000).

Vitamin-K is required in early stages of Ranikhet Disease. It has also been observed that vitamin A in excess than the minimum levels needed for growth is important in the prevention of severe lesions and losses from chronic respiratory disease (CRD).

Vitamin A is involved in maintaining the integrity of the cells of the mucus membranes and the secretion of mucus. Thus, it seems one of the ways through which vitamin A increases the resistance to pathogens. Vitamin A is helpful in increasing the antibody synthesis against pathogens which are able to gain entry in the body. It has been demonstrated in the case of *salmonella* infection in chickens. Normal vitamin A levels in the diet, increases the protein content from 20% to 30% caused a marked increase in the mortality of chicks infected with *Salmonella gallinarum*. It was suggested that excess protein above the normal requirements markedly increases the vitamin A requirements of chicks and decreases the storage of this vitamin. Probiotics like *S. cerevisia* supplemen-tation to diet prevent mycotoxicosis a certain extent.

## Disorders of the Nervous System

Neural disorders account a tremendous loss in rapid growing poultry industry. Vitamin A deficiency results in poor bone remodeling owing to inhibition of osteoclast production. Affected birds become ataxic because of compression of the central nervous system. Vitamin A deficiency is an extremely rare cause of leg weakness in the modern poultry industry and it is much more likely that poultry suffer from hypervitaminosis A. Vitamin E deficiency causes three distinct diseases such as nutritional encephalomalacia or Crazy chick disease, Muscular dystrophy and exudative diathesis. Vit. E or synthetic antioxidants are equally effective in preventing nutritional encephalomalacia while Se is not able to prevent the symptom. Supplementation of selenium had been reported to enhance the preventive effect of dietary vitamin E at a level which was too low to be effective in preventing exudative diathesis and muscular dystrophy.

However, supplementation of selenium or methionine with 2.5 to 10 mg vitamin E/kg had little preventive effect against encephalomalacia in chicks fed dilauryl succinate. Since a toxic effect of selenium at the level of 10 mg/kg has been reported and a dietary level not more than 5 mg/kg has been recommended (Poley *et al*., 1941), supplemental selenium higher than 4 mg/kg would not be expected to have any preventive effect against encephalomalacia due to dilauryl succinate.

Nutritional encephalomalacia is a problem in poultry production which depends both on the actual vitamin E supply and the dietary amount of polyunsaturated fatty acids. Uncontrolled lipid oxidation caused by disturbances of that system may play a crucial role in some important poultry diseases and toxicoses. The first route of lipid peroxide loading of the organism is via the feed, such as through oxidised lipids. In other two diseases both Vit E and Se appear to be involved. Although Se does not prevent muscular dystrophy, its addition to a Se low diet dicreases the amount of dietary Vit E needed to prevent the disease. But exudative diathesis can be prevented by either of the two. It is interesting to note, that Yoshida and Hoshii, famous nutritionists were able to reproduce all the clinical signs of the disease by feeding dilauryl succinate. These signs could not be prevented or reversed with vitamin E levels in the plasma. However, dietary inclusions of vitamin C minimized the dilauryl succinate-induced condition. Normally chickens require 5-10 I.U of Vit E/ Kg of diet (NRC Recommendation).

Riboflavin deficiency is associated with demyelination of peripheral nerves and consequent locomotion difficulty. The classical disease associated with this deficiency is known as curled toe paralysis. It is reported that a condition similar to curled-toe paralysis, which occurred in turkeys fed with 3-Nitrogen, 4-hydroxyphenylarsonic acid. It was found that dietary levels of this substance greater that 50 ppm caused demyelization of peripheral nerves.

Very rarely, birds hatch with nervous disorders when supplemented with extra thiamine in breeder rations.

