The right amount of amino acids is key for formulating low CP diets

There is currently a trend for stricter regulations to reduce nitrogen (N) pollution resulting from intensive livestock production. Examples include the new fertiliser ordinance in Germany in 2017, and the maximum dietary crude protein (CP) standards of the China Feed Industry Association in 2018. One of the most effective ways to solve this problem is to lower the dietary CP level, while balancing with crystalline amino acids in the diets.

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Increased availability of crystalline AA such as Lys, Met, Thr, Trp, Val and Ile coupled with their decreasing price promotes the further reduction of dietary CP levels, while meeting pigs' amino acid requirements more closely. Numerous studies have showed that feeding pigs with low CP diets reduces nitrogen excretion to the environment, while improving dietary protein utilisation.

Required diets

Pig diets must contain adequate quantity and quality of nutrients particularly amino acids, minerals, vitamins and energy for their normal body protein synthesis. Indeed, early research proved that optimal feed intake and growth performance of weaned pigs can be achieved by feeding them with purified diets based on an array of essential amino acids, non-essential amino acids and corn starch (energy source).

This kind of diet – without grains and soybean meal (SBM) – does not represent today's typical swine diets, but it supports the nutritional concept that pigs can grow well as long as an adequate amount of all essential and non-essential amino acids (independent of source) are provided in the diets and if they are fed ad libitum.

More recent studies confirmed that the CP level of finishing pig diets can be reduced to around 13% with little or no SBM without affecting performance and carcase traits by formulating the diets on the same levels of standardised ileal digestible (SID) amino acids and net energy basis.

Minimum and maximum levels

Reduced growth and carcase performance of finishing pigs was reported when dietary SBM inclusion was reduced from 10.6 to 7.7, 4.9, 2.7 and 0% despite the fact that dietary CP was kept constant at 12%. This raises a question: do we need to include a certain minimum amount of protein meal, for example, SBM or animal by-products, as a source of amino acids in swine diets?

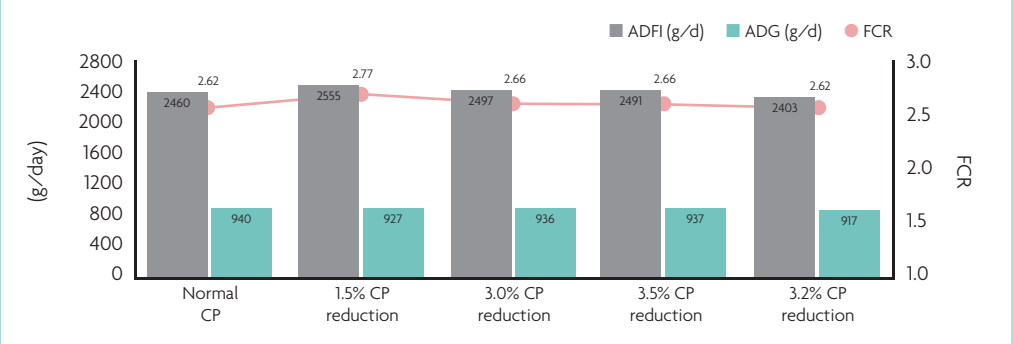
Other accompanying questions are: what are the maximum inclusion levels of crystalline amino acids in pig diets? How low can we go with lowering the dietary CP level in different pig diets? Would feeding low CP-amino acid fortified diets reduce feed intake and carcase quality of pigs? The amount we can lower the CP level in pig diets without compromising performance depends on the Lys level in a particular diet.

Average CP:	14.9%	13.9%	12.9%	11.9%	12.3%
Grower 1 (25-50kg, day 0-15)					
CP (%)	17.1	16.3	14.0	12.6	13.8
SBM (%)	14.7	11.9	4.5	0.0	0.0
Number of AA added	4	5	9	9	12
SID Lys:CP (%)	5.5	5.8	6.8	7.5	6.9
Grower 2 (50-80kg, day 16-59)					
CP (%)	15.1	14.6	13.0	12.0	12.3
SBM (%)	8.3	6.6	1.5	0.0	0.0
Crystalline AA	4	5	9	9	10
SID Lys:CP (%)	5.4	5.6	6.3	6.8	6.7
Finisher (80-115kg, day 60-94)					
CP (%)	14.5	13.0	12.6	11.7	12.1
SBM (%)	7.0	2.6	0.0	0.0	0.0
Crystalline AA	4	5	6	8	8
SID Lys:CP (%)	4.8	5.4	5.6	6.0	5.8

The SID Lys was balanced at 0.95, 0.82 and 0.70% and other amino acids were balanced according to the ideal ratios in diets for Grower 1, Grower 2 and Finisher phases, respectively. A similar level of net energy at 10.0, 9.8 and 9.7 MJ/kg was maintained in diets for Grower 1, Grower 2 and Finisher phases. The total calcium and phosphorous levels were 0.70 and 0.56% in Grower 1 diets, 0.60 and 0.52% in Grower 2 diets, and 0.56 and 0.48% in Finisher diets, respectively.

Table 1. Inclusion levels of soybean meal (SBM), grains and crystalline amino acids (AA) in the diets.

Fig. 1. Effect of lowering dietary protein level on the overall pig performance (day 0-94).



Experimental design

Having these questions in mind, a 94-day growth trial was conducted at the swine research farm of the University of Applied Sciences Bingen, Germany to evaluate the effects of lowering dietary CP level and balancing with amino acids on the growth performance and carcase composition of growing-finishing (27-115kg) pigs.

