Phase feeding in broiler production – 1

by Dr Andreas Lemme, Degussa AG, Feed Additives, Rodenbacher Chaussee 4, D-63457 Hanau-Wolfgang, Germany.

As soon as most animals are born they depend on an external diet supply enabling them to satisfy their energy and nutrient requirements for maintenance metabolism and growth. This change in nutrition is most abrupt in mammals which, once the umbilical cord is cut, require complete external feeding.

In contrast, poultry, and hence broilers as well, have certain post-hatching energy and nutrient reserves in the yolk sac, off which to live for the first hours or even days.

However, it should be remembered that the yolk sac merely meets the maintenance demand. In their investigations, Bigot et al. studied the body weight development and the weight development of both the digestive tract and the breast muscle in two groups of broilers.

While one group had access to feed immediately after hatch, feed supply was delayed for 48 hours in the second group. Broilers initially deprived of feed did not show any increase nor any decrease in body weight, whereas chicks having feed immediately available started eating it and promptly exhibited weight gains.

An identical effect was described for the weight development of digestive tract and breast muscle. Bigot et al, also studying the weight loss and the resorption of the yolk sac during the first days of life, did not see any differences between the two experimental groups, suggesting that the yolk sac only satisfies the maintenance requirement. Therefore, chicks should be allowed access to feed as soon as possible. It is not only early access, but also the nutrient concentration in the diet and its composition, which govern the early developmental phase and, thus, the overall performance of the broilers. As a rule of thumb, a body weight difference of 10g on day 10, on average, develops into a difference of 30-50g on day 35.

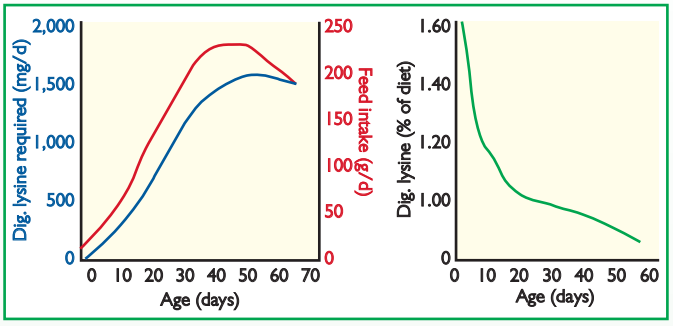

Fig. 2. Relationship between daily digestible lysine requirement (left, blue), daily feed intake (left, red line) and optimum digestible lysine level in diet (right).

In a dose response trial conducted with broiler chicks at the Agricultural University of Wroclaw, Poland, gradually increasing methionine and cystine (Met+Cys) levels were fed from days 1-14.

As well as the weight development, growth of the digestive tract and resorption of the yolk sac was studied. Already on day five, pronounced effects of rising Met+Cys levels on weight gain were noted (Fig. 1). These became more marked with increasing age, and were accompanied by (or attributable to) an enhanced growth of the digestive tract. The resorption of the yolk sac was not influenced by the Met+Cys supply.

Optimum feeding

From the two examples described above it can be derived that, for an optimised broiler production, chicks should be allowed access to feed as early as possible and to diets containing all the nutrients in sufficient amounts and balance.

While the latter would obviously be applicable to the broilers' entire life, there is an inherent difficulty in that the nutrient demand varies on a day by day basis. Furthermore, daily feed intake changes steadily. So, there is a need to harmonise both aspects to establish a sound basis for feed optimisation.

Fig. 2 shows the daily nutrient demand, daily feed intake and the optimum nutrient content as exemplified for digestible lysine, the reference amino acid in the concept of the ideal (balanced) protein.

As can be seen from the curves the daily lysine requirement increases from hatching until about day 40, to diminish again thereafter.

This pattern reflects the daily gain which is characterised by a very similar curve. Moreover, the daily feed intake also changes with age or body weight, reaching its maximum some 14 days later.

From the two plots, the optimum level of digestible lysine in feed can be derived by dividing the lysine demand by the amount of feed consumed. A similar procedure can be adopted for all nutrients and the diet energy as well. In this context all factors impacting feed intake are basically important.

The ideal condition

In the great majority of countries worldwide, feeding broilers until slaughter is done in two to five phases. Each phase involves a short period of suboptimal supply and a short period of oversupply (Fig. 3). The more phases are being considered, the closer one can adjust to the ideal curve. Hence, from a nutrient supply perspective, the ideal world would imply daily adjustments of feed composition. Whole wheat supplementation as typically prac-

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Fig. 1. Effects of increasing dietary levels of Met+Cys on the body weight development of broiler chicks until day 14 (Jamroz et al., 2006).

