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Poultry feed availability and nutrition in developing countries

Feed supplements and additives

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The objective of feed formulation is to derive a balanced diet that will provide appropriate quantities of biologically available nutrients required by the bird. In addition to energy and protein, formulations contain supplements to provide minerals, vitamins and specific amino acids. These supplements must be added to all diets as they provide essential nutrients necessary for health and performance. Modern feed formulations also contain a diverse range of non-nutritive additives, which may not be essential but have an important bearing on performance and health. In many cases, the need for their inclusion is well understood: A major factor to be considered in selecting these additives is their efficacy. Feed supplements and additives are used in only small quantities, and it is particularly important that they are mixed carefully with the main ingredients so that they are evenly distributed.

NUTRITIONAL SUPPLEMENTS USED IN POULTRY FEED FORMULATIONS

Mineral supplements

Only part of birds' mineral requirements is provided by the natural feedstuffs in their diets. Mineral supplements must therefore be included in feed formulations.

Major minerals: Poultry require relatively large amounts of some minerals, such as calcium, phosphorus and sodium. Calcium and phosphorus are needed for normal growth and skeletal development, and poultry have unusually high requirements for calcium during the period of egg production, for the formation of strong egg shells. The calcium supplements commonly used in poultry feeding are limestone, crushed sea shells or sea-shell flour. Limestone powder can be included at no more than 3 percent, because higher levels will lower feed intake. It is therefore necessary to provide the extra calcium needed by high-producing layers as shell grit or limestone grit.

To meet the phosphorus needs of poultry, formulations must be supplemented with inorganic phosphorus sources. In diets containing fishmeal and meat and bone meal, supplementation with inorganic sources may not be necessary. The inorganic phosphates used in poultry diets are dicalcium phosphate, bone meal, rock phosphate, defluorinated phosphate and tricalcium phosphate, all of which supply both calcium and phosphorus. It is important that the inorganic phosphates are obtained from reliable sources, as contamination with fluorine can be a problem in some regions. Excess levels of fluorine in the phosphate source can adversely affect bird performance.

A recent development in phosphorus nutrition has been the availability of commercial phytase enzymes, which assist the bird's digestion and utilization of the phosphorus bound in phytic acid. This enzyme improves the availability of phosphorus from plant materials and reduces the need for inorganic phosphates in feed formulations. This enzyme is a non-nutritive additive.

Common salt is included in all diets as a source of sodium and an appetite stimulant. Salt is added in poultry diets at levels of 0.2 to 0.4 percent. Excessive salt increases water consumption and leads to wet excreta. The use of salt can be lowered or even omitted if more than 5 percent fishmeal is used in the diet.

Most formulations also contain 0.2 to 0.3 percent sodium bicarbonate (common baking soda); inclusion of this substance is particularly important in hot climates. When environmental temperatures are high, birds increase their respiration rate to increase the rate of evaporative cooling, thereby losing excessive amounts of carbon dioxide. This may be reflected in reduced growth rate and a decline in egg-shell quality, often seen in high-producing layers. Under these conditions, the replacement of part of the supplemental salt with sodium bicarbonate is recommended.

Trace minerals: These elements are required in the diet at concentrations in trace amounts, usually about 0.01 percent. Trace minerals (zinc, copper, iron, manganese, cobalt, selenium) are therefore usually added in the form of proprietary premixes.

Vitamin supplements

All vitamins, except vitamin C, must be provided in the diet. Vitamins are required in only small amounts, and are usually provided in propriety vitamin premixes, which can be purchased from commercial suppliers. Although vitamin premixes represent only 0.05 percent of the diet, they can have a large effect on bird performance.

Crystalline amino acids

Pure forms of individual amino acids are now commercially available. Currently the limiting amino acids in poultry diets – methionine, lysine, threonine and tryptophan (in that order) – can be purchased at reasonable cost and included in poultry diets to balance dietary amino acid levels. Amino acid supplements now play a very important role in improving protein utilization in animal feeding.

