OPTIMUM BROILER FEEDS; THE AVIAGEN PROTEIN CALCULATOR

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Summary

A method is described for calculating the level of balanced protein in broiler feeds which will maximise economic returns under different production and price scenarios. Empirical estimates of bird response derived in a series of experiments are used as the basis of the calculations. The results obtained are specific to the input data used but in general the method emphasises the importance of considering the whole enterprise in making nutritional decisions and the significant effects of economic circumstances on optimum nutrient levels.

I. INTRODUCTION

Two developments make it appropriate to keep protein and amino acid levels in broiler diets under review. Firstly, continued genetic improvements in broiler growth, efficiency and body composition mean that dietary nutrient levels may require adjustment. This is especially true for protein because of the emphasis on body composition and the yield of saleable product. Secondly, it is now widely accepted that the choice of dietary protein and amino acid levels should be an economic decision to be made for each company or enterprise. This idea replaces the concept that chickens in general have characteristic ‘requirements’ which should be met under all conditions.

Determining economically optimum protein levels requires a lot of information but this is readily available in a modern broiler enterprise. Complexity is handled by the use of computers. Here we describe an empirical model approach to optimising protein levels in broiler feeds.

II. PRINCIPLES AND LIMITATIONS

As with any empirical model the calculations are limited by the trials used to determine bird responses. The data presented are for the Ross 308 breed and other conditions are as described below.

‘Protein’ is defined as Balanced Protein (BP) with ratios between the minimum levels of digestible essential amino acids and digestible lysine as defined in the Ross Broiler Manual (2002). With the ingredients used, including crystalline lysine, methionine and threonine, levels of LYS, MET, MET+CYS and THR were held at the minimum balanced ratios and one other essential amino acid (usually ARG or VAL) was also at the minimum ratio and in addition determined the crude protein level. Small excesses of other amino acids and total crude protein are assumed to have no effect on bird performance. To permit calculation of optimum BP levels throughout the life of the birds all nutrient scales are related to the recommendations in the Ross manual. Thus BP level 100 represents the manual amino acid recommendations in starter (0-10d), grower (11-28d) and finisher feeds.

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III. TRIAL PROCEDURES

Four trials were completed with commercial Ross 308 broilers during 2003-2004. Trial facilities provided replicated litter-floored pens in each of which about 90 day-old male or female chicks were placed at 16 birds/m² and reared to 49 days. Birds were removed for determination of body composition or by thinning to prevent the stocking density exceeding 34 kg/m². Light, about 10-15 lux, was either provided for 23 hours each day or according to a light restriction programme. Feed and water were available ad libitum.

Trial diets were designed to provide different levels of BP as described above. Across all trials, BP levels varied from 70 to 120% of the standard used and in all treatments the same relative level was used in the starter, grower and finisher phases. Energy and other nutrient levels were as in the Ross Broiler Manual (2002).

Feeds were formulated from ingredients available in a commercial feed mill using a high quality commercial database to describe ingredient compositions. The same feed specifications were used in all trials but diets were re-formulated on each occasion to take account of changes in the ingredient database. The main protein contributing ingredients were wheat or maize, highpro soybean meal, full fat soybean meal, fish meal, DL-methionine, L-lysine HCl and L-threonine. Vitamin and mineral supplements were according to UK practice. All feeds contained xylanase enzymes but no growth promoters, coccidiostat or other additives. Birds were vaccinated against coccidiosis at day-old. All starter feeds were presented as sieved crumbs and grower and finisher feeds as 3mm pellets. All feeds were heat treated for a high standard of biosecurity.

Accuracy of feed preparation was assured by the ingredient database and by well-controlled weighing and mixing routines. Levels of crude protein and calcium were checked on all batches for conformity to expectation and feeds were re-mixed if suitable standards were not reached. Nutrient levels in feeds are described here by the theoretical values.

Bird weights and feed intake were measured for each pen at frequent intervals of about 7 days. Dead birds and birds culled because of leg defects were weighed and recorded daily. Birds were removed at about 32 and 46 days for processing and determination of body composition. Processing on a small-scale commercial line provided the following observations on individual birds; live weight, eviscerated carcass weight, breast meat weight, thigh meat weight, drum meat weight, thigh, drum and wing portion weights and abdominal fat pad weight. The following subjective scores were made during each trial; clinical leg defects, feather score and litter condition by pen. The results of the four trials were combined by expressing all data relative to the common treatment BP=100.