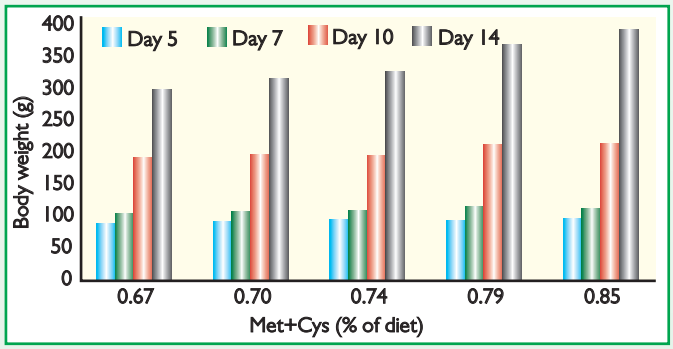
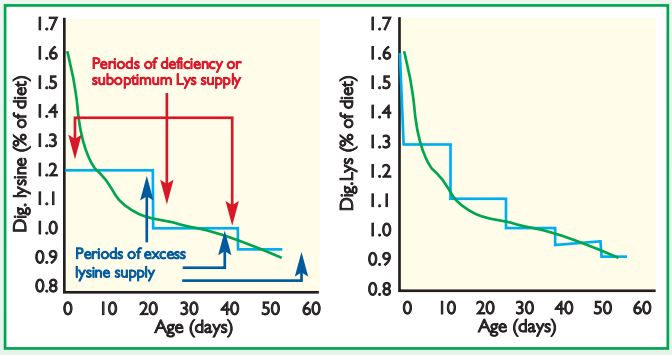


Fig. 3. A three phase (left) and a five phase (right) feeding schedule depicted for digestible lysine.



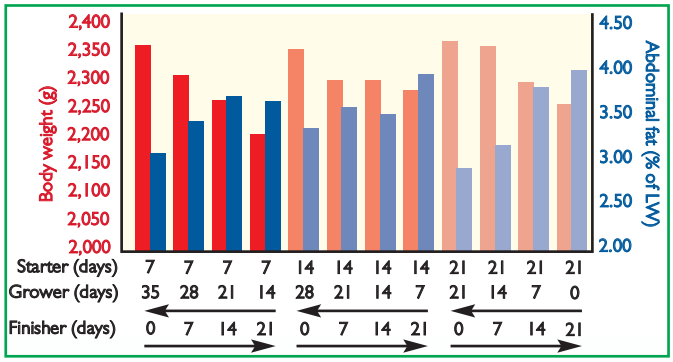


Fig. 4. Effects of varying the starter, grower and finisher phase lengths at given standard diets (Starters: 3135kcal ME/kg, 21.3% crude protein, 0.93% Met+Cys; Growers: 3195 kcalME/kg, 20.2% crude protein, 0.85% Met+Cys; Finishers: 3250kcal ME/kg, 17.7% crude protein, 0.77% Met+Cys) and a total feeding period of 42 days on the weight development (red) and the fat retention of broilers (blue; according to Saleh et al., 1997).

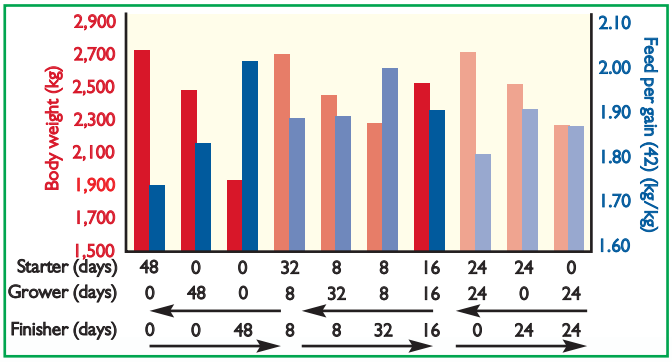


Fig. 5. Effects of varying the starter, grower and finisher phase length at given standard diets (Starters: 3200kcal ME/kg, 23% crude protein, 0.93% Met+Cys; Growers: 3200kcal ME/kg, 20% crude protein, 0.72% Met+Cys; Finishers: 3200kcal ME/kg, 18% crude protein, 0.60% Met+Cys) and a 48 day total feeding period on the body weight development (red) and the feed conversion of broilers (blue; according to Roush et al., 2004).

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tised in Denmark is an approach along these lines.

A suitable feeding technology is employed to change the ratio of unground wheat and a concentrate by following a day by day regimen.

In this respect, the composition of the concentrate and the mixing ratio are key success factors.

The number and the length of the phases should be in line with the demand curve. Basically, optimum dietary amino acid levels are known to diminish with age, whereas the energy content increases.