## Metabolic Disorders

Metabolic disorders such as ascites, skeletal disorders, aflatoxicosis, poor digestibility due to inhibitors and presence of β-glucans and pentosans, all cause considerable losses to the poultry industry. In most cases target organs are liver, pancreas kidneys, lungs and heart. Effective quality control of materials being used in manufacture of feeds prevent these metabolic disorders and addition of central enzymes to feeds containing barley or wheat, can improve the growth and feed efficiency in broilers. Simple heat treatment destroys trypsin inhibitors in soybean meal and thus provides one of the best source of protein for the chickens. Similarly, use of β-glucanase and xylanase can take care of metabolic problems caused by use of barley, jowar and wheat in poultry rations. Combination of genetic and some managerial methods will have to be used to control ascites which cause concern especially in the fast growing broiler chickens. As modern meat-type chickens show a high incidence of leg problems, metabolic diseases and increased fat deposition, a slower growth rate is pursued to avoid these negative selection responses. Early quantitative feed restriction seems to be a possibility to control these unwanted losses without significant reduction in final body weights (Lippens *et al*., 2000).

In many parts of the world, poultry is confronted to aflatoxicosis with feed containing mycotoxins that are metabolites of moulds or fungi growing in field crops or within stored grain. Mycotoxins can be very harmful to birds, even to low concentration, exerting their effect by derangement of normal metabolic functions in various major organs within the body.

Rickets is most often associated with a nutritional deficiency or imbalance. These imbalances or deficiencies may occur due to mixing errors; inaccurate ingredient nutrient estimates; variable content of Ca, P, or both, when formulating diets; and vitamin deficiencies due to loss, primarily of vitamin D activity in vitamin premixes. Deficiencies may also occur as a result of transient or chronic intestinal disease that impairs absorption (mal-absorption syndrome, coccidiosis, etc.). Tibial dyschondroplasia (TD) appears to be most prevalent in rapidly growing birds and this may be related to transient deficiencies during the rapid growth phase of long bones, specifically the tibia, because the proximal tibia is the site of the fastest-growing growth plate. The addition of vitamin D3 alleviates the clinical signs of this disease primarily by inducing maturation of chondrocytes (Driver *et al*., 2006). The concentration and ratio of Ca and P in the diet have also been implicated in affecting chondrocyte differentiation (Edwards *et al*., 1983) and thus in the incidence and severity of TD. The mycotoxin fusachromanone, and the dithiocarbamates thiram and disulfuram induce the occurrence of severe TD lesions.

The embryo has limited access to minerals, except Ca. Most are contained in the yolk, and their concentration in general cannot be greatly influenced by maternal diet. Access, however, can be improved by dietary mineral source selection. Use of management methods to reduce metabolic diseases that rely primarily on decreasing feed consumption, without increasing mineral concentration in the pre-starter phase (hatch to 8 or 14 d), may have negative unintended consequences on the sound development of the skeletal system.(Julian, 1998). Major parts of ingredients in the diet of poultry come from cereals and leguminous seeds. The nutritional value of these ingredients depends, besides their chemical composition, on the extent to which the nutrients are digested, absorbed and utilized. Various factors may interfere with these processes.

A major class of factor are the so-called anti-nutritional factors (ANFs) which can cause metabolic disorders resulting in poor growth, lower egg production and lower efficiency of feed utilization. There are factors which affect digestion and utilization of protein (trypsin inhibitors) and then there are factors which have negative effect on utilization of minerals (glucosinolates, phytic acid, oxalic acid and gossypol).

## Heat stress and Nutrition

Any departure from the normal routine causing inconvenience to birds becomes a cause of stress. Birds are more susceptible to high environmental temperature than low due to absence of sweat glands in the feathered body, fatty nature and high body temperature. The degree of susceptibility to tropical heat stress is higher in broilers than layers. Among broilers, males are more susceptible to heat stress than females. Good layers housed in cages are more susceptible than poor layers reared on deep litter. Prominent effect of heat stress in poultry production is decline in eggshell quality due to excessive loss of carbon dioxide through panting. Temperature has an inverse relationship with poultry feed intake, high relative humidity in the study area usually encourage outbreak of poultry diseases which invariably reduce egg production. Heat naturally causes a decrease in feed consumption as chickens eat primarily to meet

their energy requirements. The increase in temperature decreases the energy requirement and feed intake but the requirements for protein, minerals and vitamins do not decreases.

The biological mechanism by which heat stress impacts production and reproduction is partly explained by reduced feed intake; but also includes altered endocrine status, reduction in nutrient intake and absorption, and increased maintenance requirements resulting in a net decrease in nutrient/energy availability for production.

