Feeding the modern commercial broiler

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Today's commercial broiler is the fastest growing and most efficient bird ever produced; it represents the combined efforts of genetics and management. However, with this tremendous potential also comes greater susceptibility to different types of stress.

Knowledge related to bird energetics, stress management and waste production are evolving and new management approaches are being employed. More thorough understanding of energy metabolism is fundamental to improving profitability of production enterprises.

Leanness and uniformity

Consumer demand for lean poultry products necessitates that product leanness and uniformity be improved. As a result, technologies resulting in greater protein production, not overall bird mass, will be emphasised. The shift of focus to the profit centre of muscle tissue necessitates that nutritional advances occur which enable muscle growth at optimal rates while minimising fat accretion.

Though this direction may slow bird growth rate, which has been artificially enhanced via lipid accretion, research directed at reducing the growth depressing consequences of stress may help offset this dilemma.

Nonetheless, technological developments must occur within the bounds of increasing environmental restrictions, which are becoming more intense.

Transforming energy

One of the basic laws of physics is that energy may not be created nor destroyed, it simply changes form. During the process of broiler production, energy is transformed from the feed to the bird, excretory waste products and heat.

Any reductions in excretory waste and/or heat losses would mean that the desired bird mass could be produced with less feed input or that the same feed input would create more bird mass.

The principal goal of the broiler production team is to optimise bird performance by providing the best production environment possible, the successful process of which results in reduced energy waste and enhanced production efficiency.

In this regard it is useful to view the big picture comprising the interface between the bird, its ration and combinations of obligatory (substrate conversion) as well as environmentally, nutritionally and managerially mediated energy losses. Once variables controlling energy wastage are identified, efforts to find a better way and successfully improve FCR are possible. Adverse ambient temperatures, elevated bird activity, immune challenges illustrate a small fraction of the factors elevating energy loss.

In this regard, it is also important to realise that a calorie not expended as heat production can have a multiplier effect when it comes to dietary savings. This occurs because the metabolic efficiency associated with producing the desired and/or metabolically essential events such as activity and immunological responses are not 100%.

Simple equation

Though many forms of energy are possible, adding the energy contained in the bird with energy loss will equal the original amount contained in the feed.

In all species energy retention is the net result of energy inputs minus expenditures as excreta and heat.

Bird heat production is influenced by a myriad of factors including ambient temperature, ration composition and tissue type synthesised as well as activity).

Failure to account for variations in heat production, regardless of source, results in inaccurate ratios of ingested MEn calories available for tissue accretion to dietary protein and other nutrients.

Factors elevating bird activity include stocking density, lighting programme, feed and water space, feed processing via pellet quality, ambient temperature, water quality, ration substrate availability and immunological challenge via elevated body temperature and/or the production of immunological defenders (antibodies, T cells, B cells).

The importance of these factors varies with the company. Part of the impact may be explained by region; however, even companies within the same region can be markedly different. Note that only one of the factors impacting heat loss (ambient) would be expected to be consistent within a particular region. The remainders are company influenced.

The art of nutrition

The sum total of the various factors, and how they are handled, is in the zone whereby the 'science' of nutrition transfers to the 'art' of nutrition.

For example, many companies have their seasonal adjustment (winter versus summer programmes), carcase yield and/or composition adjustment and rations to elevate the number of birds successfully reaching the product stage (less mortality, condemnations) or to improve FCR. But are there additional approaches?

Keep in mind that the objective for any energy scheme is to provide a tool estimating ration energy value to the bird, in terms of tissue accretion, so that appropriate nutrient and energy ratios may be provided.

If broilers were reared in consistent ambient, immunological and managerial environments (eliciting constant energy cost) with steady supplies of defined feedstuffs (consistent energy input) then virtually any energy system would be accurate.

However, such is not the case and an energetic understanding of interactivity between the bird, its ration and fluctuating production environment is needed.

Formula for success

Clearly the diet formula provides energy inputs, this must be coupled with metabolic efficiency for conversion of substrate into tissue and production environment mediated outputs to complete the picture.

The bird will take away from the energy pool with added activity and/or metabolic response to cope with stressors regardless of form.

To date, the metabolisable energy (MEn)

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system has been accepted as the standard for ration formulation.

However, the MEn system by definition, does not quantitatively predict bird feed energy deposition. Any heat increment change alters MEn utilisation and, thereby, can affect the cellular energy/nutrient ratios. Alterations in the cellular energy/nutrient ratio may enhance fat deposition.

For example, recent and ongoing studies directed at evaluating the MEn system indicate that cellular energy supply does not necessarily reflect MEn consumption.

The greater heat increment from protein MEn calories versus those from starch and fat make low protein diets lipogenic.

Oxygen required per unit protein synthesis is 380% greater than that for fat.

Consequently, any factor changing heat loss would, thereby, alter its utilisation for retention and create unexpected cellular energy:nutrient ratios.

Numerous variables

Energetic efficiency of MEn use for tissue gain depends upon numerous variables. Efficiency varies with substrate source, for lipogenesis being approximately 75, 84, and 61% for carbohydrates, fats and proteins, respectively.