TABLE 1

Non-nutritive feed additives commonly used in poultry feed formulations.

Additive	Examples	Reasons for use
Enzymes	Xylanases, ß-glucanases, phytase	To overcome the anti-nutritional effects of arabinoxylans (in wheat and triticale), ß-glucans (in barley) or phytate (in all plant feedstuffs); to improve the overall nutrient availability and feed value
Antibiotics[1]	Avilamycin,virginiamycin, zinc bacitracin, avoparcin, tylosin, spiramycin	To control gram-positive, harmful bacterial species in the gut; to improve production efficiency; as a prophylactic measure against necrotic enteritis
Coccidiostats	Monensin, salinomycin, narasin	To prevent and control the clinical symptoms of coccidiosis
Pigments	Xanthophyll (natural and synthetic)	To increase yolk colour in eggs and to improve the skin colour and appearance of carcasses
Antioxidants	Butylated hydroxy toluene (BHT), butylated hydroxy anisole (BHA), ethoxyquin	To prevent auto-oxidation of fats and oils in the diet
Antifungals		To control mould growth in feed; to bind and mitigate the negative effects of mycotoxins
Antibiotic replacers[2]		
i. Direct-fed microbials	Probiotics	To provide beneficial species such as *lactobacilli* and *streptococci*
ii. Prebiotics	Fructo oligosaccharides (FOS), mannan oligosaccharides (MOS)	To bind harmful bacteria
iii. Organic acids	Propionic acid, diformate	To lower gut pH and prevent the growth of harmful bacteria
iv. Botanicals	Herbs, spices, plant extracts, essential oils	To prevent the growth of harmful bacteria
v. Antimicrobial proteins/ peptides	Lysozyme, lactacin F, lactoferrin, α-lactalbumin	To prevent the growth of harmful bacteria

[1] The use of avoparcin, zinc bacitracin, spiramycin, virginiamycin and tylosin phosphate as animal feed additives was banned in the European Union in 1998.

[2] Envisaging a total ban on in-feed antibiotic use, a multitude of compounds (individually and in combination) are currently being tested.

NON-NUTRITIVE ADDITIVES USED IN POULTRY FEED FORMULATIONS

Poultry formulations also contain an array of substances known as "feed additives". These are non-nutritive substances usually added in amounts of less than 0.05 percent to maintain health status, uniformity and production efficiency in intensive production systems. These additives have now become vital components of practical diets. Table 1 presents a list of commonly used feed additives.

Two recent developments relating to feed additives deserve special mention. First, there is increased interest in the use of feed enzymes to improve the utilization of nutrients in raw materials and to reduce feed cost. Improvements in nutrient availability are achieved by one or more of the following mechanisms: i) degradation of specific bonds in ingredients not usually degraded by endogenous digestive enzymes; ii) degradation of anti-nutritive factors that lower the availability of nutrients; iii) increased accessibility of nutrients to endogenous digestive enzymes; and iv) supplementation of the enzyme capacity of young animals. Enzymes widely used in the poultry industry are the carbohydrases that cleave the viscous fibre components in cereals (Table 1) and phytases that target the phytic acid-complexes in plant ingredients. More recently, technically successful enzyme preparations for use in maize-soybean diets have become available. Future advances in feed enzyme technology will involve the development of enzymes that can be used to target the anti-nutritive factors in non-traditional feedstuffs and improve their feeding value.

The second development is the recent ban on the use of in-feed antibiotics in animal feeds in some countries. In other countries, the number of in-feed antibiotics available for use in poultry diets has been restricted. Antibiotics have been used in poultry diets for many years as protection against pathogens and sub-clinical diseases, and for the resulting improved growth. The withdrawal of this preventive measure has serious implications for the productivity of birds, encouraging considerable research effort into finding potential alternatives for antibiotics, some of which are listed in Table 1.

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