Responses of growing male broilers to graded threonine levels at low and adequate balanced dietary protein

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Abstract

A dose-response trial where graded levels of dig. Thr at 17 % (low) and 20 % (adequate) balanced dietary protein were fed to 14-35 days old male broilers was conducted. Responses suggested that the dietary protein content has a strong impact on optimum dig. Thr level. It was thus recommended that protein levels and protein balance in a dose-response trial should meet bird's requirement in order to obtain an optimum dietary amino acid level. According to the data presented an optimum level of 0.78 % for dig. Thr was determined.

Introduction

Threonine is suggested to be the third limiting amino acid in broiler diets. However, it is also known that optimum dietary amino acid levels can be influenced by a number of factors of environmental, management, health related, genetic and nutritional nature. In this context an experiment with growing broilers was conducted in order to examine the dietary factor "balanced protein level" on optimum dietary Thr levels.

Material and Methods

A total of 1280 male 14 day old Ross 308 broilers with an average live weight of 409±28.1 g were equally allocated to 40 floor pens with 32 birds each. Four replicate pens were assigned to each of 10 dietary treatments in a 2 (balanced protein level) x 5 (dig. Thr level) factorial arrangement. The protein levels considered were low (17 %) and adequate (20 %) while dig. Thr:Lys ratios comprised a range from 54 % to 74 % at both protein levels.

Until day 14, birds were fed a commercial pelleted starter diet containing 21 % crude protein, 1.15 % dig. Lys, 0.84 % dig. Met+Cys, 0.76 % dig. Thr, and 13.2 MJ ME/kg.

The compositions of the experimental basal 17 % and 20 % balanced protein diets are given in Table 1. Aliquots of both diets were supplemented with L-Thr to achieve the dig. Thr:Lys ratios of 54, 59, 64, 69, and 74%. Within both balanced protein levels, the ratios of all dig. essential amino acids (except Thr) to dig. Lys were balanced according to the ideal protein concept. The desired amino acid profile in % of dig. Lys was: 74 (Met+Cys), 54-74 (Thr), 17 (Trp), 71 (Ile), 80 (Val), and 107 (Arg). Analyses of all diets for protein and amino acids consistently confirmed the expected values. Pelleted feed and water were available on *ad libitum* basis. Body weights and feed consumption were recorded from day 14 to 35. After termination of the experiment, 15 birds per treatment were selected for carcass evaluation. Data were analysed by ANOVA including multiple range test (LSD, $p<0.05$) and exponential regression analysis.

Results and Discussion

Weight gain was generally on a high level. Breeder's recommendations (Aviagen, 2002) indicate a weight gain of about 1580 g for the period from 14 to 35 days of age for male Ross 308 broilers which has been achieved or clearly exceeded by most of the treatments (Tab. 2). Average feed intake was relatively high resulting in a relatively high average feed conversion ratio. Mortality was low and only 0.86 % in this trial.

Statistics revealed significant effects for both dietary balanced protein level and dietary dig. Thr level or dig. Thr:dig. Lys ratio on all criteria but there were no significant interactions(Tab. 2). However, regarding weight gain there tended to be an interaction ($p = 0.06$) indicating the lower magnitude of the response at 20 % dietary protein which can be obtained by the equations and curves shown in Fig. 1. The latter suggested an asymptotic response of 261 g weight gain at 17 % dietary protein while it was only 125 g at 20 % balanced protein.

Table 1: Experimental basal diets with low and adequate balanced protein levels

Ingredients, % of diet	**low protein**	**adequate protein**	**Energy and nutrients (%)**	**low protein**	**adequate protein**
Wheat	44.0	44.0	Energy, MJ ME/kg	13.4	13.4
Corn	14.1	3.5	Energy, Kcal/kg	3200	3200
Soybean meal	10.9	19.8	Balanced protein	17.0	20.1
Peas	20.0	20.0			
Vegetable fat	6.9	8.7	TFD Lys*	0.92	1.09
L-Lys HCl	0.28	0.25	TFD Met+Cys	0.68	0.81
DL-Met	0.22	0.26	TFD Thr	0.49	0.59
L-Cysteine HCl	0.05	0.08	TFD Trp	0.16	0.20
L-Thr	0.02	-	TFD Ile	0.65	0.77
L-Isoleucine	0.07	0.05	TFD Val	0.74	0.88
L-Valine	0.10	0.10	TFD Arg	0.98	1.20
L-Arginine	0.03	0.02	Calcium, total	0.78	0.78
Vitamins, Minerals, etc.	3.33	3.24	Phosphorus, total	0.60	0.60

* TFD: true fecal digestible

Results confirmed the nutritional thesis that the maximum performance (asymptote) of a dose-response is defined by the next limiting factor; and that performance can be improved by increasing this next limiting factor. In the current experiment, performance at 17 % balanced protein was obviously limited by the essential amino acids since increasing the balanced protein level from 17 to 20 % shifted the curve to the right and to the top (Fig. 1). The curve at 20 % balanced protein began at asymptote level of the curve at 17 % protein (1612 g). This was similar for breast meat yield (Tab. 2).

