

## IMPACT OF A BALANCED AMINO ACID PROFILE ON BROILER PERFORMANCE

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**Summary.** Three trials have been conducted to evaluate the application of the concept of the "Ideal Protein" (IP) in broiler diets.

Two dose-response experiments with male broilers were conducted to study the effect of graded dietary amino acid (AA) levels on performance. The objective of the third experiment evaluated interactions between balanced dietary amino acid level and grow out period. According to the IP concept the ratios between the essential AA and lysine were identical in all diets within an experiment. Data revealed that current broiler breeds have a high performance potential which could be realised by optimising the AA supply of the birds. Even IP levels higher than 140% of current recommendation increased performance. However, especially amino acid supply during the early live showed the strongest impact on the performance in subsequent phases and therefore on final performance. Higher supply with balanced amino acids compared to current recommendation during the starter phase might be meaningful to ensure high performance and profitability.

**Keywords:** Broiler, Amino acid requirement, Ideal protein, dose-response trial

## SUBALANSUOTŲ AMINO RŪGŠČIŲ ĮTAKA BROILERIŲ PRODUKCIJOS GAMYBOJE

**Santrauka** „Idealo proteino (IP)“ broilerių racionuose koncepcijai įvertinti atlikti trys bandymai.

Du bandymai atlikti su broileriais gaidžiukais ir nustatytas tam tikrų papildomų dozių poveikis. Šių bandymų tikslas – ištirti ribojamųjų amino rūgščių įtaką broilerių augimui.

Trečiojo bandymo tikslas – patikrinti ryšį tarp subalansuotų amino rūgščių kiekio pašaruose ir augimo periodo. Laikantis IP koncepcijos, nepakeičiamųjų amino rūgščių ir lizino santykis visuose eksperimento racionuose buvo pastovus.

Eksperimento duomenys rodo, kad galima padidinti ir taip didelį dabartinių broilerių rūšių potencialą, optimizavus amino rūgščių kiekį paukščių racione. IP kiekį padidinus net iki 140 %, palyginti su dabar rekomenduojamu, broileriai augo geriau.

Didžiausią įtaką broilerių augimui (kartu ir visose vėlesnėse augimo fazėse) turėjo pradinėje broilerių augimo fazėje pateiktas amino rūgščių kiekis.

Didesnis negu dabar rekomenduojamas subalansuotų amino rūgščių kiekis pradinėje broilerių augimo fazėje (startinis) gali būti reikšmingas, siekiant geresnių augimo rezultatų ir didesnio pelno.

**Raktažodžiai:** broileris, amino rūgštys, amino rūgščių poreikis, idealusis proteinas, dozės veiksmingumo bandymas.

**Introduction.** Genetic potential of current broiler breeds has been improved considerably during recent years. Apart from weight gain and feed conversion ratio breeder companies focus more and more on breast meat yield. It is well known that these performance criteria - especially breast meat yield - respond sensitively to suboptimum amino acid supply. However, increasing performance potential likely leads to changes in nutrient and thus amino acid requirement. On the other hand the development of the "Ideal Protein" concept has been an important progress on the animal nutrition side. This concept suggests that the ratios between the essential amino acids and lysine (as reference amino acid) are almost not influenced while the quantitative amino acid requirement is affected by many factors. The aim of the present experiments was to examine the response of modern broiler types to increasing levels of dietary protein which is balanced according to the "Ideal Protein" concept. Two trials were conducted to study the effects of graded levels of an ideal protein on various performance criteria during one single grow out phase ( grower /

finisher) whereas a third experiment focused on the interactions of several grow out phases and "Ideal Protein" (IP) levels.

**First Experiment.** The first experiment was performed with 600 male Ross 208 broilers. After the period of 13 days where the birds received a commercial starter diet, broilers were assigned to five experimental treatments. Each treatment was repeated six times with 20 birds per replicate. Distribution of birds ensured a similar initial weight of 462 g/bird per treatment and followed a complete block design. Broilers were kept in cages. Temperature and ventilation were computer controlled and maintained optimal according to breeders recommendation. Five experimental diets were formulated containing graded levels of balanced protein. Thus, the ratios between apparent faecal digestible Met+Cys, Thr, Trp, Arg, Val, and Ile and Lys (100%) were 76 %, 63 %, 18 %, 111 %, 76 %, and 68 % in all experiments. In addition, the ratio between non-essential and essential amino acids was also maintained the same in all diets.

