TSAA requirements for nursery and growing pigs

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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 article is on the methionine or total sulphur amino acid (TSAA) requirements of nursery and growing pigs.

Obviously, one cannot discuss methionine requirements without including a discussion on the other sulphur amino acid, cystine. Therefore, for the purposes of this discussion, methionine and cystine will be referenced together as the sulphur amino acids.

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 98 values. The selected papers are shown in Table 1 along with a brief summary of each trial in terms of lysine level, sex, number of pigs, and replicates used.

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 (2-10). It is also evident from this table that there was an enormous range in the lysine levels used.

Table 2 shows the body weight range, average daily gain (ADG), feed efficiency in terms of gain to feed (G:F), and the sulphur 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. Some 13 of the 15 trials indicated that the requirement for optimum performance was between 8.7 and 11.9mg/g ADG.

On average pigs required 10.4mg of digestible SAA per g of ADG. Kerr et al., 2002, employed the same methodology to determine the lysine requirement.

They concluded performance was optimised with 17.9mg digestible lysine per gram gain. In practice, many people support lysine requirements as high as 18.7mg 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

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Publication	Lysine level Total	Lysine level Digestible	Sex	Pigs per pen	Replicates per treatment
Schutte et al., 1991	1.1	0.85	Gilts and barrows	10	4
Leibholz, 1984	0.84	0.73	Barrows	5	2
Kirchgessner et al., 1994	0.94	0.8	Gilts and barrows	1	12
Roth and Kirchgessner, 1987	1.02	0.87	Gilts and barrows	1	12
Lenis et al., 1990	0.88	0.73	Gilts and boars	1	8
Chung et al., 1989	0.8	0.7	Barrows	1	6
Roth et al., 2000	0.62, 0.70, 0.78	0.48, 0.56,0 .64	Gilts and barrows	1	12
Loughmiller et al., 1998	0.56,0 .70	0.50, 0.56	Gilts	3	4
Knowles et al., 1998	0.65	0.62	Gilts	2	8

Table 1. The publication reference, lysine level, sex, number of pigs per pen, and number of replicates per treatment for each paper selected from the literature.

Table 2. The reference, body weight range, average daily gain (ADG), feed efficiency (G:F), and sulphur amino acid requirements in terms of total percent, digestible percent and mg per g of ADG for each paper selected from the literature.

Reference	Body weight (kg) Initial	Body weight (kg) Final	Performance ADG (g)	Performance GF	SAA requirement Total (%)	SAA requirement Dig (%)	SAA requirement 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	10.5
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

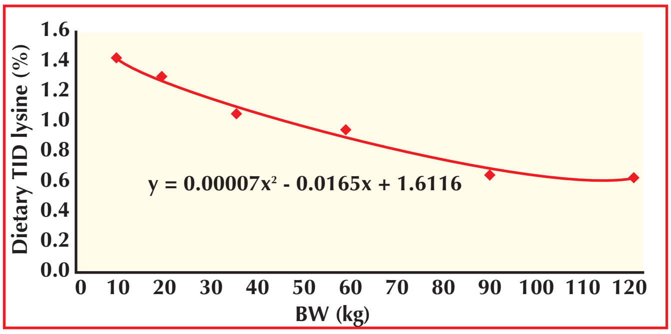

Fig. 1. Lysine requirement for lean genetics estimated at the University of Missouri. (Source: Dr Gary Allee and Dr James Usry, research data of University of Missouri-Columbia and Ajinomoto Heartland LLC).

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trials cover a time period of 20 years, utilise a variety of ingredient and genetic types, and have a small number of replications.

Recent research

A large amount of work relating to SAA 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 Genetiporc) utilising typical corn and soybean diets in a commercial type setting where there are 20 pigs per pen. In addition, the lysine requirements for these facilities are known and in some cases were estimated at the exact same time as the TSAA requirements.