The high availability of fat MEn for tissue gain, however, requires that fat is used for lipogenesis.

Utilisation of protein for tissue energy gain depends upon the biological value of the protein source and should not be constant. Indeed, one could summarise that the bird's energetic efficiency for use of protein or any substrate is the net result of partitioning consumed substrate energy into maintenance needs versus accretion of protein and fat.

Recommendations for dietary protein concentration for optimum rates of lean tissue accretion range from high to low levels complemented with specific amino acids.

Whether the carcase leanness associated with feeding high protein diets is attributable to substrate limitations (amino acids), or due to greater heat production per kcal MEn for dietary amino acids carbohydrate and fat is subject to debate. Research conducted by Mittelstaedt (1990) examined the true metabolisable energy (TME) utilisation of carbohydrate, protein and fat sources for energy, protein and fat gain.

Despite similar TME consumption among the energy supplemented groups, carcase energy was impacted significantly. Total carcase energy gain was 17, 27, and 30% greater for the gelatin, starch, and corn oil groups, than for birds fed the basal diet. Estimated energy gain from the basal ration was similar among the energy supplemented groups due to nearly identical feed consumption.

However, total calories gained differed across experimental groups with the highest value of 436kcal/bird observed for the corn oil group versus only 167kcal/bird for the gelatin. As a result, energetic efficiency varied among the energy supplemented groups.

Elevated heat loads

An additional consequence of low protein MEn utilisation efficiency is that the bird's heat load is increased. Elevated heat load has little consequence when birds are housed at or below thermoneutral temperatures. However, if the bird's heat load is elevated by high ambient temperature distress, without a concomitant increase in heat dissipation, elevated heat load can be devastating.

Belay and Teeter (1992) fed birds fed various protein levels and calorie/protein ratios. Increasing dietary energy and (or) narrowing calorie protein ratios by relaxing restrictions on amino acid balance (which necessitated increased dietary protein) significantly impacted bird performance.

Improving amino acid balance and lowering dietary crude protein concentration increased survival both in the thermoneutral environment (4.4%) and within the heat distressed environment (10.8%; $P < 0.05$).

Lowering crude protein (at adequate amino acid balance) for heat stressed broilers certainly can prove beneficial.

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Bird nutrient need must be expressed in proportion to energy to better control product lean and lipid content. Any variability attributable to feed energy value, regardless of source, will alter the ration nutrient to energy ratio. Such is the case with MEn values as the production environment directly impacts its utilisation efficiency.

As a result, live bird, carcase and final product composition becomes not just a factor of the feedstuff MEn, but also how the company poultry production team controls and adjusts for the factors mediating the heat loss changes. Therein lies a portion of the art of poultry production. In the end, failing to adequately adjust for heat losses creates a product of varying lipid content.

Consumers today desire birds containing a consistent and acceptable lipid content and new methods are needed for the 'art' of nutrition to become more of a consistent science.

The ideal environment

Though the general intent is to provide the traditionally defined 'ideal' environment, in reality it is difficult to do so and production declines in the form of live weight and/or feed conversion.

From a nutritional point of view, how should one account for these circumstances and how should these various aspects be valued? The purpose of Effective Caloric Value (ECV) is to provide a method that enables the assignment of energy value to a seemingly limitless array of nutritive and non-nutritive factors that define the production environment.

The ECV system utilises the observed body weight and FCR to estimate the amount of dietary MEn that would be required to mimic a level of bird performance under reference standard production conditions. Company ECV values may well differ from computed and/or determined MEn computations, but ECV is performance based reflecting bird response to MEn under the conditions the birds are reared.

Effective caloric values that differ from company MEn values may be due to matrix differences and/or production environment differences. Nonetheless, ECV affords company personnel the opportunity to place caloric value, by difference, upon various components of the poultry production team.

Historically, managerial, nutritional, and environmental aspects of broiler production have been viewed as separate entities.

However, these multifaceted components overlap and the final production outcome is contingent upon the management/nutrition/environment interface. Fundamentally, energy metabolism can serve as the common denominator among these seemingly disjointed factors.

For example, facility and/or managerial improvements may decrease broiler activity energy expenditure, and consequently, additional energy becomes available to the bird. Assuming diets provide sufficient energy for lean tissue accretion, the additional calories would be shunted to depot fat.

Managerial and environmental factors potentially impacting bird energy expenditure in the production environment include:

- Stocking density.
- Lighting regime.
- Litter quality.
- Feed form.
- Transportation.
- Human interaction.
- Temperature.
- Humidity.
- Altitude.
- Noise.

A method to estimate the performance value of varying production systems as dietary MEn has been developed. Potential applications for ECV include:

- Seemingly disjointed processes that influence performance as body weight and FCR may be assigned energy values and used as an aid to influence live, carcase and product composition.
- Identifying nutritional dead zones created by dietary additions that impact MEn but reduce other factors, as pellet quality, impacting body weight and/or FCR.
- Comparing production systems to a standardised value.
- Enhancing management efficacy. ■