Table 1: Feed ingredients, nutrient and energy content of the experimental diets of Trials 1 and 2

Ingredients (%) IP-level	Experiment 1		Experiment 2	
	Low	High	Low	High
Corn	22.4	36.4	21.7	34.7
Wheat	6.5	10.4	6.9	11.0
Soybean meal	20.2	32.3	22.3	35.7
Meat meal	3.1	5.0	3.1	5.0
Fish meal	3.1	5.0	1.9	3.0
Animal fat	4.7	4.0	4.7	4.0
Soybean oil	2.0	1.5	2.0	1.5
L-Lys HCl	0.13	0.21	0.12	0.20
DL-Met	0.23	0.36	0.21	0.34
L-Thr	0.02	0.02		
Corn starch	24.8	-	23.5	-
Cellulose	4.9	1.3		
Polyethylene	3.2	0.8	7.7	0.4
Molasses			1.5	1.5
Minerals, sand, vitamins	4.7	2.7	4.4	2.7
<b>Energy and nutrient content (%)</b>				
AME <sub>n</sub>	12.9	12.9	12.9	12.9
Crude protein	17.4	26.8	18.0	27.5
Crude fat	8.9	9.1	9.6	9.4
Crude fibre	6.3	3.6	1.6	2.5
Ash	6.3	5.7	5.8	6.1
App. fecal dig. Lys*	0.91	1.44	0.90	1.43
App. fecal dig. Met	0.48	0.76	0.47	0.75
App. fecal dig. Met+Cys	0.69	1.08	0.68	1.07
App. fecal dig. Thr	0.57	0.91	0.57	0.90
App. fecal dig. Trp	0.19	0.26	0.16	0.26
App. fecal dig. Arg	1.01	1.59	1.00	1.58
App. fecal dig. Val	0.69	1.10	0.68	1.09
App. fecal dig. Ile	0.62	0.96	0.61	0.96

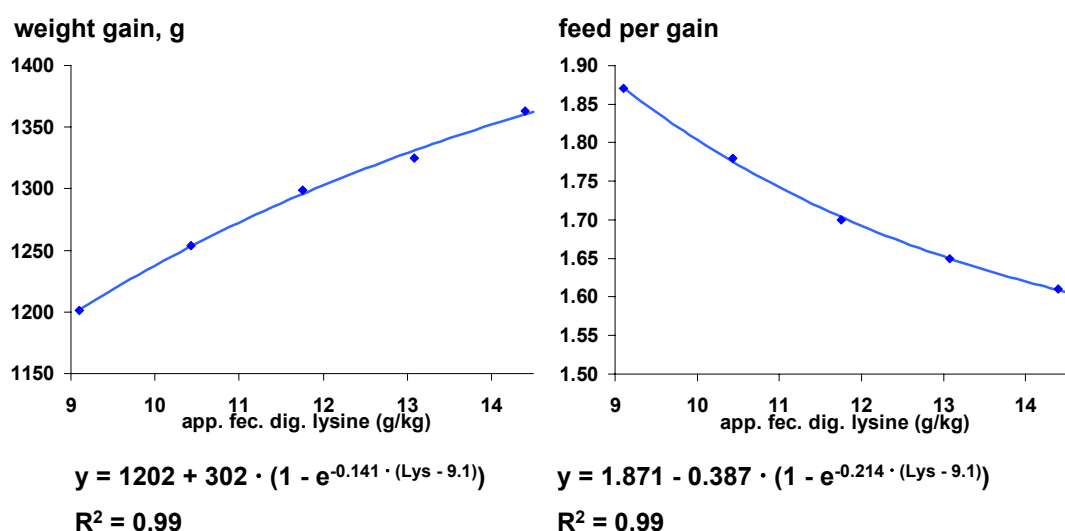


Figure 1: Effects of increasing amino acid levels which were balanced according to the "Ideal Protein" concept on weight gain and feed conversion in male broilers 14 to 34 days of age

The level of balanced protein was increased from 17.4% to 26.8% corresponding to 0.91% to 1.44% apparent faecal digestible Lysine. These level represented 93 % and 147 %, respectively, of the recommendation according to CVB (1998). Diet composition as well as

energy and nutrient contents are given in Table 1. Experimental diets were fed from day 14 to 34. Weight gain and feed conversion were determined for this period.