A total of 160 pigs (Topigs x Pietrain; initial body weight of 27.2 ± 2.7kg) with two pigs per pen and 16

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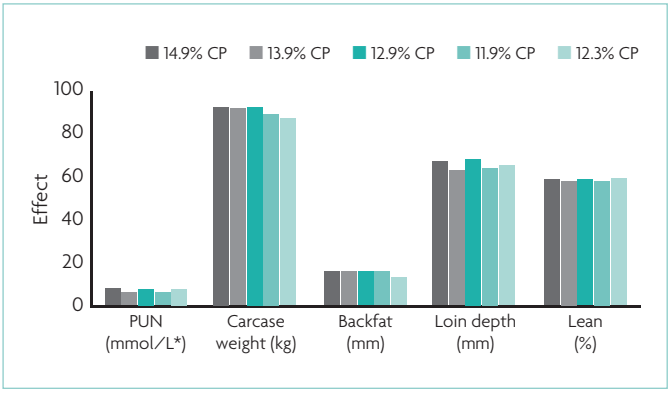

Fig. 2. Effect of lowering dietary protein on PUN and carcase quality (day 94). *PUN level was significantly lower in diets containing 13.9 and 11.9% CP compared with 14.9% CP diet.

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pens (eight barrow pens and eight gilt pens) per treatment were assigned to five diets based on wheat, barley, SBM and wheat bran for each of the Grower 1 (25-50kg, days 0-15), Grower 2 (50-80kg, days 16-59), Finisher (80-115kg, days 60-94) phases.

For each phase, a step-wise reduction of CP level in diets 1 to 5 (1.5, 3.0, 3.5 and 3.2 percentage-point CP reduction on average for three phases) was achieved by reducing SBM and adding amino acids (Table 1).

Analysed ingredients amino acid content were used but corrected for SID basis for the diet formulation (AMINOD at 5.0). Up to nine essential amino acids (Lys, Thr, Met, Trp, Val, Ile, Leu, His, Phe) were supplemented in diets 1 to 4; the lowest CP diet in Grower 1 phase contained as high as 1.25% Biolys (equivalent to 0.88% L-Lys.HCl) and supplying 72% of total SID Lys content.

Glutamine, glycine and proline were supplemented additionally in diet five (Grower 1 and 2 phases) to maintain a SID Lys:CP ratio of not greater than 6.9% as an attempt to prevent non-essential amino acids becoming deficient. This was because Lys is the first limiting amino acids for the growth of pigs, and the optimal dietary CP level is closely related to the dietary Lys level in the diet.

All diets were balanced for similar net energy content. On trial day 94, blood was collected (from the jugular vein) from six barrows per treatment to measure plasma urea nitrogen (PUN). After the 94-day trial, all pigs were slaughtered to assess carcase composition.

Additionally, a five-day nitrogen-balance trial was conducted by feeding 16.2% CP (50:50 mix of diets 1 and 2) or 13.3% CP diet (diet 3) from Grower 2 phase to four pigs (initial body weight of 50.0 ± 2.1kg) to measure nitrogen balance.

Results

During each phase and the overall 94-day period, average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR) as well as final body weight were not different among treatments (Fig. 1). Adding non-essential amino acids in diet five of Grower 1 phase had no additional benefits compared with the remaining diets.

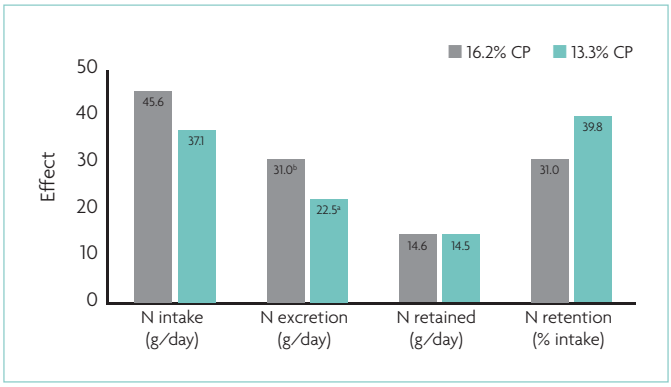
As expected, the ADG and ADFI were lower but FCR was better for gilts compared with barrows (data not shown).

The PUN concentration (day 94) decreased linearly as dietary CP was lowered and was lowest for the lowest CP diet which indicates a reduction in deamination of excess amino acids (Fig. 2).

The carcase weight and all other measured carcase traits, such as backfat thickness and lean percentage, were not impacted by the CP levels (Fig. 2).

Daily nitrogen retention (g/day) remained the same but total nitrogen excretion was reduced by 27% by lowering the CP level from 16.2 to 13.3% which means that 1% CP reduction gives us roughly 9% reduction in total nitrogen excretion to the environment (Fig. 3).

Fig. 3. Lowering dietary CP level reduced N excretion without affecting N retention (N-balance study).



Conclusions

In conclusion, lowering dietary CP level by removing SBM completely with high inclusion of crystalline amino acids up to 1.25% Biolys, is possible to maintain optimal feed intake, growth and carcase performance of growing-finishing pigs.

The key is that low protein diets should be balanced for adequate level of both essential amino acids and non-essential amino acids combined with formulating on net energy basis. ■

References are available from the author on request