Growth is mainly a function of nutrient intake which in turn is affected by feed intake. In Fig. 1, weight gain is plotted against dig. Thr intake. Taking 95 % of the asymptotic response as optimum, 17.72 g dig. Thr intake would be the optimum intake at 17 % balanced protein whilst it would be 24.30 g at adequate balanced protein level. Related to the average feed intake of 3018 and 2942 g in the 17 and 20 % protein treatments, the corresponding dietary dig. Thr levels would be 0.59 and 0.83 %. The 20 % protein response curve began at the asymptote level of the 17 % protein response curve indicating that the response at 17 % balanced protein was limited by other essential amino acids. This finding might suggest an overall response curve to dig. Thr intake including all treatments. A regression curve through all data points (except for those of treatment 4 and 5, as the performance was obviously limited) might therefore reveal a better estimate for optimum Thr intake as a wider range of Thr intake is covered and more data points describe the sensitive part of the response curve.

The r^2 of 0.97 suggested a good fit and the respective optimum dig. Thr intake at 95 % of asymptotic response was 23.30 g corresponding to 0.78 % dig. Thr in the diet (average feed intake: 2980 g). Responses on breast meat yield were of similar nature and regression through all data points except for those of treatments 4 and 5 revealed an optimum dig. Thr intake 23.34 g (0.78 % dig. Thr in the diet).

Table 2: Effects of graded dietary Thr levels at two protein levels on performance of 14 to 35 day old male broilers

Trt	Protein	Thr:Lys	Weight gain*	Feed intake*	Feed conversion	Breast meat
	%	%	g	g	kg/kg	% of carcass
1	17	54	1351 ± 99.7^{e}	2853 ± 47.5^{d}	2.124 ± 0.1992^{a}	32.0 ± 2.55^{d}
2	17	59	1577 ± 72.7^{d}	3078 ± 83,0^{a}	1.956 ± 0.1413^{b}	33.6 ± 2.00^{cd}
3	17	64	1606 ± 19.7^{cd}	3035 ± 115.7^{ab}	1.892 ± 0.0545^{bcd}	34.9 ± 2.24^{abc}
4	17	69	1609 ± 51.3^{ab}	3050 ± 54.9^{ab}	1.903 ± 0.0791^{bc}	35.6 ± 1.78^{ab}
5	17	74	1605 ± 52.1^{cd}	3074 ± 34.0^{a}	1.921 ± 0.0764^{b}	34.1 ± 1.93^{abc}
6	20	54	1623 ± 49.9^{bcd}	2861 ± 75.8^{d}	1.765 ± 0.0349^{cde}	33.9 ± 3.71^{bc}
7	20	59	1677 ± 85.1^{abc}	2924 ± 48.3^{cd}	1.748 ± 0.1088^{de}	35.8 ± 2.00^{a}
8	20	64	1712 ± 77.6^{ab}	2977 ± 73.4^{bc}	1.744 ± 0.0965^{e}	35.8 ± 2.22^{a}
9	20	69	1756 ± 52.6^{a}	2937 ± 51.1^{cd}	1.674 ± 0.0734^{e}	35.3 ± 3.41^{abc}
10	20	74	1723 ± 31.3^{a}	3012 ± 40.6^{abc}	1.750 ± 0.0200^{de}	35.5 ± 1.97^{ab}
CP**			< 0.001	0.001	< 0.001	0.003
Thr : Lys**			< 0.001	< 0.001	0.049	< 0.001
CP * Thr : Lys**			0.061	0.175	0.293	0.310

* Different superscripts (a-e) within a column indicate significant differences (LSD, $p<0.05$).
** Probability of error for main effects according to ANOVA analysis.

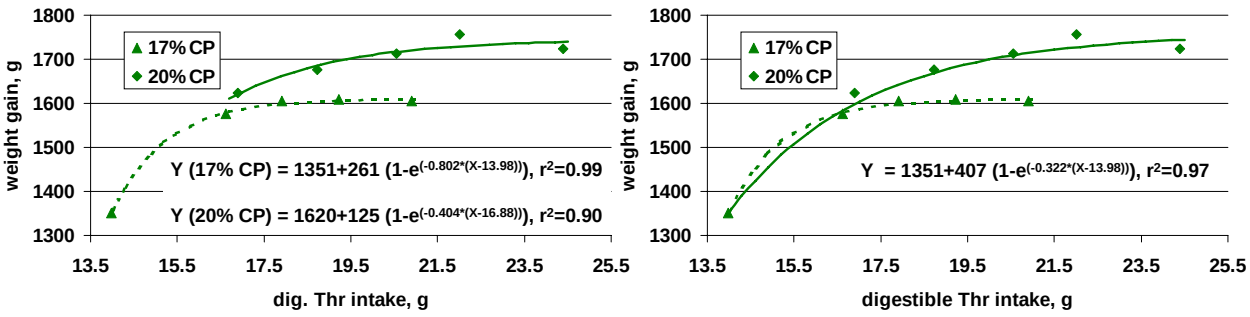

Figure 1: Weight gain responses of 14 to 35 days old male Ross 308 broilers to increasing dig. Thr intake analysed either for low and adequate dietary protein levels separately (left) or considering all data points except for treatment 4 and 5 (right).

It can be concluded, that the response in an amino acid dose response trial depends very much on the protein level and very likely also on the balance of the dietary protein (the latter not tested in this trial). So, trials conducted to derive recommendations for optimum dietary amino acid levels should cover the sensitive part of the response curve with as much as possible data points and should ensure that all nutrients other than that under test meet or exceed practical levels in order to avoid a limitation in performance.

References:

Aviagen (2002) Ross Broiler Management Manual. *Aviagen Ltd.*, Newbridge, Scotland.