Phase feeding in broiler production – 2

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The question if and to which extent shortening or prolonging the finisher phase at the expense of the grower phase would impact the performance and the profitability in broiler production was investigated in a feeding trial conducted by Aviagen Ltd in Scotland.

The study was also undertaken to see if potential effects of phase length changes could be compensated for by adjustments of the amino acid supply.

A total of 8,640 sexed day-old male and female Ross 308 broiler chicks were equally distributed to 96 floor pens (90 chicks/pen). The trial diets were formulated according to the Ross recommendations (see Table 1).

All birds were given the starter diet for 10 days. While the grower diet composition was identical for all birds, the duration of the grower phase was varied.

More specifically, considering the recommended duration of 18 days (until day 28), the grower phase was either shortened by one week (until day 21) or prolonged by one week (until day 35). As the final age was 49 days for all broilers, the finishing phase, therefore, became accordingly longer or shorter. Moreover, the broilers received increasing levels of balanced protein in the finisher phase (Table 1, balanced on the basis of digestible amino acids).

Digestible AA	Starter 100%	Grower 100%	Finisher 70%	Finisher 100%	Finisher 120%
MJ ME/kg	12.6	13.2	13.3	13.3	13.3
Lys	1.27	1.08	0.62	0.88	1.06
Met	0.47	0.41	0.24	0.34	0.41
Met+Cys	0.94	0.82	0.48	0.69	0.83
Thr	0.80	0.69	0.41	0.58	0.70
Trp	0.22	0.18	0.11	0.16	0.19
Arg	1.33	1.16	0.67	0.96	1.15
Ile	0.84	0.72	0.42	0.60	0.72
Val	0.94	0.81	0.47	0.67	0.80

Table 1. Profiles of the digestible amino acids in the experimental diets fed in a growth trial with Ross 308 broilers until aged 49 days.

Amino acid levels for the female birds ranged from 70-100% whilst for the males they ranged from 80-120% of the Ross recommendations (110% was left out) because a flatter response curve was assumed for female broilers on the grounds of earlier investigations. Analyses confirmed the targeted amino acid levels.

The energy contents were 12.6MJ ME/kg in starter, 13.2MJ ME/kg in grower, and 13.3MJ ME/kg in finisher diets. This also implies that the 100% grower diet differed only marginally with respect to the energy content from the 120% finisher diet – a significant detail in interpreting the findings.

Fig. 6 shows the effects of varying phase lengths and increasing levels of balanced protein in finisher feed on the feed conversion ratios in broilers. For either sex, both a longer grower phase and an increasing amino acid supply resulted in an improved feed conversion.

The best feed conversion ratios were noted with the longest grower period and highest amino acid supply. No differences were seen between the three treatments with 120% balanced protein in males.

The facts that the amino acid supply in switching from grower to finisher feed did not change and energy supply through the grower feed was not performance limiting are likely explanations.

Basically, these findings suggest that, as the grower phase is shortened, the performance level can only be maintained if the amino acid supply in the finisher feed is increased. For the female birds, one may even speculate that optimum balanced protein level is in the area of 110% of the recommended figures. As a first approximation to a profitability analysis, one may consider the effects on the production efficiency factor (PEF), an index combining feed conversion ratio, growth performance, mortality, and final bird age (Fig. 7).

Again a marked trend was noted in that both an increasing duration of the grower period and a rising level of balanced dietary protein improved the production efficiency. And, again, highest amino acid levels and longest grower periods suggested the optimum combination.

The effects of increasing amino acid supply were most pronounced for either sex for the longest finishing phase (from day 21).

This is due to the fact that a 70% (female) or 80% (male) diet is in the deficient or suboptimal range for a longer time if fed already from day 21, compared with switching to the finisher feed not until day 35.

The trial data were also used for profitability calculations. These are shown in Fig. 8 and are based on assumptions including feed prices of £159.60 per tonne and £154.70 per tonne for the starter and grower diets, respectively.

The respective prices for the 70, 80, 90, 100 and 120% finisher diets were 129.70, 134.50, 139.80, 145.00, 150.00 and 155.00 (all prices given as £/tonne).

The price per kg of breast meat

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Fig. 6. Effects of gradually increasing levels of balanced protein in finisher diets fed from either day 21, 28 or 35 until day 49 to male (left) and female broilers (right), on the feed conversion ratio.

