Responses of growing broilers to varying dietary energy and balanced amino acid levels

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Abstract
In a feeding trial with a 3 (dietary energy levels) x 4 (dietary balanced protein levels) factorial arrangement a total of 4320 male Ross 308 broilers were fed starter (1-10 days), grower (11-32 days), and finisher diets (33-46 days). Reduction of dietary energy, by decreasing the oil supplementation, increased feed intake independently of dietary amino acid levels. Feed intake generally increased nonlinearly with increasing balanced protein levels. However, due to the energy effect on feed intake, amino acid intake was influenced indirectly. Data suggested that weight gain was driven by amino acid intake. Breast meat yield also increased nonlinearly with increasing amino acid intake while abdominal fat decreased. Data suggested, that within the energy ranges tested, if dietary energy has to be reduced compared to common standards, optimum dietary amino acid levels should not be reduced to the same proportion, provided the amino acid composition has been balanced.

Introduction
In a number of regions in the world the availability of oils as dietary energy sources is limited or even zero. As a consequence low energy diets with dietary energy levels 10% or even lower compared to current recommendations are produced. The question arose whether and - if yes – to what extent dietary amino acids should be adjusted to reduced energy levels.

Materials and Methods
A total of 4320 male day old ROSS 308 broiler chicks (43.5g) were equally distributed to 12 dietary treatments with 90 birds per pen and 4 pens per treatment. Throughout the experiment temperature, humidity, and light program were in line with the recommendations given in the Ross Management Guide (Aviagen, 2002).

Dietary treatments comprised 12 diets varying in dietary energy and amino acid levels. In the 3 (energy) x 4 (amino acids, AA) factorial arrangement, starter (1-10 days), grower (11-32 days), and finisher diets (33-46 days) were formulated by linear programming in order to contain 100 and 90% dietary energy and 70 and 100% dietary AA related to the Ross Broiler Management Guide (Aviagen, 2002, Table 1). Intermediate energy (95%) and AA levels (80, 90%) were achieved by blending the diets to the required proportions. Minimum constraints according to the recommendations were set for digestible Lys, Met+Cys, Thr, Trp, Arg, Ile, and Val. So, depending on the treatment, the constraint level of the individual AA were met or slightly exceeded. However, Lys, Met+Cys. and Thr were always at limiting levels and their dietary levels always met exactly target values in the feed formulations. In general all diets were fairly well balanced and feed analyses on crude nutrients and AA confirmed calculated values. Only Met+Cys was consistently about 0.03 to 0.05 %-points lower than expected.

Diets were purely vegetarian and mainly based on corn and low protein soybean meal accounting for the low raw material quality often found in the regions with low dietary energy. However, wheat bran and corn gluten meal enabled the constraints set in linear programming to be more closely met. While in the 100% energy diets between 4.4 and 6.5 %
soybean oil were used, no lipid source was added in the 90 % energy treatments (For more details see Lemme, 2005). The crumbled (starter) or pelleted feeds and water were offered ad libitum.

Body weights and feed consumption were recorded at day 10, 21, 32, 39 and 46. FCR data were corrected for mortality. At day 36 and 46, seven birds per pen were selected for carcass evaluation focussing especially on breast meat yield and abdominal fat accretion. Data were evaluated by ANOVA, and exponential regression. In the following, data for 32 day old broilers are presented since weights of about 2000 g seems to be representative of final weights in relevant regions. This also means, that birds received only the starter and grower diets.

**Results**

As shown in Fig. 1, feed intake nonlinearly increased with increasing dietary AA level. Reducing the dietary energy resulted in increased feed intake. The differences between the 95 and 90 %-energy treatments appears smaller than the differences between the 100 and 95 % energy treatments. The reason for this non-linear effect remains unclear but it could have been driven by energy metabolism (heat increment). At 70 % AA level a feed spillage (particularly at 100 % energy) has been observed and, thus, these intake data should be interpreted carefully.

![Figure 1: Effects of increasing dietary AA level at three dietary energy levels on feed intake (top) as well as on energy intake (bottom, left) and AA intake (bottom, right, Met+Cys taken as reference) in 1 to 32 day old male Ross 308 broilers](image)

Energy intake could be maintained in the 95% energy treatments compared to 100 % confirming the theory that broilers are able to eat according to a certain energy requirement (Fig. 1). However, further reducing dietary energy resulted in a consistent reduction of energy.
intake. In addition, an effect on AA intake particularly at 100% energy could be observed. So, dietary energy levels indirectly affected AA intake.

Weight gain responses suggested that birds performed equal if not better at reduced energy levels (Fig. 2) reflecting the effects on feed, energy, and AA intake, respectively. However, when plotting against AA intake (Met+Cys was taken as reference, Fig. 2) all the data points appear to be on only one dose-response curve. The exponential regression curve \( r^2=0.99 \) suggests that the response of the broilers in any treatment was determined by AA intake which in turn was driven by the dietary energy level and the corresponding feed intake. Thus, dietary energy had an indirect effect on growth but no direct effect. Furthermore, estimations indicated that in order to achieve the same performance as in the 100% energy treatments dietary AA levels should not be reduced to the same extent as the dietary energy. From this viewpoint data do not support the idea of a proportional AA reduction in low energy diets. This will exploit the genetic potential of the modern Ross 308 and will improve biological performance on relatively higher levels of balanced dietary protein. Economic analyses with local raw materials prices and income figures will determine what dietary protein level will maximise profitability.

![Figure 2: Responses of 32 days old male broilers to increasing dietary AA supply (for AA intake Met+Cys taken as reference) at three dietary energy levels on weight gain (top), feed conversion (bottom, left) and breast meat yield (bottom, right)](image)

Feed conversion decreased with increasing dietary AA levels, which is consistent with a number of studies investigating effects of increasing balanced protein levels. Data for the 70% AA levels were biased by feed spillage which was most pronounced at 100% energy.

Carcass evaluation data basically confirmed the findings in weight gain. Breast meat yield responded in a non-linear manner to increasing AA levels at any energy level whilst abdominal fat percentage decreased (data not shown). As for weight gain, there was a reasonable good fit of a regression curve through all data points when breast meat yield was related to the AA intake \( r^2=0.93 \). Generally, the data suggest that for optimum AA
utilisation for meat accretion, not only a high AA intake but also a relatively high AA to energy ratio is needed. Otherwise a surplus in dietary energy would be retained as body fat. Mortality ranged between 1.7 and 5.6%. Whilst the energy level had no systematic effect, mortality tended to increase with increasing dietary AA levels. Finally, it can be added, that the nature of the responses and the related effects of feed and AA intake on the discussed criteria were very similar in 46 days old birds.

References: