

Future Developments in Poultry Nutrition

Dr Steve Leeson

Department of Animal and Poultry Science
University of Guelph, Guelph
Ontario, Canada

Developments in poultry nutrition have generally been driven by the need to sustain genetic potential within the confines of ever evolving systems of poultry production. Over the last 50 years we have developed quite sophisticated systems for quantitating the available nutrients in both ingredients and diets and this has allowed us to provide birds with quite precise levels of nutrients required for production. Only for energy are we perhaps one step removed from accurately describing the nutrient needs of birds for productive purposes.

As the genetic potential and the characteristics of poultry have evolved, so we have manipulated diet specifications to suit market needs. In general, such changes have been quite minimal, since maintenance needs for nutrients are fixed, and with few notable exceptions the composition of eggs and meat is difficult to change. Subtle changes in diet specifications are often a reflection of change in the metrics used to describe efficiency. Examples of the latter are the newer interest in egg solid yield as opposed simply to egg weight, and the nutrient requirements of birds for purposes of optimizing immune responsiveness rather than simply growth rate or classical feed efficiency.

At the feed mill our past goals have been aimed at assurance of consistency in nutrient content of feed, coupled with minimizing the content of anti-nutrients. While techniques such as Near Infra Red analysis allows for rapid identification of abnormal samples in terms of nutrients as complex as amino acids and even available energy, by and large our quality control programs have provide us with historical data that helps us to build more robust databases for consideration in future decision making.

External influences

All poultry companies have evolved to accommodate consumer and societal issues. The nutrient profile of poultry products now impacts poultry nutrition for production of specialty products, while the need to avoid natural and man-made antinutrients that impact both birds and humans, has had major impact on feed manufacture.

Perhaps the single largest factor to impact poultry production and poultry nutrition has been the mandatory or voluntary removal of antibiotics from feeds, spurred by reports from organizations such as the World Health Organization. Very much an emotional issue lacking sound scientific judgment, the current trend for less reliance on feed as a vector to dose meat birds with “antibiotics” is likely to be irreversible. It is difficult for long-term management of

meat birds without recourse to use of antibiotics, and the current trend for dramatic increase in use of water-borne antibiotics is both worrying and presumably self-defeating if these products in fact pose a real health risk to humans. However it seems that consumers accept such dosing of birds as a positive welfare issue when bird health is an issue, a situation that highlights the fickle priorities of wealthy consumers. In this regard it seems that not allowing birds to free-range in many countries is now acceptable to consumers since the threat of personally contracting AI suddenly supercedes prior concerns about bird welfare.

Poultry nutrition has also been impacted in the move to produce specialty foods that are most often enriched with an array of nutrients. In general the fatty acid profile of eggs and meat mirror that present in the diet and so it is a relatively straightforward task to formulate diets that result in direct incorporation of diet fatty acids into poultry products. Such fatty acids are usually polyunsaturates and so there is the added challenge of limiting the rate of their oxidation in the feed, in the bird and in the resultant poultry products. Currently, flaxseed and fish oils have been the major ingredients incorporated into designer poultry feeds.

Government regulatory agencies are also impacting both feed formulation and feed manufacture. No one will argue that the process of feed manufacture today is becoming exponentially more complex in terms of accountability and traceability of feeds and their component ingredients. As yet, such regulations have had minimal impact on quality control procedures at the mill that are used to verify nutrient content of feeds. Once the novelty of reconciling pharmaceutical products diminishes, then regulatory agencies may well focus on accountability of nutrient supply. Currently we have little confidence in the composition of feeds leaving the mill, since our analytical procedures are more likely conducted with a view to developing an historical database. Regardless of analytical systems used, the most costly and important nutrient in feed, namely available energy still eludes us in terms of rapid, accurate and precise measurement.

The current cost of feed energy is another major issue facing animal production in general, and to a large extent is again a consequence of government intervention. For apparently political reasons, the US government has decided to provide sufficient subsidy to attract significant diversion of corn to ethanol production. There has been considerable discussion on the wisdom, morality and overall economics of this industrial process, but much like the aforementioned consumer issues, such decisions are not made on the basis of sound scientific, or in this case economic, reasoning. Unfortunately there are no ingredients available that can replace corn worldwide in the quantities now used by the poultry and swine industries.

Environmental concerns are obviously another current issue that have become a political agenda, fodder for the media, and consequently topical with consumers. Manure management has already received considerable attention in many countries leading to regulations that have impacted feed formulation. In addition to current concerns about phosphorous and nitrogen excretion, there may be comparable regulations attached to excretory rates of copper and zinc. Likewise the release of ammonia from poultry houses and stored manure is now being quantitated, presumably with the intent of mitigation partly by alteration to feed formulation.

Digestion, bird health and antibiotics

The perceived threat to human health from use of feed-borne antibiotics, growth promoters and certain anticoccidials has created significant interest in increasing our understanding of digestive physiology and the dynamics of the gut microflora. A basic tenant of gut microbiology suggests that bacteria, and especially pathogens have much greater difficulty in colonizing the gut of older birds that have a firmly established microflora, and this is the basis of the Nurmi concept of prevention. From a nutritional point of view there are perhaps steps that can be taken to influence early gut colonization. Unfortunately a clear understanding of how nutrition impacts gut microbiology is hampered by the fact that we know little about the nutrient requirements of pathogens vs. symbiotic organisms vs. those of the bird. Likewise, we are slow to identify the species of all bacteria that reside in the gut, a situation that obviously limits our attempts at microbial control or manipulation.

