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BROILER MANAGEMENT TODAY - NUTRITION

Controlling growth benefits health and overall performance

By **Dr. JOHN HALLEY**

Nutrition plays a vital role in improving broiler welfare as well as maximising economic performance. The importance of 'fine tuning' the diet is increasingly being recognised, as Professor Colin Whitehead explains in this edition.

Prof Whitehead is recognized as one of the world's leading authorities on poultry nutrition, being chairman of the World Poultry Science Association's nutrition working group and currently WPSA vice president.

His article points to the key factors which influence broiler health and profitability.

Energy and protein

Broiler growth and body composition can be regulated by altering energy and protein (and individual amino acid) levels. It can be beneficial for a broiler not to achieve its maximum growth potential, given the association between fast growth and certain metabolic disorders.

Calcium and phosphorus

Bone quality is more sensitive than growth rate in determining desired requirements. With the tightness of feed specifications for calcium and phosphorus - and the importance of avoiding excessive phosphorus to minimise pollution - levels sometimes fail to meet needs.

Extra vitamins can help birds withstand transport rigors

Minerals and vitamins

Total levels in commercial diets are generally higher than needs, and this enables birds to cope with more stressful conditions, to maximize their immuno-responsive capability and provide for any destruction during feed manufacture and storage. Extra vitamin C and E can help birds withstand the rigors of transportation, improve welfare and meat quality.

Enzymes

Enzymes have welfare as well as performance benefits. Excreta are less sticky, improving litter quality and reducing hock burn and other skin lesions.

About the Author
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As a member of the World Technical Support Team, Dr. Halley provides technical training sessions for Cobb customers worldwide.

Prevention of metabolic disorders

Slowing growth by modifying feed composition, providing mash rather than pellets or restricting intake can help combat leg disorders, ascites and cardiac problems.

Early feed restriction can improve walking ability

The first three weeks when bones are most susceptible to initial lesion development are critical. Slowing early growth can be achieved by feeding starter diets of lower nutrient density (eg, 11.5 MJ ME, 190 g CP/kg). Using a higher nutrient density later will allow birds to catch up lost bodyweight.

Early feed restriction can improve overall bird health and walking ability, with greater activity in recovering spilled feed leading to better leg quality.

Supplementary vitamin D can help prevent certain leg problems as modern fast growing broilers have particularly high requirements for this nutrient.

Early benefits in lower nutrient density

By **Professor COLIN C. WHITEHEAD**

Modern broilers can suffer from a number of metabolic problems that affect health and productivity and that can have adverse consequences for welfare. Some of these problems, such as leg weakness and ascites, have been around for a long time, but may have been exacerbated by intense selection for fast growth in broilers. Nutrition has been found to play an important role in combating some problems and improving broiler welfare, and this raises several questions.

Do we fully understand the nutritional requirements of modern fast growing broiler genotypes? Are there important genetic nutritional interactions? But even where nutrition is not directly involved in a problem, nutritional manipulation or feed management may play a part in improving livability and welfare. This article describes some of the ways that nutrition may impact welfare and gives recommendations for the optimum rearing conditions for modern broilers.

Energy and protein

The energy, protein and amino acid contents of the diet are major factors determining the output, feed efficiency and body composition of birds. For broilers, diets of high energy content promote fast growth, so metabolizable energy (ME) contents are generally not less than 12.5 MJ/kg. (2,986 Kcal/kg). As birds grow, the proportion of the feed needed for body maintenance increases. Thus starter diets usually have relatively high crude protein (CP) content (22-23% CP) whereas finisher diets may contain only 16-18% CP, depending upon the age to which the birds are grown. However, there are considerable variations in the nutrient compositions of commercial diets fed at different stages, for a number of very different reasons.

