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Poultry feed availability and nutrition in developing countries

Main ingredients used in poultry feed formulations

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Feed represents the major cost of poultry production, constituting up to 70 percent of the total. Of total feed cost, about 95 percent is used to meet energy and protein requirements, about 3 to 4 percent for major mineral, trace mineral and vitamin requirements, and 1 to 2 percent for various feed additives. Poultry diets are formulated from a mixture of ingredients, including cereal grains, cereal by-products, fats, plant protein sources, animal by-products, vitamin and mineral supplements, crystalline amino acids and feed additives. These are assembled on a least-cost basis, taking into consideration their nutrient contents as well as their unit prices. Table 1 shows common ingredients used in poultry feed formulations in most parts of the world.

MAIN INGREDIENTS: AVAILABILITY ISSUES

Energy sources constitute the largest component of poultry diets, followed by plant protein sources and animal protein sources. Globally, maize (corn) is the most commonly used energy source, and soybean meal is a common plant protein source. However, other grains such as wheat and sorghum, and plant protein meals such as canola meal, peas and sunflower meal are also widely used in some countries. The main animal protein ingredients are fishmeal and meat meal. Almost all developing countries are net importers of these ingredients; the poultry feed industries in Africa and Asia depend on imports, which are a drain on their foreign exchange reserves. Quite often, the semi-commercial and commercial sectors in these countries are forced to limit their output of compounded feeds.

TABLE 1
Common ingredients used in typical poultry feed formulations

1. Energy sources:
   - cereals (mainly maize),[1] cereal by-products
   - animal fats and vegetable oils
2. Plant protein sources:[2] soybean meal
3. Animal protein sources: fishmeal, meat and bone meal
4. Mineral supplements:
   - calcium supplements: limestone, shell grit
   - calcium and phosphorus supplements: dicalcium phosphate, defluorinated rock phosphate, bone meal
   - trace minerals: trace mineral premixes
   - sodium sources: salt, sodium bicarbonate
5. Miscellaneous:
   - vitamin supplements: vitamin premixes
   - crystalline amino acids: methionine, lysine, threonine
   - non-nutritive feed additives: enzymes, antibiotics, etc.

[1] Wheat and sorghum are widely used in some parts of the world.
[2] Canola meal, peas and sunflower meal are also used in some parts of the world.

The diversion of grains, particularly maize, from the animal feed market to ethanol production is a major recent development that has caused severe grain supply problems in the world market, with dramatic price increases. With government policies to promote the use of biofuels, the global production of ethanol has rapidly increased in recent years, and further large increases are expected in the future. Despite record prices, the import demand for main ingredients in developing countries continues to increase to meet the feed demands of an expanding poultry sector, putting further pressure on prices. Paradoxically, the solution for the rocketing price of maize could come from the biofuel industry, through its major co-product – distillers' dried grains with solubles (DDGS) – which has been shown to be a good source of available amino acids and energy. Worldwide, feed millers are showing keen interest in DDGS because of its cost-effectiveness and ready availability. Good-quality DDGS is a potentially useful feed ingredient, containing about 25 percent protein and 10 percent fat, and rich mineral and vitamin resources. The amino acid availability in DDGS is similar to that in soybean meal. This may be the only raw material whose supply is assured and will increase in the future.

MAIN ENERGY SOURCE

The predominant feedgrain used in poultry feeds worldwide is maize. This is mainly because its energy source is starch, which is highly digestible for poultry. In addition, it is highly palatable, is a high-density source of readily available energy, and is free of anti-nutritional factors. The metabolizable energy value of maize is generally considered the standard with which other energy sources are compared.

In North America and Brazil, the feed industry has benefited from surplus maize, resulting from increased mechanization and the application of genetic and agronomic techniques to raise productivity. In the Asian and African regions, however, maize yield per hectare is low, and in most countries, production has never been sufficient to meet the needs of the growing human population. The net result is a continuing shortage of maize for feed use in these regions.

The other energy source that meets most of the same criteria as maize is low-tannin sorghum. Sorghum can be grown in low-rainfall areas and is a popular crop in hot, drought-prone regions. The high tannin content of many older sorghum varieties limits their use in poultry diets, but low-tannin varieties are now available and can be used in poultry diets without any limitation. The energy value of low-tannin sorghum is 90 to 95 percent that of maize.

MAIN PLANT PROTEIN SOURCE

After energy-yielding raw materials, protein supplements constitute the largest component of poultry diets. Plant protein sources supply the major portion of dietary protein (or nitrogen) requirements. The plant protein source traditionally used for feed manufacture is soybean meal, which is the preferred source for poultry feed.

Soybean meal contains 40 to 48 percent crude protein, depending on the amount of hulls removed and the oil extraction procedure. Relative to other oilseed meals, soybean protein has a good balance of essential amino acids, which can complement most cereal-based diets. The amino acid availability in soybean meal is higher than those for other oilseed meals. The metabolizable energy content is also substantially higher than in other oilseed meals.

Raw soybeans contain several anti-nutritional factors, including protease inhibitors, which can negatively affect protein digestion and bird performance. However, these inhibitors are destroyed by heat during the processing of soybean meal. Properly processed soybean meal is an excellent protein source for all classes of poultry, with no restrictions on its use.