Presumably any nutrients indigestible to the bird will be potential nutrients for all bacteria including pathogens. Certainly the digestibility of diets by very young birds is up to 20% less than our expectations. To some extent this inadequate digestion of conventional broiler starter diets has led to the introduction of pre-starter diets that are composed of highly digestible ingredients. If nutrient supply to bacteria in the lower intestine impacts population size and/or proliferation of certain species, then perhaps we should start to consider the supply of indigestible, as well as digestible, nutrients in poultry diets, and especially for young birds. While an interesting theoretical concept, it has practical limitations during formulation.

There is renewed interest in fibre nutrition of all classes of poultry, in terms of both gut health and impact on microflora. With the advent of high nutrient-dense diets in the late 1970`s, the role of fibre was relegated in importance. The notable exception was the negative effect of non-starch polysaccharides (NSP`s) in small grains and means to overcome adverse effects of associated increase in digesta viscosity through use of exogenous enzymes. In both human and animal nutrition various fibre components are now being scrutinized for beneficial effects on gut health and potential to modify the gut microflora. The difference in emphasis, from negative to positive attributes, relates to inclusion level. At low inclusion levels (perhaps less than 1%) there may be advantages to using NSP`s as a means of beneficially modifying the gut microflora, especially in situations where antibiotic growth promoters are not used. Fermentation of NSP`s to VFA`s such as butyrate may be one mode of action in controlling proliferation of pathogens and improving gut health. Butyrate resulting from the microbial fermentation of dietary components such as resistant starch, appears to be important for normal development of epithelial cells. Butyrate derived from fermentation of non-starch polysaccharides is credited with improved gastrointestinal health in humans and a reduced incidence of colon cancer. We have recently shown improved performance of broilers fed butyrate triglycerides in cocci-challenged birds. Our knowledge of the role of fibre in monogastric nutrition is somewhat hampered by rudimentary knowledge describing various fibre components, their solubility, and changes that occur with transit through the digestive tract.

Energy costs and bird response to energy

Energy costs are high because of demand for corn and the fact that there are no viable alternatives available worldwide. Coupled with the diversion of corn for ethanol production is the concomitant loss of availability of reasonably priced fats and oils that are being used as a feedstock for biodiesel.

A question often asked is what are the alternatives to corn and high-priced wheat in poultry diets? The answer is already established since we have a reasonable idea of the nutrient profile of all alternate ingredients. Limitation to their use is often inadequate supply. Distillers grains is a relatively new alternate ingredient in terms of quantity now being produced, although one wonders about the long-term viability of drying this product such that it can be used any great distance from the refinery. There is considerable variation in composition and nutrient availability in DDG's, and so knowledge of the feeding value of locally produced products is essential.

With high-energy prices, there is often discussion about using lower energy diets. Traditionally this is not a valid assumption, since when feed prices are high it is often most economical to use diets as efficiently as possible, and this means high, rather than low, nutrient density. However this premise assumes an adequate supply, albeit at greater cost, of conventional ingredients. However, with constraints on ingredient supply it may be impractical to sustain normal levels of nutrient density, and so lower energy diets may be the only alternative.

Both layers and meat birds still eat quite precisely to their energy requirements. The key to successful use of lower energy diets lies in prediction of change in feed intake and corresponding adjustment to all other nutrients in the diet.

When only energy is reduced, then both broilers and layers consume less energy as diet energy level declines. Presumably this reduction in diet energy is in fact a consequence of reduced feed intake precipitated by excess or imbalance of other nutrients in the diet. When all nutrients are tied to energy then both broilers and layers exhibit a remarkable ability to maintain energy intake when confronted with a major decline in diet energy concentration. For both broilers and layers a reduction in diet nutrient density of 10-15% is practical in terms of the birds ability to adapt and perform adequately, assuming that this can be achieved economically.

The economics of using diets with lower nutrient density is invariably predicated on the unit energy price in corn or wheat vs. that in alternate lower energy ingredients. Alternate ingredients are very much dependent on local agronomics and or/supply of ingredients from various industrial processes. Corn Distillers Grains is an obvious potential ingredient in certain countries, and its nutritive value is now well documented . An ingredient that will be available in increasing quantity is glycerol, produced as a by-product of the biodiesel industry. The EU and USA together produce around 1m tones of glycerol, and this number will double for each 2% of diesel fuel replaced by biodiesel. Already supply exceeds current demand for conventional uses, and so it could be an attractive energy ingredient for the feed

industry. As a carbohydrate with a GE of 4300kcal/kg it has potential to supply significant quantities of energy.

Conclusions

Current progress in genetic potential will likely continue unabated in the near future, and so the underlying decision has to be made as to whether or not to sustain this potential through feed formulation. The biological limit to increased genetic potential may well be calcium and bone metabolism. In broilers this relates to maintaining skeletal development in ever younger birds, since inadequate calcification will likely impact bird welfare and the efficiency of mechanical processing. For layers, the immediate past surge in egg numbers has miraculously been achieved without apparent compromise to shell quality. However, as we approach the situation of birds being in excess of 90% production after 52 weeks of lay, there are likely to be limits to the birds ability to sustain skeletal integrity sufficient to placate all segments of society. While current topical issues of diversion of corn, wheat and fat into industrial processes will to continue to impact feed ingredient prices and availability, economic development in Asia will likely be the major long-term factor influencing global feed prices and so our decisions in setting diet specifications.