The results are shown in Figure 1. Weight gain increased almost linearly from 1201 g to 1363 g with

increasing IP levels. Feed conversion improved tremendously from 1.87 in birds fed the diet containing 0.91 % apparent faecal digestible lysine to 1.61 in birds which received the diets containing 1.44 % app. faec. dig. lysine. Prediction of the performance according to breeders recommendation would be 1410 g for weight gain and 1.70 for feed conversion for the same period of time. However, the response curves indicate that further improvements might be possible with even higher IP levels.

**Second Experiment.** In the second dose response experiment 720 male Ross 508 broilers were used. Experimental feeds were fed from day 28 to 41 whereas commercial diets were fed in the starter (day 1-14) and grower phase (day 15 -27). Each treatment was repeated

six times with 20 birds / cage. Average initial weight was 1284 g/bird at day 28, and again, birds were assigned to the treatments to ensure similar weight and variability between the treatments. Environmental conditions were identical to the previous trial. In this experiment 6 experimental diets were formulated according to the design of the first study. App. fae. dig. lysine and CP content was 0.90 % and 18.0 % in the low IP diet respectively, whereas in the high IP diets the respective contents were 1.43 % and 27.5 %. With respect to amino acid supply the low and high protein diet represented 92 and 146 % of the CVB recommendation. Apart from weight gain and feed conversion also breast meat yield was investigated.

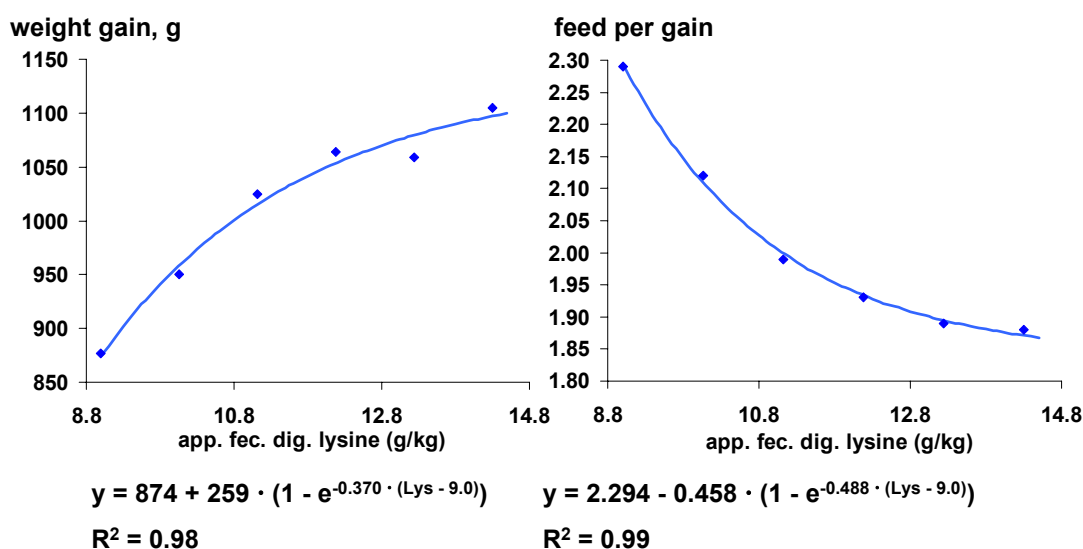


Figure 2: Effects of increasing levels of balanced amino acids on weight gain and feed conversion in male broilers 28 to 41 days of age

