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Lysine requirement for maintenance in growing pigs ☆

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Abstract

Probably due to methodological problems the knowledge about the AA requirement for maintenance in pigs is rather scarce. In the present study an alternative experimental approach was applied and its underlying hypothesis was tested, whether protein retention decreases with body weight (BW), when daily lysine intake remains constant and acts as the limiting factor for protein retention, and whether this decrease reflects the increasing requirement of lysine for maintenance. If this hypothesis can be confirmed, lysine requirement for maintenance can be calculated when assuming a certain value for lysine concentration in body protein, since marginal efficiency of dietary lysine utilisation for protein retention is not affected by its level of intake (when being below the level necessary for maximum response), BW, protein retention capacity of the animal nor by energy intake. A series of N balances experiments using twelve castrated male pigs were performed at approximately 35, 55, 80, 110, and 140 kg of BW and body composition was determined by the D_2O dilution technique. Two lysine intake levels were tested to prove that the animals on the lower level respond to additional lysine and, therefore, have received a lysine-limiting diet, the prerequisite for the alternative. Based on the extent of the decrease in protein retention with BW the following estimates for the maintenance lysine requirement were derived: 18 mg/kg BW, 71 mg/kg $BW^{0.75}$, 29 mg/kg fat free substance, and 121 mg/kg body protein. These estimates are higher than values reported in the literature, which might be caused by methodological differences or by the higher feed intake of the animals in the present study.

Keywords: Growing pigs; Lysine; Maintenance requirement

1. Introduction

Lysine requirement for maintenance is a relatively small, however significant fraction (0.05–0.1) of the total lysine requirement of intensively growing pigs. Probably due to methodological problems, precise knowledge about the factors affecting the lysine requirement for maintenance in pigs is rather scarce which makes it difficult to precisely determine the total lysine requirement. Roth et al. (2003) investigated the maintenance requirement for essential AA (i.e. AA intake level at N equilibrium) in adult sows where the requirement was determined as the *x*-intercept of the linear regression equation between N retention and AA intake. This approach requires an experimental feeding strategy close to the expected values for maintenance, consequently implying a strong reduction of nutrient intake in growing pigs. Therefore, the question arises, whether those values can be applied to the intensively fed animal. The approach used in experiments undertaken by Fuller et al. (1989) for growing pigs is to

☆ Dedicated to Professor Dr. Dr. h.c. Karl-Heinz Menke on his eightieth birthday.

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measure the response of protein retention to different AA intake levels. The coefficients of the linear regression equations reflect the dietary AA requirement for retention of 1 g body protein, whereas the daily amount of the respective AA needed to maintain N equilibrium is determined by extrapolating to the *x*-intercept. Although estimates of the latter approach are derived from animals in a physiologically normal nutritional situation, the relatively far extrapolation to N equilibrium reduces the accuracy of the estimate. In the present study evaluated an alternative to determine the lysine requirement for maintenance in the growing pig which is based on the constant marginal efficiency of lysine utilization for protein retention when lysine intake is below the level necessary for maximum response (Susenbeth, 1995). In this approach a lysine-limiting diet is provided to the animals and the decrease in protein retention with ascending BW reflects the increasing requirement of lysine for maintenance when the same amount of lysine is ingested independent of BW. The prerequisites of this approach are that (i) lysine intake is below the required level to meet animals' protein retention capacity and (ii) the ratios of other essential AA to lysine are distinctly higher than the respective critical values of the Ideal Protein (Wang and Fuller, 1989). A further aim of the study was to examine whether fat free substance (FFS) or body protein (BP) which probably can be seen as metabolic more active compartments are more closely related to the maintenance requirement for lysine than BW or metabolic BW ($BW^{0.75}$). Since highly digestible protein and AA sources were used for formulating semi-synthetic diets in many studies reported in the literature, values received for the requirement for total (as present in the diet) AA may be very similar to the amount of ileal digestible AA. Probable consequences when comparing values with those derived from diets consisting of commercial feedstuffs will be discussed later in more detail.

Table 1
Components (g/kg; as-fed basis) and chemical composition (g/kg DM) of the basal diet

Ingredients	
Barley	365
Wheat	365
Wheat gluten	120
Soybean meal, 45% CP	100
Soybean oil	20
Vitamin mineral premix [a]	30
Analyzed components	
DM	917
CP (N × 6.25)	235
Crude fiber	41
Crude fat	6
Crude ash	36

[a] Provided the following amounts per kg of the diets: vitamin A, 15,000 I.U.; vitamin D, 1800 I.U.; vitamin E, 120 mg; vitamin K, 3 mg; thiamin 1.5 mg; riboflavin, 6 mg; vitamin B_6, 3 mg; vitamin B_{12}, 0.03 mg; niacin, 15 mg; pantothenic acid, 6 mg; choline cloride, 150 mg; Co 1 mg; Cu 30 mg; Fe 190 mg; I 2.2 mg; Mn 50 mg; Se 0.45 mg; Zn 100 mg; Ca 8.8 g; Na 1.5 g; P 0.3 g; phytase, 750 FTU; methionine 0.2 g.

Table 2
Concentration of essential amino acids in protein [a]

Amino acid		g/16 g N	Relative to lysine (%)	
Level of lysine supplementation	0	4.26	100	
	+	5.00		100
Methionine		1.57	37	31
Cystine [b]		1.71	40	34
Threonine		3.01	71	60
Tryptophan		1.16	27	23
Isoleucine		3.80	89	76
Leucine		6.94	163	139
Valine		4.12	97	82
Tyrosine [b]		3.06	72	61
Phenylalanine		5.46	128	109
Histidine		2.73	64	55

[a] analysed values.
[b] conditionally non-essential.

2. Materials and methods

2.1. Animals

Twelve castrated male pigs (PIC Germany) were bought from a commercial farm and utilized for the experiment from 23 to 147 kg of BW.

2.2. Diets and feeding

All animals received 1.3 kg/d of a basal pelleted diet throughout the whole growing period (feed components and composition are given in Table 1). They were allotted to two treatments of a constant medium (11.5 g/d) or high-lysine intake (13.5 g/d) according to BW to reach similar mean BW for both experimental groups. The high-lysine intake level has been reached by adding free lysine to the diet. Concentrations of essential AA in protein and the ratios to lysine are given in Table 2. Two equal meals were provided at 0730 and 1730. Pigs were weighed weekly and feed allowances were also weekly adjusted for the respective groups according to BW to meet the increasing demand for energy with BW. Therefore, to maintain constant intake levels of protein and AA, appropriate amounts of wheat starch as a protein free component were fed separately from the remainder of the diet to meet an energy intake level of 1.3 MJ ME/kg $BW^{0.75}$. A lysine-free mineral–vitamin-premix (for the supply of nutrients to the diet see Table 1) was also added separately to ensure a proportion of 30 g/kg of the total diet.