TSAA Requirements for Nursery and Growing Pigs

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▪ Introduction

The use of synthetic amino acids in swine nursery and growing diets is a common practice implemented throughout the world. The majority of the research to date has focused on the use of synthetic lysine. Researchers have spent considerable time and money determining the lysine requirement and the maximum amount of synthetic lysine that can be fed in a practical pig diet.

With the present knowledge of lysine requirements, drastic variations in ingredient costs, and environmental pressures to lower crude protein, it has become increasingly more important to know the requirements for the next limiting amino acids. Methionine, threonine, and tryptophan are available in synthetic forms. These amino acids are also considered to be the next limiting amino acids in swine nursery and grower diets. A better understanding of the pigs' requirements for each of these amino acids will result in lower feed costs, improved diet formulations, and a reduction in nitrogen excretion.

The focus of this paper will be on the methionine or total sulfur amino acid requirements of nursery and growing pigs. Obviously, one cannot discuss methionine requirements without including a discussion on the other sulfur amino acid, cystine. Therefore, for the purposes of this discussion, methionine and cystine will be referenced together as the sulfur amino acids (SAA).

▪ Literature Review

Southern et al., 2004 recently undertook the difficult task of reviewing all the literature that has been published examining the SAA requirements of nursery and growing pigs. Like most projects of this type, many assumptions and considerations had to be made when selecting appropriate papers for inclusion. The specific assumptions were first, if a diet was fed to the same animal over different periods, only data from the first period was used. This was done to prevent biasing the data by including numerous data points from one trial. Secondly, only data where there was a response over the basal diet were included. Thirdly, a wide variety of methods were applied to determine the actual requirement including the authors' conclusions, quadratic and linear models. Finally, the ileal digestibility had to be calculated when not explicitly published by the author. This was done using NRC 1998 values.

Table 1. The citation, body weight range, average daily gain (ADG), feed efficiency (G:F), and sulfur amino acid requirements in terms of total percent, digestible percent, and mg per g of ADG for each paper selected from the literature.

	Body Weight, kg		Performance		SAA Requirement		
Citation	Initial	Final	ADG, g	GF	Total, %	Dig, %	Dig mg/g ADG
Schutte, et al., 1991 (Exp. 1)	13	38	440	0.43	0.65	0.52	11.94
Schutte, et al., 1991 (Exp. 2)	14	38	642	0.52	0.64	0.58	10.93
Leibholz, 1984	21	35	505	0.37	0.41	0.35	9.36
Kirchgessner et al., 1994	20	60	666	0.44	0.56	0.48	11.03
Kirchgessner et al., 1994	20	60	699	0.47	0.52	0.44	9.44
Roth and Kirchgessner, 1987	31	60	757	0.44	0.53	0.46	10.33
Lenis et al., 1990 (Boars)	35	65	835	0.42	0.57	0.46	10.96
Lenis et al., 1990 (Gilts)	35	60	847	0.41	0.54	0.43	10.51
Chung et al., 1989	53	75	990	0.36	0.66	0.40	11.03
Roth et al., 2000 (Lys = .62)	53	105	750	0.32	0.35	0.27	8.68
Roth et al., 2000 (Lys = .70)	53	105	837	0.34	0.41	0.34	9.91
Roth et al., 2000 (Lys = .78)	53	105	865	0.35	0.45	0.36	10.40
Loughmiller et al., 1998 (Exp 1)	54	108	890	0.26	0.44	0.39	13.37
Loughmiller et al., 1998 (Exp 3)	72	102	880	0.36	0.26	0.25	6.85
Knowles et al., 1998	74	110	780	0.21	0.29	0.26	11.07

The selected papers are shown in **Table 1**. There was a considerable amount of variation regarding breed, sex, diet and trial design used. It is important to note that many of the trials used individual animals as replicates while others used very few pigs per pen (2 to 10). Certainly, none of the trials used typical industry type settings.

Table 1 shows the body weight range, average daily gain (ADG), feed efficiency in terms of gain to feed (G:F), and the sulfur amino acid requirement needed to obtain maximum performance. The SAA requirement is represented in terms of percent total, percent digestible, and milligrams per gram of ADG. These values were determined using the variety of models and assumptions detailed above. Representing the data in terms of mg of digestible SAA per g ADG allows for easier comparisons across trials and is not dependent on whether or not the trial was a ratio or requirement study.

Results indicated that the requirement for mg dig. SAA / g ADG was fairly constant across most trials. Thirteen of the 15 trials indicated that the requirement for optimum performance was between 8.7 and 11.9 mg/g ADG. On average pigs required 10.4 mg of digestible SAA per g of ADG. Kerr et al., 2002 employed the same methodology to determine the lysine requirement. They concluded performance was optimized with 17.9 mg digestible lysine per gram gain. In practice, many people support lysine requirements as high as 18.7 mg especially for the leaner, fast growing genetic lines. In terms of ratios, these data would imply a SAA:Lys ratio between 56 and 58% depending on the lysine requirement. When evaluating these results, it is important to note that these trials cover a time period of 20 years, utilize a variety of ingredient and genetic types, and have a small number of replications.

