L-valine supplementation in low CP diets to enhance piglet performance

The production of 1kg pork has the highest global warming potential directly after the production of 1kg beef. Nitrogen excretion is still one of the major criticisms of modern pig production. Each 1% decrease in swine dietary crude protein (CP) causes almost 2.8% reduction in nitrogen excretion.

by Dr Diana Siebert, Technical Center, CJ Europe GmbH. www.cjbio.net

Protein, after energy, is the most expensive nutrient in swine diets, thus from an economical point of view it is important to think about protein strategies. Furthermore, excessive dietary protein may be fermented in the hindgut and is consequently associated with gastrointestinal disorders like post-weaning diarrhoea.

To formulate pig feed with a low CP content, diets are routinely supplemented with lysine (Lys), methionine (Met), threonine (Thr) and tryptophan (Trp), as well as, to a growing extent, with valine (Val).

In European diets, Val is expected to be the fifth limiting amino acid in pigs, while isoleucine (Ile) is the sixth limiting amino acid.

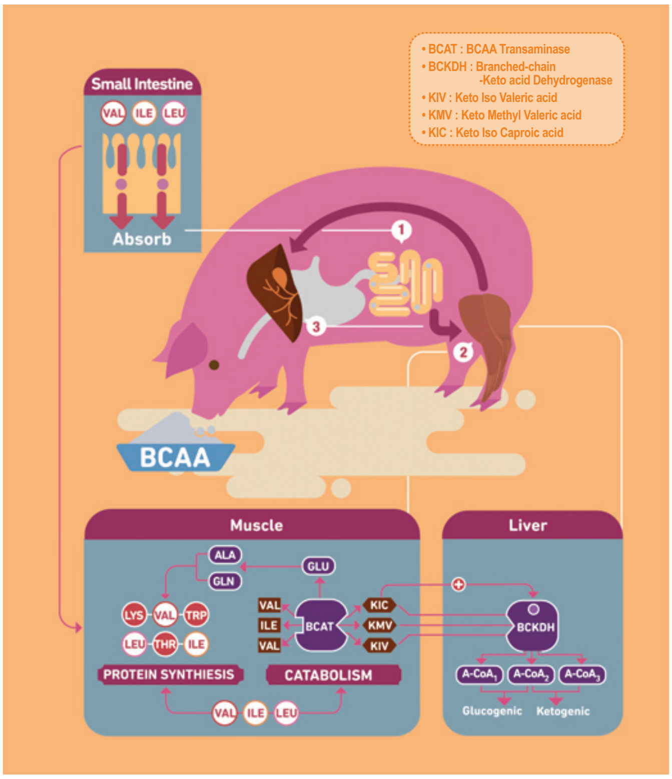
With the application of ideal amino acid ratios, it is possible to reduce the dietary CP content and maintain the pig's growth performance and carcase merit.

Metabolism of valine

Based on its chemical structure, Val, leucine (Leu) and Ile are amino acids with an aliphatic side chain with a branch. Consequently, all three belong to the so-called branched-chain amino acids (BCAAs).

BCAAs account for about 30% of the essential amino acids (AA) in the muscle, already suggesting their importance for muscle build up. Unlike other AA, BCAAs are not primarily metabolised in the liver but in the muscle.

Fig. 1. Metabolism of branched-chain amino acids.



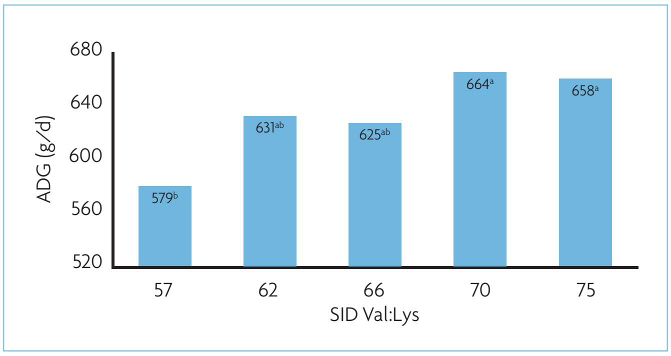


Fig. 2. ADG (g/d) of piglets in the late starter period (day 29-43) with varying SID Val:Lys ratio. [a,b] Different superscripts between columns indicate a statistical significance ($p < 0.05$).

Val, Leu, and Ile share a common metabolism because they get degraded by the same enzymatic system in a two-step process (Fig. 1).

First, the BCAAs get degraded by the BCAA Transaminase (BCAT) to form branched-chain α-keto acid (BCKA) products.

In a second step, BCKAs undergo oxidative decarboxylation reaction catalysed by BCKA dehydrogenase (BCKDH) complex.

Thus, BCAAs in the diet need to be balanced. In particular, a Leu over-supply may affect the requirement of Val and Ile because Leu act as a stimulator for the common enzyme system and consequently reduces the availability of Val and Ile.

However, an excess of Leu seems to have a higher impact on Ile, rather than Val. Blood byproducts are very high in Leu and extremely low in Ile, which creates a strong imbalance between the BCAAs.

Valine requirements

In a rat model, it was shown that a Val-deficient diet led to severe anorexia. Suarez et al. (2012) confirmed a comparable effect in piglets (17.5kg) in a double choice test.

The authors tested three different Val inclusion levels (0.73, 0.78 and 0.83 Val:Lys) and a diet without crystalline Val. The animals clearly preferred Val-supplemented diets over a diet without the addition of Val.

Deficiencies in the dietary BCAA content have been reported by several authors to have a negative impact on feed intake. A reduction of ADFI was seen in diets that were deficient in Val, but also in Ile-deficient diets.