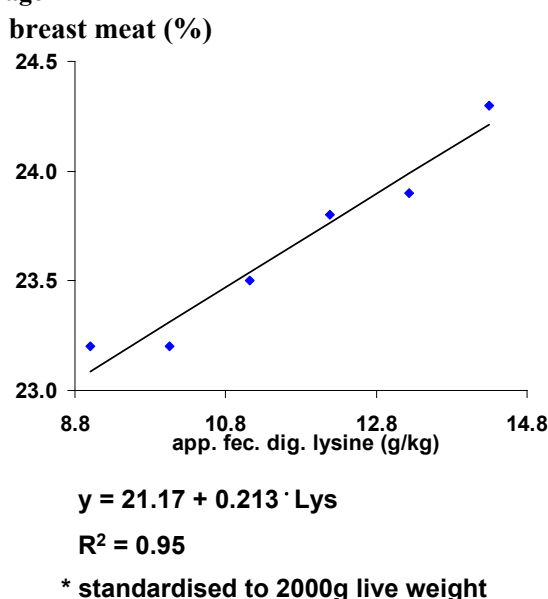


Figure 3: Effect of incremental levels of balanced amino acids on breast meat yield (% of carcass) fed to male broilers from day 28 to 41



Table 2: Diet composition, energy and nutrient content of the experimental feed of trial 3

EAA level, %	Starter phase		Grower phase		Finisher phase	
	100	120	100	120	90	110
Corn	37.5	45.2	30.7	37.1	32.6	40.1
Wheat	8.3	10.0	12.5	15.0	12.3	15.0
Corn starch	13.9	0.5	13.1	0.5	14.3	0.5
Soybean meal	23.2	27.8	24.7	29.6	24.7	30.2
Soy isolate	0.3	0.4	1.0	1.2	-	-
Potato protein	2.9	3.5	2.5	3.0	1.8	2.2
Fish meal	3.3	4.0	1.7	2.0	-	-
Soybean oil	1.5	1.5	3.0	3.0	3.1	3.1
Animal fat	2.0	2.0	4.0	4.0	4.0	4.0
L-Lysine HCl	0.16	0.19	0.16	0.20	0.18	0.22
DL-Methionine	0.23	0.28	0.24	0.28	0.20	0.25
L-Threonine	-	-	0.001	0.001	0.004	0.01
L-Arginine	0.12	0.14	0.09	0.11	0.06	0.08
Minerals, inert fillers	5.5	3.5	5.3	3.0	5.8	3.3
Standard premix *	1.0	1.0	1.0	1.0	1.0	1.0
<b>Energy and nutrient content</b>						
Crude protein*	20.8	24.5	20.4	24.2	18.0	21.8
Crude fat*	6.1	6.3	9.3	9.8	9.8	9.4
Crude fibre	3.1	2.6	3.3	2.6	3.4	2.7
kcal AME/kg	2850	2850	3000	3000	3000	3000
App. faec. dig. Lys	1.05	1.26	1.02	1.22	0.89	1.09
App. faec. dig. Met	0.53	0.64	0.51	0.61	0.41	0.53
App. faec. dig. M + C	0.79	0.95	0.76	0.92	0.67	0.82
App. faec. dig. Thr	0.66	0.80	0.64	0.77	0.56	0.69
App. faec. dig. Trp	0.22	0.26	0.22	0.26	0.19	0.23
App. fec. dig. Ile	0.75	0.90	0.73	0.88	0.64	0.79
App. fec. dig. Val	0.85	1.02	0.83	0.99	0.72	0.88
App. fec. dig. Arg	1.18	1.41	1.14	1.37	1.00	1.22

Both experiments show that current broiler breeds can realise a very high performance level provided the feed is optimised according the "Ideal Protein" concept. Both studies were performed at different age periods. Because of the different kind of response (almost linear vs. non-linear) question arose whether there are interactions between feeding varying levels of IP and the grow out phases. Therefore, a third experiment was conducted.