The amount of protein needed to provide the required amino acid content and balance will depend upon the amino acid composition of the feed ingredients and the availability and cost of synthetic amino acids. Protein is a relatively expensive component of a diet and it seems that the requirement for the first limiting amino acid increases nearly in direct proportion to the CP content of the diet (Morris et al., 1999). It is therefore a desirable practice to formulate diets to meet the individual amino acid requirements at the lowest economical CP content. Failure to meet the requirement for an amino acid can result in depressed growth in broilers but without the appearance of any specific lesions. Birds have an appetite for both protein and energy and will regulate food intake to meet their needs for both of these nutrients. Thus a bird will over consume a diet marginally deficient in protein or an amino acid in order to optimize its intake of the limiting nutrient. Overconsumption of energy will be a consequence of this adaptation. Conversely, a bird will consume less of a diet containing a high protein content and will have an improved feed conversion and be leaner. Manipulation of the dietary ME/CP, particularly in finisher diets, is used as a means of controlling the body fatness of market broilers (Jackson et al., 1982). The growth and body composition of broilers during different periods can thus be regulated by altering the dietary contents of protein (and amino acids) and energy. This practice is not considered to have any detrimental welfare effects, even though a broiler may not reach its maximum weight for a given age. It may even be beneficial for a broiler not to achieve its maximum growth potential, given the association between fast growth and a number of metabolic disorders, as is discussed later.

Fat and fatty acids

Broilers have a dietary requirement for essential fatty acids (EFA). The main EFA is linoleic acid which acts as a precursor for other members of the n-6 series such as arachidonic acid and derived prostaglandins. Birds also appear to have a much smaller requirement for fatty acids of the n-3 (linolenic acid) series. Other body fatty acids (n-9 series) can be synthesized *de novo* from carbohydrate precursors. Specific lesions, particularly in the skin, can result from EFA deficiency if the diet content of linoleic acid falls below the requirement of about 10g/kg. However, this seldom occurs in practice since diet ingredients contain EFAs. Also supplemental fats and oils are widely used to achieve desired dietary ME values.

Calcium and phosphorus

These nutrients are essential for good bone formation and bone quality is more sensitive than growth rate as a criterion for determining the desired requirements. The balance between these nutrients is also important and the normal contents of starter diets are about 10g calcium and 4.5g available phosphorus / kg (an approximate ratio of 2:1). Deficiencies or imbalances of these nutrients can have severe effects on the bone quality and welfare of broilers. The main consequence is rickets, either of the calcium deficiency or phosphorus deficiency type, which can occur when the diet content of either nutrient is too low, or the diet content of one is too high and induces a deficiency of the other.

An increase in the incidence of tibial dyschondroplasia (TD) is another consequence of an imbalance, particularly when the calcium:phosphorus ratio falls below the optimum (Edwards and

About the Author

Colin Whitehead *was brought up in Edinburgh, Scotland, receiving his B.Sc., Ph. D. and DSc. degrees from Edinburgh University. He joined the Poultry Research Center in 1969 carrying out research in poultry nutrition and establishing the aetiology of biotin in preventing broiler fatty liver and kidney syndrome. He widened his fields on interest to become an authority in poultry bone biology and has carried out extensive research on nutritional and genetic factors in body composition and bone abnormality. An author or co-author of over 350 papers in refereed journals and other publications, he is a former President of the WPSA UK Branch and Secretary of British Poultry Science. Currently, he is a Vice-President of WPSA, Secretary/Treasurer for the WPSA European Federation and Chairman of the WPSA Nutrition Working Group. He was inducted into the International Poultry Hall of Fame in 2004.*

Veltmann, 1993). TD can still occur even under optimum calcium and phosphorus feeding but rickets should be preventable by correct diet formulation. Given the tightness of dietary specifications for calcium and phosphorus, and the importance of avoiding excessive use of phosphorus to minimize pollution, diet contents sometimes fail to meet specifications.

Other minerals and vitamins

Diets are routinely supplemented with minerals and vitamins within ranges designed to avoid deficiencies or toxicities. Deficiencies of these nutrients generally result in impaired performance and specific lesions that can be considered to be detrimental to the welfare of the bird. Toxicities are less common, but also impair welfare.

Sodium is a major supplemental mineral, usually in the form of sodium chloride (salt). Deficiency can result in stunted growth and skin and feather abnormalities. Excessive dietary salt levels can predispose broilers to ascites. The dietary balance between the different anions and cations (principally Na+, K+ and Cl-) is thought to influence broiler performance and an optimum value for the balance has been proposed (Mongin and Sauveur, 1977).

Practical diets have a natural content of the vitamins but not usually in amounts adequate for normal health and performance. Vitamins supplements are therefore routinely added to diets. The amounts required by poultry have been established experimentally and are reviewed regularly (e.g. NRC, 1994). However, these requirement values are the minimum needed under good experimental conditions and the total amounts provided in commercial diets are generally considerably higher than the requirements. These higher amounts are needed to enable birds to cope with the more stressful conditions experienced under practical conditions, to maximize the capacity of the immune system and to take account of any destruction that might occur during diet preparation and storage.