IV. ESTIMATES OF BIRD RESPONSE TO BALANCED PROTEIN

Performance data for males and females separately were calculated at 1.7, 2.0, 2.5 and 3.0kg by suitable regression analysis and interpolation. Age at each bodyweight, feed conversion ratio corrected for mortality, mortality, eviscerated yield and weights of breast, thigh, drum and wing portions, weight of breast and dark meat and abdominal fat were determined. Responses to BP in the pooled, scaled data for all experiments were determined by linear or exponential regression.

Figures 1a and 1b show typical response data derived from these experiments and as used in the calculation of optimum BP levels.
Figure 1. The responses in Ross 308 males of age (■) and breast meat weight (□) at 2kg (left-hand figure) and of FCR (■) and wing portion weight (□) at 2kg (right-hand figure) to variations in BP. Data points derived from 4 experiments as described in the text. Regression lines were fitted by least-squares procedures using the NLREG computer program.

V. CALCULATION OF OPTIMUM BALANCED PROTEIN LEVELS

All calculations are set up in a spreadsheet. The bird performances at each bodyweight are calculated by solving equations for lines similar to those shown in Figure 1. Feed input costs are determined by formulating feeds containing 70 to 130% of the amino acid levels used as standard. Feed manufacturing and transport costs are added. Other production and processing costs are entered from data for the individual enterprise. This part of the calculation can easily be adapted for individual companies. Costs are distinguished as fixed, and therefore proportional to the time taken to reach a given bodyweight, or variable, and therefore unaffected by time. Revenue is determined by the range of products sold by the company. Revenue rates can be determined at the point considered appropriate for guiding nutritional decisions (e.g., contract grower prices, inter-department transfers, customers sales etc).

In the current version of the spreadsheet the data are combined to determine margins over all costs corrected for, or ignoring, mortality and downgrades. Margin is determined at the farm gate (revenue from live weight only), after primary processing to eviscerated carcasses or after full processing to portions and/or processed products. Again these aspects of the calculations are readily adapted to the individual business. In addition indices of performance such as the Production Efficiency Factor (PEF) or feed costs per kg of product can be calculated easily.

VI. RESULTS

The results obtained in these calculations are obviously specific to the conditions set. However some general trends emerge and data such as those in Table 1 are frequently obtained. These results show that higher levels of BP are required to yield maximum profit after processing than at the farm gate. Males are more responsive than females in this respect at 3kg but not at 2kg.
Table 1. Protein levels yielding maximum profit for 2kg and 3kg male and female broilers. Profit is assessed for the grower (revenue live weight), as processed whole birds (revenue eviscerated carcass) and after processing (revenue breast meat plus portions). Economic conditions approximate to those in the UK at December 2004. Values are relative to the standard digestible amino acid levels recommended by Ross Breeders (2000) which = 100.

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The values shown in Table 1 are at the maximum calculated margin. No account is taken of very small differences in margin which might be available at lower protein levels. For example the detail for processed 2kg male birds shows that although the maximum margin (€1.2916) occurs at 110% BP as in Table 1, even down to 100% BP the margin is only reduced to €1.2706, i.e. by about 1.6 percent. If risk is discounted to some extent, a feeding level somewhere in this range might rationally be selected. Methods for doing this more sophisticated economic analysis have not yet been devised.

The method provides a powerful method of evaluating the effect of feed prices on optimum feeding strategies. For example the figures given in the column for 2kg males birds in Table 1, namely 103, 104 and 110, are obtained when changing the BP level costs €8.81 per tonne per 10 BP units. When this relative cost of protein is reduced to €3.31 per tonne these values change to 117, 118 and 121. When protein cost increases to €13.31 per tonne the resulting optimum BP levels are 98, 99 and 107 relative to the standard used. The relative cost of protein is found to vary widely in different parts of the world.

VIII. DISCUSSION

Although the method is constrained by the trials, it is believed that the results are applicable under a wider range of conditions. For example moderate deviations from the feeding programme used are assumed to be acceptable and different energy levels are accommodated by assuming that the responses to BP : energy ratios are independent of energy level. This conclusion is encouraged by the experiment described recently by Lemme et al. (2005). However bird responses to BP may be different in other strains of broiler as shown by Kemp et al. (2005) and this emphasizes the need to keep the effect of genetic changes in broilers on optimum nutrition under continuous review.

REFERENCES