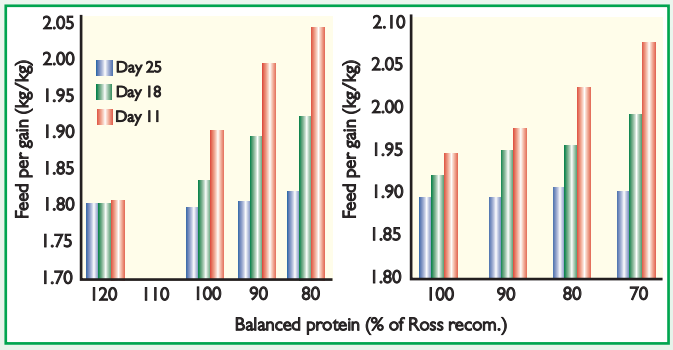
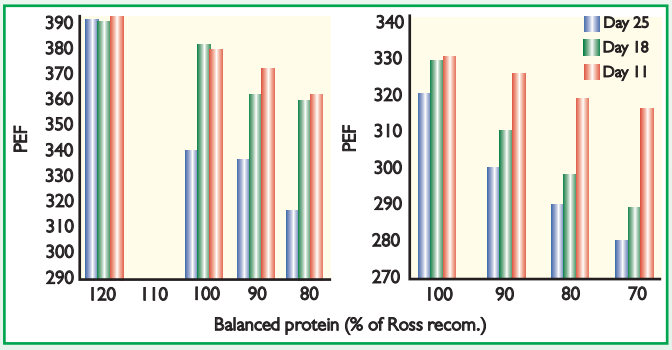


Fig. 7. Production efficiency factor (PEF) as a function of the dietary balanced protein level in the finisher feed and time of introduction of the finisher feed for male (left) and female broilers (right). PEF= ((survival rate, % x end weight, kg) / (age, days x feed conversion, kg/kg)) x 100.



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was assumed to be £4.00. The calculations were standardised to final weights of 3kg and 2.5kg for the male and the female birds, respectively. As several simulations revealed that the general nature of the outcome is hardly influenced by changing feed protein cost, changing revenues or target weights, the results are presented in more general terms on a relative scale.

The calculations clearly suggest that the grower period should not be shortened without appropriately adjusting the amino acids in the diet.

Quite the reverse, the simulations demonstrated that a high supply of amino acids until slaughter, either by prolonging the grower phase or by increasing the dietary amino acid levels in the finisher feed at short grower period, enhances the profitability (Fig. 8).

Presentation of diet

Another broiler trial with varied phase lengths was conducted in the experimental station of Aviagen Ltd in Scotland. In this investigation undertaken with only male Ross 308 broilers, the lengths of the starter phase at the expense of the grower phase were 7, 14 or 21 days.

Finisher feed was fed to all birds from day 28. Furthermore, in an approach similar to the previous trial, the amino acid levels in the starter feed were increased in three steps from 80, 100 to 120% of the Ross recommendations (Table 2).

In the grower diet, either 90 or 110% of the current recommendations were implemented, finally resulting in a total of 18 treatments.

The composition of the finisher feed was in line with the recommendations. The feed energy contents in the starter, grower, and finisher diets were 12.6, 13.2, and 13.3MJ ME/kg, respectively. The total fattening period was 42 days.

The findings obtained in this trial were not as definite as those of the prior experiment. Still, following the starter phase – irrespective of its duration – a clear dose response to the dietary amino acid levels was noted. The body weights ensuing from the 80% starter diet were 10-15% lower and those obtained from the 120% diet were roughly 5% higher compared with the recommended 100% level after the starter phase which length varied (data not shown).

Digestible AA	Starter 80%*	Starter 100%*	Starter 120%*	Grower 90%	Grower 110%	Finisher 100%*
MJ ME/kg	12.6	12.6	12.6	13.2	13.2	13.3
Lys	1.02	1.27	1.53	0.97	1.19	0.88
Met	0.49	0.64	0.78	0.48	0.61	0.45
Met+Cys	0.75	0.94	1.13	0.74	0.90	0.69
Thr	0.64	0.80	0.96	0.62	0.76	0.58
Trp	0.22	0.27	0.32	0.21	0.26	0.20
Arg	1.10	1.40	1.72	1.06	1.35	0.97
Ile	0.67	0.85	1.03	0.66	0.82	0.60
Val	0.76	0.94	1.13	0.73	0.89	0.67

Table 2. Digestible amino acid profiles of the experimental diets fed in the second growth trial with Ross 308 broilers until the age of 42 days.

The increase in amino acid levels from 90-110% in the grower diet resulted in an average final weight that was approximately 3% higher.

Finally, irrespective of the protein content of the grower diet, an 80% amino acid supply in the starter phase adversely affected the body weight development (Fig. 9).

Increasing the amino acids to 100% very clearly influenced the final weight, demonstrating that the amino acid supply during the initial phase of life is crucial. Further raising the amino acid supply to 120% produced a positive effect only when a high amino acid supply in the grower phase followed (110%), and only if the starter diet was fed at least 14 days.

Presumably, in case of an early diet change on day seven, the chicks had difficulty with intake of the pellets compared with the crumbs of the starter diet. Growth data suggested that a starter diet with 120% amino acids should be fed for 14-21 days, and subsequently a 110% grower diet so as to optimise the performance. Similar responses were also described by Wijtten et al.