Protein or amino acids and energy are those components in the rations which entail the highest cost and feed on the whole accounts for roughly two thirds of the total production cost. Therefore, continuous search is under way to find new methods of how to improve the profitability through feed changes.

Modern feeding concepts which, typically, include a diet formulation on the basis of digestible amino acids can cut feed cost or enable a more reliable performance prediction which, in the long run, will be reflected in an improved profitability.

Consistent adoption of the ideal protein concept in conjunction with elevated dietary amino acid levels, even though not reducing the cost of feed, has a marked impact on growth and, in particular, on feed conversion. Kidd et al. reported an enhanced profitability for this strategy.

However, not all the strategies adapted to improve the profitability through feeding are likely to be sustainable. While broiler diets become cheaper with advancing phase, for example, from pre-starter through to finisher feed, the daily feed intake, as can be seen from Fig. 2, increases until about day 55.

High feed consumption entails comparatively high cost of diet, specifically at the later fattening stages. As can be obtained from studies conducted by Wijtten et al. and Kidd et al., reducing nutrient or amino acid levels does not make sense from an economic viewpoint.

On the other hand, producers sometimes consider shortening the

earlier phases with the more expensive diets and, instead, providing the comparatively cheaper finisher feed over a longer period. Hence questions arise whether or not this strategy will actually bring about the hoped for cost effectiveness improvement or what the optimum phase lengths are for a given diet composition. Saleh and co-workers published a number of papers on this subject, all of which ultimately produced similar conclusions.

In the example chosen here, Saleh et al., while feeding standard diets, varied the length of the starter, the grower, and the finisher phases, within a 42 day total feeding period.

The starter diet was given for either 7, 14 or 21 days, the grower diet for zero to 35 days depending on the starter-phase duration, and the finisher diet accordingly for zero to 21 days (Fig. 4).

The outcome of this trial, at first glance, suggested that the length of the starter period did not have a strong impact on the body weight development. This may have been related to the diet composition.

In contrast, the length of the grower and/or the finisher phase had a marked effect. So, weight gain gradually impaired as the finisher phase was extended at the expense of the grower phase.

Similar effects were observed for feed conversion (data not shown).

Key information

- For optimum weight gain of broilers, chicks should receive adequate feed as soon as possible after hatching, since yolk sac nutrition during the first days can merely meet the maintenance demand.
- The daily amino acid demand increases until about day 40, with daily food intake growing until about day 55. Combining this information gives dietary amino acid levels which, being high initially, diminish with age.
- Nutrient supply to broilers can be optimised through an appropriate combination of phase length and nutrient concentration while also taking other parameters into account, in particular, aspects of cost efficiency.
- Ideally, feed should be adjusted on a daily basis to meet the broilers' needs under given conditions. Whole wheat feeding systems as practised in Denmark offer this possibility.
- Changes of the phase length or the mixing ratio of wheat and concentrate should be accompanied by nutritional adjustments in order to preclude economic losses.

Moreover, birds fed the finisher feed over a longer period were found to retain more fat, indicating a relative energy oversupply. This effect is attributable to two causes.

On the one hand, broilers switched early from grower to finisher feed had an initially inadequate amino acid supply, limiting protein deposition and causing excess energy which was accreted as fat. On the other hand, the energy content of the finisher feed was 55kcal/kg higher than that of the grower feed, aggravating the relative energy excess. To conclude, a change in the phase length, in particular at the advanced feeding stage, should be accompanied by an adjustment of the dietary energy and nutrient levels in order to prevent a performance depression.

This issue was investigated by Roush et al. To this end, the workers selected a dedicated trial design used to compute the optimum duration for each of the three phases (response surface method).

In three treatments, either only starter, only grower or only finisher feed was fed for 48 days. In further seven treatments, the length of the starter, grower, and finisher period was varied (Fig. 5). The findings showed that where solely the starter diet was fed the best performance was achieved, specifically in terms of feed conversion, whereas the sole administration of the finisher feed resulted in the poorest performance.

However, various combinations of the three phases yielded acceptable results. Evaluation of data by adopting the response surface method revealed that, in an attempt to maximise the growth performance, starter diet should be given for 37 days, and the grower diet for 11 days.

Similarly, this was also true for optimising the breast meat yield. The calculation in which growth, feed conversion and diet cost were all optimised at a time, recommended 18 days on the starter diet and 30 days on the grower diet. In this trial, the finisher diet consistently dropped out. This might be attributed to an inappropriate and, thus, performance limiting diet composition.

In other words, the comparatively high levels of amino acids in the starter diet and also in the grower diet allowed for the best response and, hence, the best feed conversion rate, which soon became obvious in terms of enhanced profitability. ■

References are available from
andreas.lemme@degussa.com

This article will be concluded in the next issue of International Poultry Production