The heat stress can be reduced by feeding diets with increased energy density. Addition of fat and reducing crude protein may help in combating stress. Management of calorie protein ratio is vital during heat stress management. Addition of salts, vitamins(C, E, B-complex group), choline chloride, betaine also helps to reduce heat stress up to certain extent. Some nutritional strategies could be used to reduce the effect of heat on broilers in finishing stage like by using feeds with a high ratio of net energy to metabolisable energy. Heat production by the broiler may be lowered by reducing the activities, feeding pellets instead of mash or by withholding access to feed before the temperature increases to stressful levels. Some advantages may be gained by adding Vitamin-C or E to the feed, because of their action in reducing lipid peroxidation resulting from the increased body temperature of the bird. Selenium is the central element in glutathione peroxidase (GPx), an antioxidant enzyme that protects cells against the oxidative damage caused by peroxides and free radicals. Zinc is another antioxidant which positively affects feed utilization through participating in the metabolism of carbohydrates, lipids, and proteins (MacDonald, 2000). A linear increase in feed intake and body weight and improvement in feed efficiency and carcass weight were reported in Zn picolinate supplemented quail reared under heat stress conditions (Sahin *et al*., 2005). Amino acid balance in the diet is especially important on heat stres. Increasing EAA associated with constant CP improved their balance as well as productive energy realized from the feed, but this improvement was as fat not muscle. Protein formation generates extensive heat production (Macleod *et al*., 1997) which appears to be limited by a bird's ability to cope with an adverse environment. Some improvement in performance can be obtained by increasing water intake. This can be achieved by cooling the drinking water and by adding salts.

## References


1. Beck, J.R.(1991).*Zootechnica International*, XIV(3):30.
2. Bedford, M. (2000).Removal of antibiotic growth promoters from poultry diets: implications and strategies to minimise subsequent problems, *World's Poultry Science Journal*, Cambridge University Press. 56: 347-365.
3. Dohms, J.E. (1990).Stress: Mechanisms of immune suppressions. proceedings 41st North central Avian Diseases and Poultry immunosuppressive Diseases Symptoms, ColumbusOH. pp.22-42.
4. Driver, J. P., A. Atencio, G. M. Pesti, H. M. Edwards Jr., and R. I. Bakalli. (2006). The effect of maternal dietary vitamin $D_3$ supplementation on performance and tibial dyschondroplasia of broilers. *Poult. Sci*. 85:39–47.
5. Edwards, H. M., Jr., and J. R. Veltmann Jr. (1983). The role of calcium and phosphorus in the etiology of tibial dyschondroplasia in young chickens. *J. Nutr*. 113:1568–1575.
6. Julian, R. J. (1998). Rapid growth problems: Ascites and skeletal deformities in broilers. *Poult. Sci*. 77:1773–1780.
7. Lippens, M, Room, G., De Groote, G. and Decuypere, E. (2000). Early and temporary quantitative food restriction of broiler chickens. Effects on performance characteristics, mortality and meat quality. *British Poultry Science* 41: 343-354.
8. MacDonald, R.S. (2000). The role of zinc in growth and cell proliferation. *J. Nutr*. 130(5S Suppl.):1500S–1508S.
9. Macleod, M. G. (1997). Effects of amino acid balance and energy: protein ratio on energy and nitrogen metabolism in male broiler chickens. *Br. Poult. Sci*. 38:405–411.
10. Poley, E. E., Wilson, W. O., Moxon, A. L. & Taylor, J. B. (1941) The effect of selenized grains on the rate of growth in chicks. *Poultry Sci*. 20:171-179.
11. Sahin, K., M. O. Smith, M. Onderci, N. Sahin, M. F. Gursu, and O.Kucuk. (2005). Supplementation of zinc from organic or inorganic source improves performance and antioxidant status of heat-distressed quail. *Poult. Sci*. 84:882–887.
12. Williams, R. B. (2005) Intercurrent coccidiosis and necrotic enteritis of chickens: Rational, integrated disease management by maintenance of gut integrity. *Avian Pathol*. 34:159-180.


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