Basically, the starter phase does not impact the final feed conversion to a large extent since, compared with the total diet intake, relatively small quantities are consumed.

The grower phase exerts a greater influence in this respect. In Fig. 10, it can be clearly seen that those broilers which, during the grower phase, were given the diet with higher amino acid levels exhibited a better feed conversion. This effect being consistent with that noted in the previous trial was also seen in experimental work reported by Wijtten et al. and Lemme et al. in which the broilers also received increasing levels of balanced protein.

While, in case of low amino acid supply (90% of the recommendations) in the grower period, no dose response trend could be observed for the overall feed conversion, the data of the birds supplied with 110% amino acids suggested that gradually rising amino acid levels in the starter diet produced a positive effect, at least if the diet was fed for 14 or 21 days.

Effects on breast meat yield are shown in Fig. 11. Responses suggested that breast meat yield was affected by all varied factors.

Feeding 110% during the grower phase resulted generally in a higher breast meat yield. In contrast to the responses on weight gain and especially feed conversion, the responses to the balanced protein levels in the starter feed and the length of the starter feed were rather consistent and were even more pronounced when broilers got the 90% grower diet. Accordingly, breast meat yield was maximised at highest amino acid levels and longest starter period.

The findings of the second trial demonstrate that the amino acid supply during the starter and the grower phases impacted the overall performance of the broilers.

In this context, it appears that prolonging the starter phase from seven to 21 days, in conjunction with elevated dietary amino acid levels in both starter and grower diets, improve the growth, the feed conversion and particularly the breast meat yield, indicating the high amino acid demand of the young chicken.

This is basically consistent with the outcome of the previous study in which the length of the grower period was varied, but also with the findings of investigations cited and reported in the literature.

Finally, economic considerations and profitability calculations will determine the optimum phase length and amino acid supply in the particular phase as can be gathered from findings reported by Roush et al. and Aviagen Ltd (first trial).

Wheat supplementation

The method of whole wheat supplementation as practised in Denmark comes close to the ideal condition of phase feeding, since concentrate is blended with whole wheat grains from day seven onwards.

This offers the possibility to daily adjust the diet according to requirements by changing the proportion of wheat and concentrate. Basically, such adjustments could also be realised by blending two compound feeds.

Increasing the wheat inclusion implies a certain feed dilution. Some producers, while putatively attempting to improve the profitability of broiler production through a higher wheat inclusion, fail to appraise the consequences this will have for broiler performance.

In Denmark, the Danish Agricultural Advisory Service conducted a broiler trial to investigate this issue. Until slaughter age, the broilers received on average 16, 22 or 28% unground wheat added to the con-

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Fig. 8. Profitability (relative scale, 100% = Ross recommendation) of the broiler production (growing + portioning) when increasing levels of balanced protein were fed from either day 11, 28, or 35 until reaching 3kg (males, left) or 2.5kg (females, right).

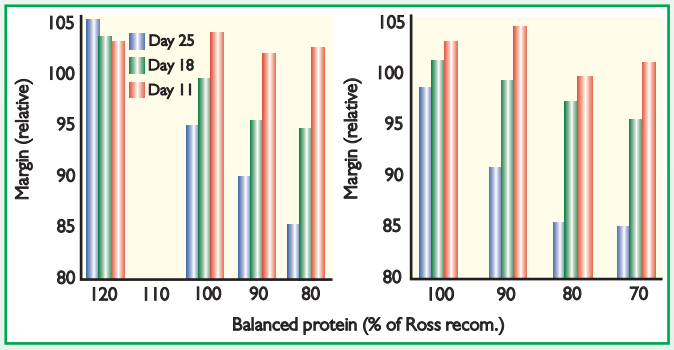
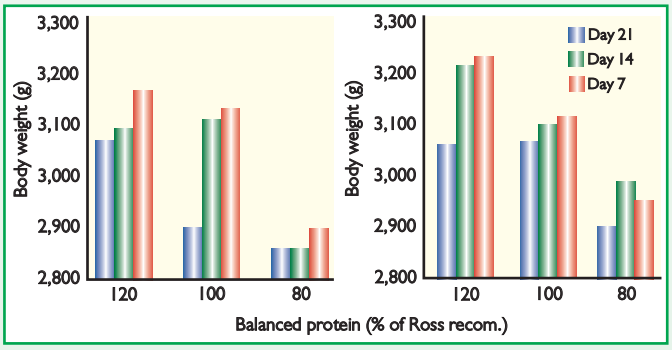


Fig. 9. Final body weights of broilers 42 days of age fed starter diets with increasing levels of balanced protein for 7, 14 or 21 days and offered grower diets with either a reduced (90% left) or elevated amino acid level (110% right).



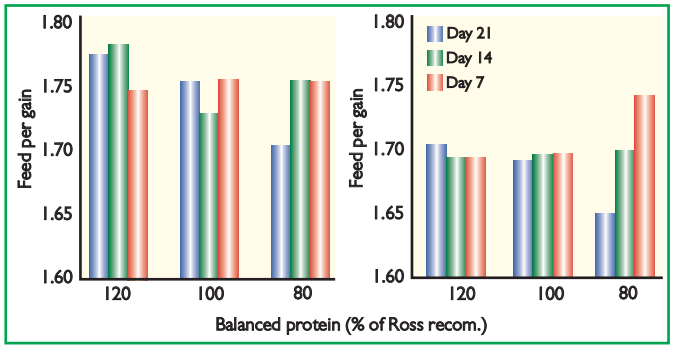


Fig. 10. Feed conversion in broilers 42 days of age fed starter diets with increasing levels of balanced protein for 7, 14 or 21 days and offered grower diets with either a reduced (90% left) or an elevated amino acid level (110% right).

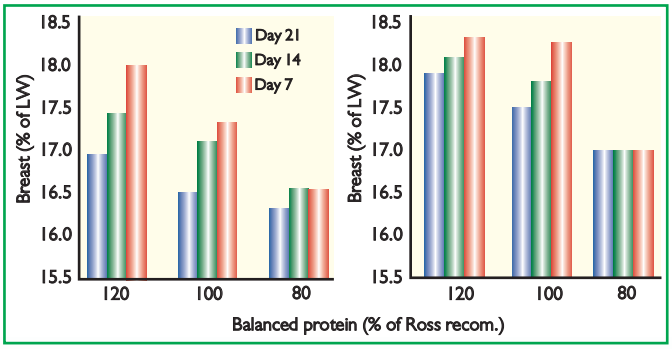


Fig. 11. Breast meat yield in broilers 42 days of age fed starter diets with increasing levels of balanced protein for 7, 14 or 21 days and offered grower diets with a reduced (90% left) or elevated amino acid level (110% right).

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centrate. The starter (days 1-7), grower (days 8-32) and finisher concentrates (days 33-36) corresponded to the Danish standard and contained 12.5, 12.3 and 12.3MJ ME/kg, 22.0, 22.4, 23.0% protein, 1.5, 1.3, 1.4% lysine, and 1.1, 0.9, 0.9% Met+Cys.

The wheat contained 12.5MJ ME/kg, 10.4% protein, 0.32% lysine, and 0.39% Met+Cys.

For technical reasons the wheat to concentrate ratio, rather than being adjusted daily, was changed every 3-4 days.

So, the broilers of the 22% variant which conformed to the Danish standard were initially fed with 6% wheat from day seven onwards, followed by a gradual increase to 32% from day 32 (Fig. 11).

The results clearly showed that increasing the wheat proportion at the expense of concentrate adversely affected the performance of the broilers of either sex (Fig. 12).

The growth performance gradually diminished with rising wheat percentage, while the feed conversion increased.

These effects were clearly seen from day 21 onwards.

In addition to the strong decrease in breast meat yield, a reduced carcase yield and an enhanced fat deposition were observed at least for an average wheat inclusion of 30%.

The effects on the breast muscle once again pinpoint the latter's sensitivity to amino acid supply.

Finally, the optimum wheat concentrate ratio is related to the constraints in terms of cost effectiveness. Increasing the wheat percentage entails lower diet cost which might in some cases compensate for a reduced bird performance.

Calculating such scenarios depends on a number of individual variables such as raw material costs, fixed costs, pricing scheme for carcase, etc and hardly permits a generally applicable interpretation.

As well as the mixing proportions of wheat and concentrate, the composition of the concentrate is of relevance.

Contemplating by analogy with the trials conducted by Aviagen Ltd and referred to above, one can speculate that for each and any mixing ratio there are optimum nutrient levels in the concentrate.

To summarise, nutrition should allow for optimum amino acid supply. Theoretically, this can be accomplished successfully by increasing the number of phases or even making dietary adjustments on a daily basis.

The optimum amino acid supply is not solely a function of the biological performance; it depends on a number of factors which may also be related to cost effectiveness.

On the other hand, it is emphasised that the lengths of the phases or, in case of whole wheat supplementing, the mixing ratio of wheat and concentrate should not be altered without making nutrient adjustments in the rations, for reasons of a putative cost reduction; otherwise, the birds' performance will be adversely affected and this, in turn, would impact the profitability as a whole. ■

References are available from the author on request
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Fig. 12. Feeding schedule (top, left) and effects of increasing whole wheat inclusion on final weight (top, right), feed conversion (bottom, left) and breast meat yield (% of the carcase, bottom, right) in 36 day old female (red) and male (blue) broilers (Dansk Landbrugsradgivning, Denmark).