▪ Recent Research

A large amount of work relating to TSAA requirements in pigs has been published by the University of Missouri over the past two years. These data have been collected on leaner type genetics (PIC and Génétiporc) utilizing typical corn and soybean diets. In addition, the trials have been performed in commercial type settings where there are 20 pigs per pen. From these trials, the authors have concluded that gain and feed efficiency are maximized with a SAA:Lys ratio between 60 and 62.

Table 2 displays a summary of this recent research in a format similar that presented for the literature review. This table shows the body weights, performance parameters, and the sulfur amino acid requirement estimated to give maximum performance. Total amino acid numbers are not indicated because in all these trials, diets were formulated on a true ileal digestible amino acid basis.

Table 2. The citation, body weight range, average daily gain (ADG), feed efficiency (G:F), and sulfur amino acid requirements in terms of percent digestible, digestible grams per day and mg per g of ADG for the recent research from the University of Missouri.

	Body Weight, kg		Performance		SAA Requirement		
Citation	**Initial**	**Final**	**ADG, g**	**GF**	**Dig, %**	**Dig, g/d**	**mg/g ADG**
Gaines et al., 2004a	7	17	481	0.74	0.82	5.33	11.08
Gaines et al., 2004a	8	20	522	0.74	0.80	5.64	10.81
Gaines et al., 2004d	11	27	509	0.68	0.71	5.31	10.44
Gaines et al., 2004b	13	25	617	0.68	0.77	6.99	11.32
Gaines et al., 2004d	13	26	650	0.69	0.79	7.44	11.45
Gaines et al., 2004c	29	45	953	0.48	0.54	10.72	11.25
Gaines et al., 2004d	45	68	1089	0.43	0.51	12.91	11.85

From Table 2, it appears as though the ADG is similar to that presented in Table 1; however there is a 20 to 30% difference in feed efficiency between the two datasets. It is evident that feed efficiency observed in the recent trials is better than that observed in the trials from the literature review and this is especially true for the lighter weight pigs.

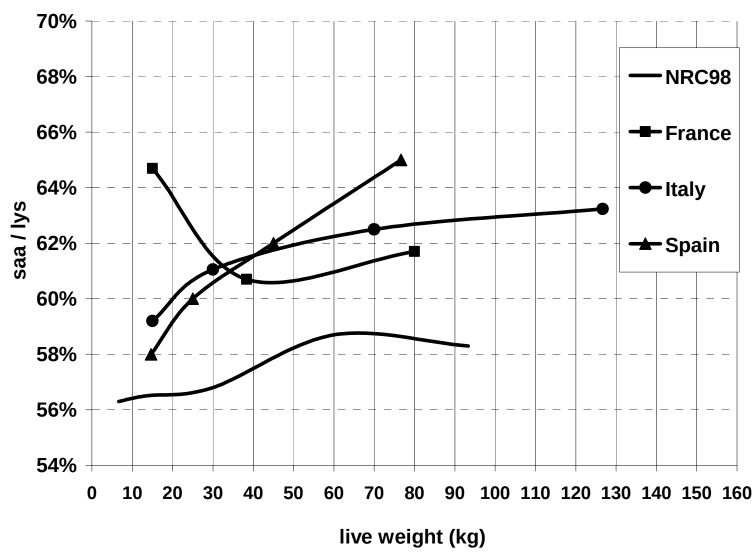
The estimated SAA requirement that optimizes performance for each trial is given in the last column of Table 2. These values are well within the range of values observed in Table 1. On average the estimated digestible SAA requirement was 11.2 mg/g ADG which is approximately 8% higher than that estimated using the literature review. The increase in requirement between the recent data and literature review could be due to differences in estimating requirements in a commercial setting versus on an individual pig basis. However, it is more likely that these differences are the result of improved genetic selection for higher rates of protein deposition.

If the estimated requirement for SAA of 11.2 mg / g ADG is related to the lysine estimate of 17.9 or 18.7 mg / g ADG then the optimal ratio of SAA:Lys would be between 60 and 63%. Gaines et al, 2004d concluded that the optimal TID SAA:Lys ratio was between 59 and 62%.

▪ Worldwide Perspective

A recent survey done by Novus International in Europe concluded that energy and lysine levels fed in the United States for nursery and growing pigs were considerably higher than those fed in Europe. However, the ratio of sulfur amino acids to lysine appeared to be very similar. **Figure 1** displays a summary of SAA:Lys ratios from three European countries as well as the recommendations from NRC, 1998. From this graph, it appears that the SAA:Lys ratio utilized in these countries is between 58 and 65. All ratios are well above the requirement from NRC, 1998, but appear include the estimates given above.

Figure 1. Body weight versus the sulfur amino acid to lysine ratio used in France, Italy, and Spain. As a reference, the NRC, 1998 is also graphed.



▪ Conclusions

Based on the results from the literature survey, it appears that historically nursery and growing pigs required approximately 10.4 mg of digestible sulfur amino acids per gram of body weight gain. However, more recent data suggest that this requirement has increased to approximately 11.2 mg / g ADG.

In terms of the SAA:Lys ratios, the range from historical, recent, and worldwide data appears to be between 56 and 65%. The most recent data and industry practice suggests ratios between 60 to 62%. Further investigation should be initiated to determine how genetics, environment, ingredient type, and other factors influence this ratio.

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