Furthermore, imbalances of BCAAs can cause a reduced feed intake. Excess Leu, in combination with a low level of Val in the diet, usually leads to a massive drop in feed intake, followed by a reduction in piglet performance.

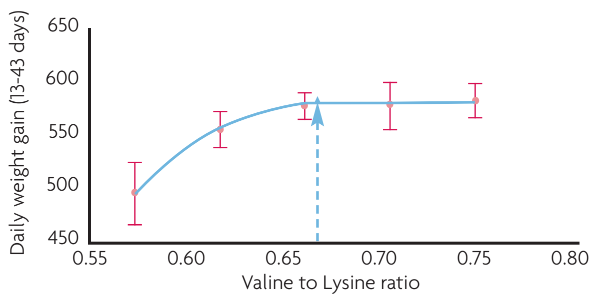
Literature and established requirement systems suggest different values for the optimal dVal:dLys ratio in 5-25kg piglets.

The National Research Council (NRC 2012) recommends a dVal:dLys of 0.68, whereas the Danish system reported a dVal:dLys of 0.63-0.65, while Gloaguen et al. (2013) and the British Society of Animal Science suggest 0.70.

CJ Europe performed a dose-response trial in cooperation with IRTA (Spain), to determine the optimal dVal:dLys ratio.

Two hundred weaned piglets (8.7±1.1kg body weight) were subdivided in to five feeding groups. The diets were based on corn and

Continued on page 27



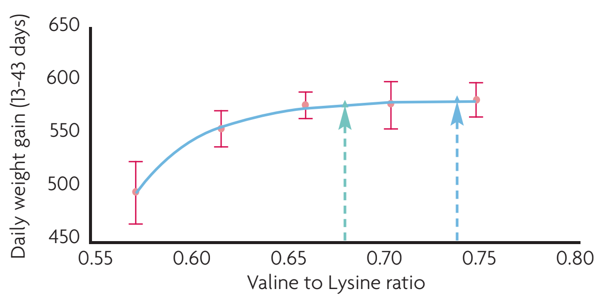


Fig. 3. Left: Curvilinear-plateau response to the addition of L-valine between 13-43 days. The estimated requirement was 0.67 (blue arrow). Right: Exponential performance response to the addition of L-valine between 13-43 days. The estimated requirements were 0.68 (95% of maximum response; green arrow) and 0.74 (99% of maximum response; blue arrow).

Continued from page 25
soybean meal as major ingredients. Only the dVal:dLys ratio varied among treatments between 0.59-0.75 in the pre-starter and between 0.57-0.75 in the starter phase (Table 1). The gradual supplementation of Val to the basal diet led to significant improvements in performance parameters (Fig. 2).

Numerically, the lowest feed intake could be observed in the pre-starter and starter periods in the Val-deficient diets, however, no statistical difference could be detected between the different groups.

The dVal:dLys requirement for the maximum ADG (Fig. 3) were 0.68 and 0.67 in the starter period (exponential asymptotic and curvilinear-plateau regression models, respectively).

The estimated requirement for optimal growth was generally in good agreement with the values proposed by NRC (2012) and Chang and Baker (1992).

Table 1. Calculated nutritional composition of dietary treatments.

Nutrients (%)	Pre-starter (0-13 days)					Starter (14-43 days)				
	TP1	TP2	TP3	TP4	TP5	TS1	TS2	TS3	TS4	TS5
	(0.59)	(0.63)	(0.67)	(0.71)	(0.75)	(0.57)	(0.62)	(0.66)	(0.70)	(0.75)
Crude protein	18.1	18.1	18.1	18.1	18.1	16.7	16.7	16.7	16.7	16.7
Energy (MJ ME/kg)	13.8	13.8	13.8	13.8	13.8	13.5	13.5	13.5	13.5	13.5
SID Lysine	1.25	1.25	1.25	1.25	1.25	1.15	1.15	1.15	1.15	1.15
SID Threonine	0.80	0.80	0.80	0.80	0.80	0.74	0.74	0.74	0.74	0.74
SID Methionine	0.47	0.47	0.47	0.47	0.47	0.43	0.43	0.43	0.43	0.43
SID Met+Cys	0.74	0.74	0.74	0.74	0.74	0.68	0.68	0.68	0.68	0.68
SID Tryptophan	0.25	0.25	0.25	0.25	0.25	0.23	0.23	0.23	0.23	0.23
SID Isoleucine	0.73	0.73	0.73	0.73	0.73	0.67	0.67	0.67	0.67	0.67
SID Valine	0.74	0.79	0.84	0.89	0.94	0.66	0.71	0.76	0.81	0.86
SID Leucine	1.32	1.32	1.32	1.32	1.32	1.19	1.19	1.19	1.19	1.19
SID Phenylalanine	0.76	0.76	0.76	0.76	0.76	0.69	0.69	0.69	0.69	0.69
SID Phe + Tyrosine	1.29	1.29	1.29	1.29	1.29	1.18	1.18	1.18	1.18	1.18
SID Histidine	0.41	0.41	0.41	0.41	0.41	0.38	0.38	0.38	0.38	0.38

Conclusion

In conclusion, reducing the CP content in swine feed ultimately reduces the environmental nitrogen load.

A deficiency in Val causes a drop in feed intake and production performance, thus, the usage of crystalline L-valine is a solution to meet Val requirements without increasing CP and to maintain growth performance of the piglets.

The estimated dVal:dLys for maximum weight gain in the starter period is supposed to be at least 0.68 and is consequently in good agreement with previous estimated values. ■

References are available from the author on request