

Protein and valine gain of broilers in response to supplemented L-valine

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Abstract

Dose-response relationships and precaecal digestibility were studied in 2 to 3 wk old broilers. Ten levels of valine were applied (5.6 to 15.3 g/kg diet), and each diet was allocated to 3 pens of 10 broilers each. Supplemented L-valine was completely digestible. Broilers nonlinearly responded to incremental valine supply in growth, protein gain, and valine gain. At marginal level of supply, supplemented valine was utilised with an efficiency of 69% for protein gain. Gained body protein contained 4.5 g valine/16 g of N. Based on protein gain, 8.1 g total valine/kg of diet were needed by broilers in this study.

Introduction

Valine (Val) is one of the essential amino acids (AAs). Good knowledge about the requirement is needed for diet formulation especially in cases when the first limiting AAs methionine, lysine, and threonine are supplemented in order to meet the requirements with low crude protein concentrations. Factorial approaches to estimate AA requirements and growth models depend on data for AA accretion, efficiency of AA utilisation, and AA maintenance requirement. Regarding Val, such data are rare in broiler chicken. Based on growth studies, a range in Val requirement of broilers from 7.4 to 9.0 g/kg becomes obvious (Farran and Thomas, 1990; Bae *et al.*, 1999; Mack *et al.*, 1999; Baker *et al.*, 2002; Corzo *et al.*, 2004). It was the objective of this dose-response study to determine the response of broilers to variable Val intake in growth, protein accretion, Val accretion, and efficiency of Val utilisation. Precaecal (pc) Val digestibility was studied as well.

Materials and Methods

A low-Val basal diet was used. It was based on peas, corn gluten, and corn, and it was supplemented with free essential and non-essential AAs in order to achieve a level for all AAs that was about 10% in excess the recommendations (GfE 1999), except valine. The analysed concentrations of CP and Val were 195 and 5.6 g/kg. In 9 other diets, Val concentration was gradually increased by L-valine supplementation. Analysed concentrations were (in g/kg diet): 5.6, 5.9, 6.3, 6.8, 7.8, 8.8, 10.7, 11.4, 13.5, and 15.3. Diets were pelleted. Two other diets containing TiO₂ were prepared on the basis of the basal diet and the diet containing 13.5 g Val/kg to study pc digestibility.

Male „Ross” broiler chickens were fed the diets *ad libitum* from d 8 of age. Three hundred chickens were housed in groups of ten in 30 floor pens. Another 6 groups of 10 representative chicks were used for baseline body composition measurements. Three pens were allocated at random to each of the 10 diets, and the experiment lasted for 14 days. At the end of the trial, all chickens were subjected to whole-body chemical analyses as described by Fatufe *et al.* (2004). Other groups of 10 birds were fed the 2 TiO₂-containing diets (4 per diet) from d 13 posthatch onwards *ad libitum*. After 8 d on the test feeds, birds were asphyxiated with carbon dioxide. The intestine between Meckel's diverticulum and 2 cm anterior the ileo-caecocolonic junction was sampled for pc digestibility measurements (Rodehutscord *et al.*, 2004). Amino acid analysis followed standard procedures using an AA analyser and ninhydrin after an oxidation step and hydrolysis as specified by Timmler and Rodehutscord (2003). TiO₂ in the diets and digesta was determined photometrically (Brandt and Allam, 1987). Accretions of protein and Val were calculated as difference between the amount in the body on d 21 (g/bird) minus the average amount determined in the blank groups on d 8 (g/bird). Nonlinear

responses to incremental Val intake were described using a 4-parameter sigmoidal model (Gahl *et al.*, 1994).

Results and Discussion

The pc digestibility of individual AAs was not significantly different between the diets containing 5.6 and 13.5 g Val/kg, except valine. Digestibility of Val from the basal diet was 46%, whereas it was 78% in the diet containing 13.5 g Val/kg. The supplemented Val was completely digestible, which confirms earlier results (Chung and Baker, 1992). The dietary Val concentration significantly affected BW gain, feed conversion, and accretion of protein and Val. Results of the parameter estimate are summarised in Table 1. BW gain increased nonlinearly from 162 g in birds that were fed the basal diet to an asymptotic y_{max} of 584 g/bird (Figure 1). The concentration of protein in gained BW was not significantly affected by Val intake and was, on average, 166 g/kg. The Val content in gained body protein increased with increasing dietary Val concentration (Figure 2). The y_{max} for Val in gained body protein was 4.45 g/16 g N, and 95% of this plateau were achieved with 6.3 g Val/kg diet.

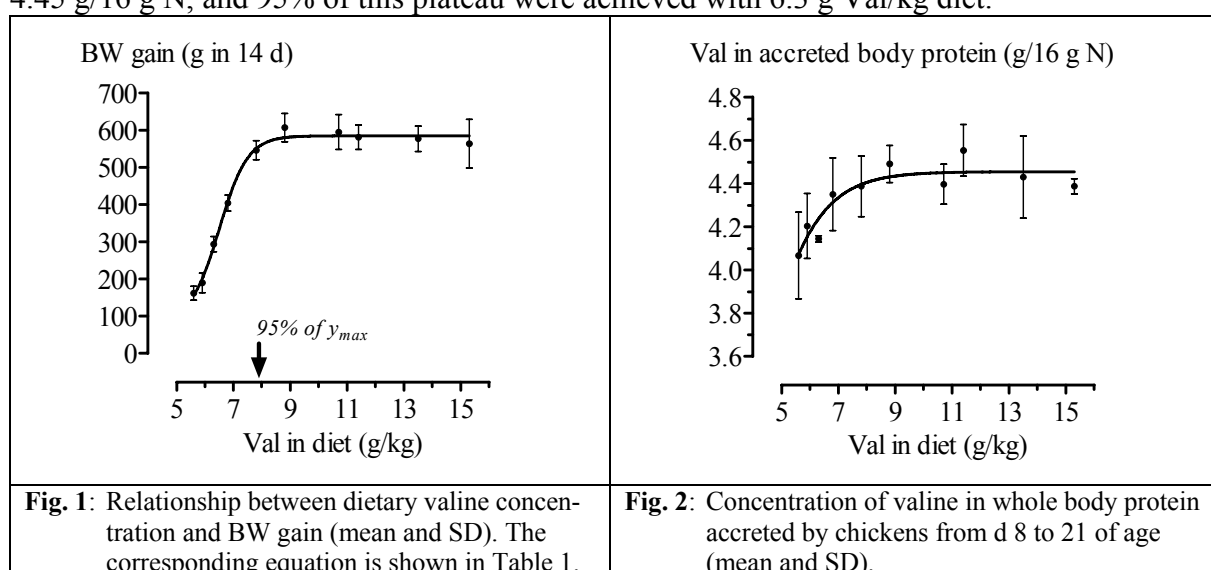


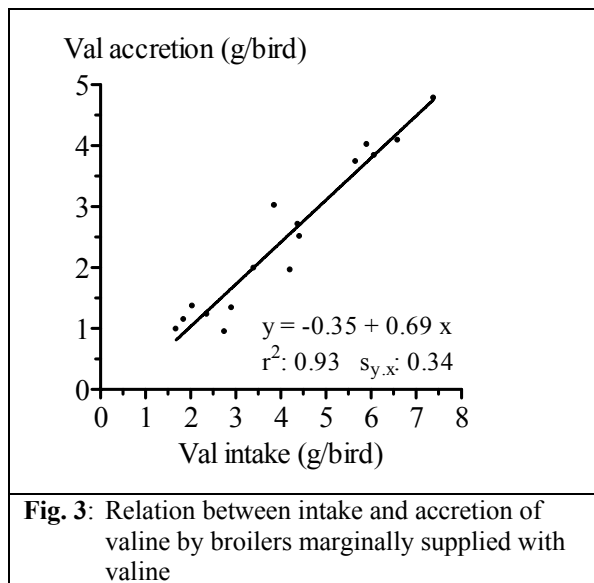
Table 1: Parameter estimates for the sigmoidal equation¹ fitted to responses of chickens achieved between 8 and 21 d depending on dietary valine concentration

	Estimated parameter				r^2	$S_{y,x}$	x at 95% of y_{max}
	y_{max}	b	c	k			
BW gain (g)	584.3	98.40	$1.353e^6$	2.161	0.97	33.9	7.9
Feed consumption (g)	797.1	97.76	$2.195e^5$	1.653	0.88	67.9	7.8
BW gain/feed (g/g)	0.735	0.481	$7.322e^{10}$	3.796	0.80	0.06	7.1
Protein accretion (g)	96.84	25.48	$7.105e^6$	2.323	0.94	7.58	8.1
Valine accretion (g)	4.305	1.007	$4.788e^6$	2.261	0.94	0.34	8.0

¹ The following equation was employed (Gahl *et al.*, 1994): $y = y_{max} + [b \times (1 + c) - y_{max}] e^{-kx} / (1 + c \times e^{-kx})$

One can consider the Val concentration needed to achieve 95% of y_{max} as a measure for the requirement under these specific conditions. According to Table 1, the values ranged between 7.1 and 8.1 g/kg, depending on the chosen response criterion. The highest Val concentration was required for protein accretion, and this value is slightly lower than the requirement given by (GfE, 1999) and (NRC, 1994). This difference may be due to the high proportion of completely digestible free valine in the diets of this experiment, which is not relevant in

practical-type diets. When calculated for the marginal range in Val supply on the basis of regression analysis, the efficiency of utilisation of Val for Val accretion was 69% (Fig. 3).



Conclusions

Free L-valine is completely digestible in broiler chicken, and the efficiency of utilisation for protein gain is about 70% at marginal level of supply. The Val content in gained body protein of 2 to 3 wk old broilers is 4.5 g/16 g N. Broilers nonlinearly respond, in protein gain, to increments in limiting Val supply. Current recommendations of GfE (1999) and NRC (1994) for 2 to 3 wk old broilers are confirmed under consideration of the high digestibility of the Val source used herein.

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