Feed additives

Diets are supplemented with a number of additives aimed at improving performance or health of birds or the nutritive value of the diet. Sources of coccidial infection are widespread and without control the disease causes extensive damage to the intestinal tract with resultant impairment in performance, morbidity and death. Some anticoccidial compounds also have antibacterial activity, but more active antibacterial compounds have been routinely added to diets. The main purpose of these antibiotics is to improve digestive efficiency and performance by reducing the populations of pathogenic bacteria. This has a beneficial effect on the health of flocks maintained under high stocking densities. However, the use of antibiotics is becoming banned in many parts of the world and this is putting more pressure on alternative strategies for maintaining flock health. New products, including organic acids, herbal extracts, oligosaccharides and probiotics are being introduced that have claimed health advantages, but good sanitary and environmental controls are increasingly essential for the production of healthy broilers.

Enzymes are another class of feed additive widely used. A range of enzymes cleaving polysaccharide and protein linkages of food in the digestive system is used to improve the nutritive values of feeds. The breakdown of non-starch polysaccharides decreases the viscosity of intestinal contents and improves the absorption of nutrients. The main purpose of these enzymes is to improve the performance and feed efficiency of broilers but there are also welfare advantages. Excreta are less sticky, resulting in better litter quality and lower incidences of hock burn or other skin lesions.

Nutrition and stress

Modifications to diet compositions can be made to help birds cope with stress. For birds reared under climatic conditions giving rise to heat stress, decreasing the CP content of the diet, using synthetic amino acids to maintain amino acid intake, and increasing the proportion of ME provided as fat will help to decrease the heat increment of the feed and metabolic heat production by the bird.

Broilers undergoing transport can be subject to a number of stresses, including heat stress. A nutritional procedure sometimes adopted with broilers involves removal of the vitamin supplement from the withdrawal diet as a cost-saving measure. However since it depletes the vitamin status of birds at a critical time, this practice needs to be re-evaluated. Provision of extra vitamins, particularly vitamins E and C, can help birds withstand the rigours of transportation, improving both the welfare and meat quality of birds arriving at slaughterhouses.

Metabolic disorders

Nutrition can influence the occurrence or severity of several metabolic disorders. Even when the disorder does not have a direct nutritional cause, slowing growth by manipulation of feed composition or supply can help to combat the problem. This is particularly true for conditions such as valgus /varus leg disorders that seem to be linked to fast growth. The incidences of cardiac or cardiopulmonary disorders in poultry can also be reduced by slowing growth. Thus feeding mash rather than pelleted diets or feed restriction have been reported to decrease the incidences of ascites and sudden death syndrome (SDS) (Proudfoot and Hulan, 1981). Modifications of dietary energy and protein contents that slow growth are also effective, though Mollison et al. (1984) have reported a beneficial effect of a high protein finisher diet (24% CP) in decreasing ascites mortality independent of an effect on growth. Dietary calcium:phosphorus ratio above NRC (1994) recommendations may also result in increased mortality from SDS (Scheideler et al 1995).

Nutritional manipulations that cause water retention or hypertension can increase the susceptibility of broilers to ascites. Thus excesses of sodium salts such as sodium chloride or sodium bicarbonate or other ionic substances in feed or drinking water can give rise to ascites.

Some disorders are linked more directly to nutrition. Fatty liver and kidney syndrome caused considerable broiler mortality in the 1960s and 1970s but is now prevented by dietary supplementation with

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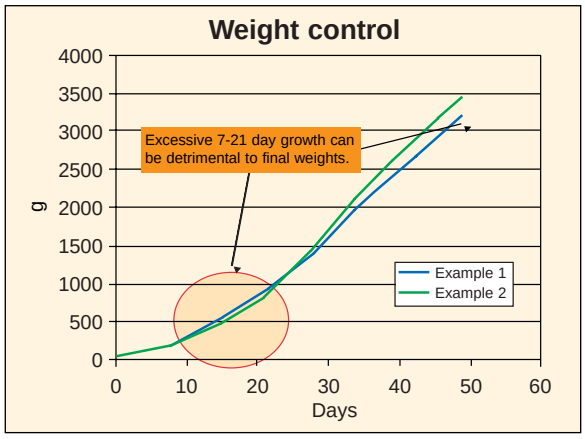
biotin (Whitehead et al., 1976). The most prevalent current metabolic disorder with a strong nutritional involvement is perhaps TD. Several nutritional factors have been associated with this condition. A decreased calcium:phosphorus ratio in the diet will increase the incidence of TD (Edwards and Veltmann, 1983), but TD is not usually prevented by an optimum ratio of these nutrients. The dietary balance between the different anions and cations, principally Na+, K+ and Cl-, can also be a factor in the development of TD, with a metabolic acidosis resulting from a high Cl- content being associated with an increase in incidence and alkalosis with a decrease (Hulan et al., 1987). However, manipulation of ionic balance has not been shown to be an effective strategy for preventing TD.