Soybean production has increased substantially over the past two decades to meet the rising demands for oil for the human food market and meal for the animal feed market. The major producers of soybeans are the United States, Brazil and Argentina, which are also the major exporters. More than 50 percent of the current crop is now genetically modified (GM), mainly for herbicide tolerance, and there is an ongoing debate and campaign to reject GM ingredients from animal diets. If GM sources are not accepted in the market place, the potential for further nutritional quality enhancement and increased productivity will be limited.

MAIN ANIMAL PROTEIN SOURCES

With the notable exception of soybean meal, plant protein sources are generally nutritionally imbalanced in terms of essential amino acids, particularly lysine, the first limiting amino acid in cereals. Unless supplemented with animal protein sources and crystalline amino acids, plant-based diets may not meet the requirements for critical amino acids for egg and meat production. Owing to their high prices, animal protein ingredients are normally used to balance the amino acid contents of diets rather than as major sources of protein. In many countries, feed manufacturers ensure that animal protein ingredients do not fall below minimum levels in poultry diets, especially for young birds whose amino acid requirements are high. The requirements for essential amino acids are progressively reduced as the birds grow older, and it is possible to meet the needs of older birds with diets containing lower levels of animal protein and relatively higher levels of plant protein. Fishmeal and meat meal are the animal protein sources most widely used in poultry diets

FISHMEAL

Fishmeal is an exceptionally good source of high-quality protein, and its price usually reflects this. It also provides abundant amounts of minerals (calcium, phosphorus and trace minerals), B vitamins and essential fatty acids. The presence of unidentified growth factors is another feature of fishmeal. Feed formulations therefore seek to ensure minimum levels of fishmeal in diets.

Fishmeal consists essentially of dried, ground carcasses of fish. Good-quality fishmeal is brown, but the colour varies according to the type of fish used and the processing conditions. A very dark colour is indicative of overheating, which can destroy amino acids, reduce amino acid availability and substantially lower the protein quality.

Fishmeal is an important – sometimes the only – source of animal protein ingredients in most developing countries. It is either imported or locally produced. Local fishmeals typically contain between 40 and 50 percent crude protein, compared with more than 60 percent protein in imported fishmeals. Local fishmeals are generally of low quality owing to lack of control over raw fish quality, processing and storage conditions. They are often adulterated with cheap diluents, including poor-quality protein sources (dried poultry manure, oilseed meals), urea and non-nutritive diluents such as sand. Some fishmeals may be objectionable because of putrefaction, impurities or excessive salt content. Samples containing as much as 15 percent salt are not uncommon. This situation underlines the lack of quality control measures in most developing countries. As salt has laxative and growth depressing effects, the salt content of fishmeals should be carefully monitored; it should be less than 3 percent for best results, but legally may be up to 7 percent.

The correct quantity of fishmeal to include depends on the types of cereal and oilseed meals in the feed formulation. The cost of fishmeal is another important determinant. In general, average inclusion levels may be up to 8 percent for young birds, and less than 4 percent for older meat birds and layers. Higher levels must be avoided in finishing and laying diets, as they may lend a fishy taint to meat and eggs. Use of fishmeal can compensate, to an extent, where husbandry conditions are less than ideal.

Future expansion possibilities in fishmeal production are limited. Production does not seem to have increased over the past 20 years, and is unlikely to do so in the future, given the pressures on world fisheries. Fishmeal is included in the overall animal protein ban in Europe, and there is also an underlying concern about possible pollutant (e.g., dioxin) levels in fishmeal.

MEAT MEAL

Meat meal contains relatively high levels of protein, calcium and available phosphorus. Meat meal is the dry-rendered product from mammalian tissues, excluding hair, hooves, horns, hide trimmings, blood and stomach contents, except in such amounts as occur in good slaughterhouse practice. Meat meals are derived mainly from bones and associated tissues such as tendons, ligaments, some skeletal muscle, gastrointestinal tract, lungs and condemned livers. Variation in the proportions of these raw materials contributes to the large variations in meat meal quality. Depending on the proportion of bone to soft tissue used in the manufacture, the finished product is designated as meat meal (containing more than 55 percent crude protein and less than 4.4 percent phosphorus) or meat and bone meal (containing less than 55 percent crude protein and more than 4.4 percent phosphorus).

Collagen is the major protein in bone, connective tissue, cartilage and tendon, and contains no tryptophan. In poor-quality meat meals, 50 to 65 percent of total protein may be collagen. Increasing the level of bone in meat meal lowers the nutritive value,

and the quality of its protein may vary greatly in terms of amino acid composition and digestibility. Protein quality is also affected by the temperature used to process the meat meal.

As a supplement to cereal-based diets, meat meal is of lower quality than fishmeal or soybean meal. Tryptophan is the first limiting amino acid in meat meal for poultry fed maize-based diets; lysine and methionine are also limiting. Normally, no more than 10 percent meat and bone meal is recommended for use in poultry diets, largely because phosphorus requirements are met at that level.

In recent years, feed manufacturers have to cope with increasing safety concerns, exemplified by the bovine spongiform encephalopathy (BSE) crisis, associated with the feeding of meat meal to ruminant animals. The use of meat meal in animal feed manufacture is now banned in some parts of the world, and the long-term future of this raw material seems uncertain.

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