Fig. 1 displays the lysine requirement chart generated at these facilities. Table 2 displays a summary of this recent research in a format similar to that presented for the literature review. This table shows the body weights, performance parameters, and the sulphur 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.

From Table 2, it appears as though the ADG is similar to that presented in Table 1; however there is a 20-30% 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 optimises 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 11.2mg/g ADG which is approximately 8% higher than that estimated using the literature review.

If the estimated requirement for SAA of 11.2mg/g ADG is related to the lysine estimate of 17.9 or 18.7mg/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%.

The increase in requirements between the recent data and literature review could be due to a variety of reasons. The most obvious is that the genetics of the animals are changing over time.

This argument makes sense when we discuss absolute requirements; however, it does not appear to explain why the ratio would change or why there is a higher requirement of digestible SAA per g of ADG.

Another more plausible explanation may be due to the fact that the estimates from the literature were done using a small number of pigs, while the recent work was done using larger groups of pigs.

In fact, if the literature data is divided into trials with single pigs versus trials with multiple pigs, the average requirement for individually penned pigs is 10.2mg per g ADG versus 10.7mg per g ADG for group housed pigs.

It is also important to compare the lysine values of the literature data to the current known requirements.

In most of the trials from the literature, the authors stated that the diets were below requirement.

However, examination of the levels (Table 1) shows that these diets were formulated to digestible lysine levels of 0.48- 0.87.

These values are drastically lower than the requirement values determined at the University of Missouri which indicate TID lysine requirements of 1.2-1.4 for nursery pigs, 0.8-1.0 for growing pigs, and 0.6 for finishing pigs.

It is possible that when diets are formulated significantly below the lysine requirement, the estimates for the SAA requirements are underestimated.

Table 3. The reference, body weight range, average daily gain (ADG), feed efficiency (G:F), and sulphur 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.

Reference	Body weight (kg) Initial	Final	Performance ADG (g)	GF	SAA requirement Total (%)	Dig (%)	Dig (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

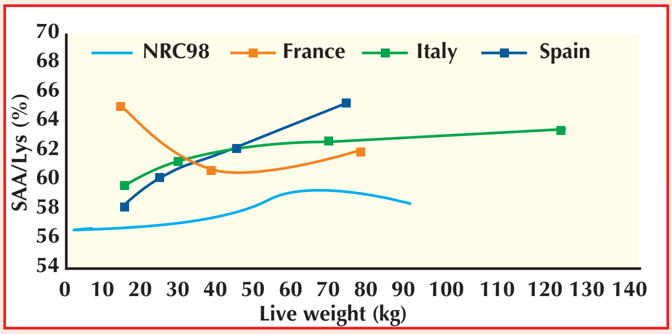
Worldwide perspective

A recent survey done by Novus International Inc's European subsidiary (Dr Pierre Buttin, Novus Europe NV/SA) 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 sulphur amino acids to lysine appeared to be very similar. Fig. 2 displays a summary of SAA:Lys ratios from three European countries as well as the recommendations from NRC 98.

From Fig. 2 it appears that the SAA:Lys ratio utilised in these countries is between 58 and 65. All ratios are well above the requirement from NRC 98, but appear to include the estimates given above.

Fig. 2. Body weight versus the sulphur amino acid to lysine ratio used in France, Italy, and Spain. As a reference, the NRC 98 is also graphed.



Conclusions

Based on the results from the literature survey, it appears that historically nursery and growing pigs required approximately 10.4mg of digestible sulphur amino acids per gram of body weight gain.

However, more recent data suggest that this requirement has increased to 11.2mg/g ADG approximately.

Further examination of the literature data suggests that perhaps the values were underestimated due to the fact individuals or very small groups of pigs were used and lysine levels appear to be well below requirement.

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 60-62%.

Further investigation should be initiated to determine exactly how genetics, environment, ingredient type, lysine levels, pig numbers and other factors influence the SAA:Lys ratio. ■

References are available from the author on request.