Dietary supplementation with vitamin D metabolites is the most effective nutritional means of preventing TD in broilers. Supplementation with 1,25-dihydroxyvitamin D has been shown to prevent TD completely in these birds (Edwards, 1990, Rennie et al., 1993) though this metabolite is apparently not effective in turkeys. Another metabolite, 25-hydroxyvitamin D, is available commercially and can also decrease TD incidence or severity in broilers (Rennie and Whitehead, 1996). This metabolite is not so potent as 1,25-dihydroxyvitamin D and its effect is more variable but increased use of this product should contribute to improved leg health in broilers. However, recent findings that supplementing diets with high levels of vitamin D3 itself, up to 10,000 IU/kg, can also prevent TD suggests that modern fast growing broilers may have a particularly high requirement for vitamin D3 (Whitehead et al., 2004).



Nutritional management

Broilers are often fed so as to maximize body weight at all ages. However, as explained earlier, rapid growth can precipitate some metabolic disorders, particularly leg problems and ascites. Manipulation of the growth profile of broilers by nutritional management can thus help to alleviate these problems. There are various forms of feed management that can be effective.

Slowing early growth

Slowing early growth can improve leg bone quality during the important first 3 weeks when bones appear to be most susceptible to the initial development of lesions (Lilburn et al., 1989). This slowing of growth can be achieved by feeding starter diets of lower nutrient density (e.g. 11.5 MJ ME, 190 g CP/kg). Feeding diets of higher nutrient density during the later period of growth will allow birds to catch up lost bodyweight, though complete compensation is more easily achieved in birds grown to older ages. However, birds grown in this way usually show lower incidences of leg abnormalities and mortality from cardiovascular problems and improved food conversion over the production period (Raine, 1986).

Feed restriction

Alterations in the growth profile of broilers can also be achieved by feed restriction. Various types of restriction have been studied, from severe over a short period to mild over a longer period. Severe restriction early in life has been reported to result in leaner birds with better feed efficiency and health, particularly improved leg health and lower mortality from ascites and SDS. The method involves giving amounts of feed sufficient only to maintain bodyweight for periods of 5 to 6 days from about 4 to 6 days of age (Plavnik and Hurwitz, 1991; Fontana et al., 1992). The birds can catch up lost bodyweight if kept to older ages (up to 8 weeks) but may not compensate fully if killed at 6 weeks when the lost bodyweight can represent the equivalent of 2 extra days of growth. Prolonging the period of feed restriction depresses final bodyweight to a greater extent. The health benefit of improved walking ability is related to the degree of body weight reduction achieved by the restriction. Thus feed restriction programs allowing more growth during the restriction period (up to 75% of ad libitum growth) are less effective in improving walking ability at 6 weeks (Su et al., 1999).

An alternative feed restriction regime involves mild restriction, by about 5%, over a greater part of the production period. This can result in little or no loss in bodyweight but improved feed efficiency. The explanation for this is that the birds become more efficient at recovering food that has been spilled in the litter. The greater activity of the birds also results in better leg quality.

Meal feeding

Fasting has been reported to decrease the incidence of TD, without causing growth depression, provided the fasts are of about 8h duration (Edwards and Sorensen, 1987). A subsequent comparison of regimes involving providing meals 2, 3 or 4 times daily has confirmed that meal feeding results in improved walking ability. Body weight at 35 days was observed in this case to decline with the frequency of meals, but the improvement in walking ability as assessed by gait scoring was greater than could be accounted for by the reduction in body weight (Su et al., 1999). It is probable that changes in activity or hormonal patterns of birds given meals have a beneficial effect on leg development and quality. The combination of meal feeding, improved genetics and the changing of lighting procedures to give longer dark periods, are thought to be major factors in the improved leg health seen in broilers in recent years.