**Third Experiment.** A total of 1440 male one day old Ross 308 chicken were assigned to 12 treatments. Each treatment was replicated six times with 20 birds per cage. All cages had similar average weight of 40 g/chick. After allocation, the experimental starter diets were fed until 14 days of age. The grower diets were fed from day 15 to 30 and the finisher diets from day 31 to 37. Two starter and two grower diets were formulated containing 100 % (1.05 % and 1.02 % app. faec. dig. Lys, respectively) and 120 % of the lysine recommendation (CVB 1996). The finisher diets contained 90 %, 100 % (0.99 % app. faec. dig. Lys), and 110 % of the lysine recommendation. In this experiment the IP published by Mack et al. (1999)

was applied. Feed analyses verified that both the ratios between essential amino acids and Lys and the ratio between non-essential and essential amino acids were identical in the diets for the individual period. The 12 treatments represented all possible combinations of the different diets and the grow out phases from the lowest supply (starter: 100 %, grower: 100 %, finisher: 90 %) to the highest supply (starter: 120 %, grower: 120 %, finisher: 110 %). Weight gain, feed conversion, and breast meat yield was investigated.

Results are given in Figures 4 and 5. Birds generally performed well. Thus, broilers of the treatment 100-100-90 gained 2228 g, which is clearly above breeder's recommendation (2104 g). The respective feed conversion was 1.60 which was in line with breeders recommendation (1.62). However increased supply of amino acids over all grow out periods increased performance substantially. Thus, birds of treatment 120-120-110 achieved the highest weight gain (2327 g) and the lowest feed conversion (1.54). Performances of the other treatments were in between. Amino acid supply

during starter period had obviously the strongest impact on final weight. Birds fed the 100 %-starter diets and 120 %-grower diet did not achieve the performance level as observed for the opposite combination. The magnitude of the responses to increased dietary amino acid levels in the grower and finisher diet in birds fed the 100 % starter diets was more pronounced compared to that observed in birds of the 120 % starter diet treatments. This indicates compensatory growth, however, it was not possible to compensate the whole difference. Feed intake and feed conversion, respectively, was a function of dietary amino acid level. Thus, average feed per gain was higher in the 120 % starter - 100 % grower treatments compared to the 100 % starter - 120 % grower diet. Although numerically weight gain and feed conversion of the treatment 120 % - 120 % - 110 % were not achieved by any of the other treatments all treatments where the broilers received the 120 % starter diet performed similarly. With respect to the breast meat yield the same tendency has been observed. Breast meat yield increased with increasing amino acid levels and length of duration. Keeping in mind both that diet cost will increase substantially with increasing the amino acid profile and that birds eat only small amounts of feed during starter phase, the most preferable combination of those tested might be 120 % starter - 100 % grower - 100 % finisher from the economical point of view.

Apart from animal performance and economical considerations also ecological aspects should be considered. The IP concept is known to increase nitrogen utilisation if utilisation of nitrogen (N) deriving from an imbalanced protein is compared to that of balanced protein. The question arises what happens when different levels of balanced protein are compared. In the present study neither N-content of the birds nor N-content of excreta had been investigated. However, assuming an average N-content of 3.2% in weight gain, N-retention and utilisation can be estimated. Results are shown in Figure 5.

The data demonstrate that N-utilisation declines with increasing IP levels and length of feeding high IP levels. In contrast to weight gain, feed conversion, and breast meat yield data best N-utilisation was estimated for the 100 % starter - 100 % grower - 90 % finisher diet, whereas the lowest levels were found for the 120 % - 120 % - 110 % treatment. Moreover, the N-utilisation estimates show, that both grower and finisher phase had a strong impact on N-utilisation whereas the starter phase only slightly affected the overall effect. Thus, also from the ecological point of view the 120 % - 100 % - 100 % combination might be the most meaningful treatment of the tested ones.

**Conclusion.** In conclusion, the experimental data show that current broiler breeds have a high performance potential which can be realised by optimising the diets according to current knowledge. The "Ideal Protein" concept has been an important development in this respect. However, amino acid supply particularly during the early live affects final performance, and suboptimum provision can not be compensated in later phases.

Experimental results, therefore, indicate that it could be meaningful to increase the amino acid supply - if balanced to the IP concept - in male broilers during the starter phase where birds eat only small amounts of feed. Thus, good overall animal performance could be ensured and profitability could be improved. Regarding ecological aspects, N-utilisation might only slightly be affected.

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