

The importance of updating arginine requirements for swine

Arginine is an essential amino acid in piglets, and it is needed for maximum performance in different phases of swine production. In the past, arginine was considered as self-sufficient. Endogenous arginine synthesised via the urea cycle and the arginine originating from raw materials were considered sufficient to cover arginine requirements. Thus, many of the nutrient requirement tables do not include recommendations for arginine.

by Dr Behnam Saremi,
Head of Technical Center,
CJ Europe GmbH.
www.cjbio.net

In 1998, the National Research Council (NRC) identified relatively low requirements for arginine in pigs, whereas, in 2012, they revised the arginine recommendations and came up with higher requirements (Table 1). Modern breeds of pigs need much higher arginine levels in their feed for maximum performance as compared to NRC recommendations (Table 1). Thus, the focus of this article is on arginine requirements in swine.

Gestating sows

In a short-term study with two sows per treatment, an arginine free diet did not affect nitrogen balance or body weight of piglets in gestating sows. Similar results were found by Easter et al. (1974).

However, it does not mean that sows do not suffer from lack of arginine. It also does not mean that the maximal foetal growth during late part of pregnancy can be achieved without arginine.

Modern sows ovulate 20-30 oocytes and deliver 10-15 live born piglets per litter and foetal mortality is highly related to the uterine capacity and placental growth.

Both polyamines and nitric oxide (NO), metabolites of arginine, also have an important role in placental development.

Moreover, arginine is a major

	Nursery piglets	Weaning piglets	Growing and finishing pigs	Gestating sows	Lactating sows
Body weight	5kg	10kg	20-100g	140kg at breeding	-
NRC (1998)	0.59	0.54	0.37 (20kg) 0.19 (100kg)	0.0	0.0
NRC (2012)	0.75	0.68	0.62 (20kg) 0.38 (100kg)	0.36 (days 0-90) 0.47 (days 90-114)	0.60 (parity 1) 0.54 (parity 2)
Wu (2014)	1.19	1.01	0.83 (20kg) 0.64 (100kg)	1.03 (days 0-90) 1.03 (days 90-114)	1.37

Table 1. Arginine recommendations for pigs (values are % of arginine in total diet). Adapted from Wu et al. (2018).

metabolite both in placenta and in allantoic fluid. Altogether, arginine seems to be a limiting factor in sows thus it has been the recent subject of different research.

Arginine supplementation between days 22 and 114 of gestation improved reproductive performance of sows (Table 2) and thus improved the number of piglets born and their survivability which was related to the higher placental weight in arginine fed sows.

Several papers (Table 3) reported positive effects of extra arginine during pregnancy in swine. Most of the literature indicates an improvement in litter size and litter weight by the addition of 0.80-1.0% of arginine to a diet that already contained 0.7- 1.0% arginine.

Arginine intake should be 1.5-2.0% of diet which is reflected in results of three new trials (Table 4). Thus, requirement of pregnant sows for arginine is much higher compared to NRC 2012 recommendations.

Lactating sows

Amino acids are not only building blocks of proteins but also have functional roles. Arginine is a precursor of NO which plays an important role in the control of blood flow. Supplementing 0.83g arginine or 50mg per day NO to diets of sows increased the blood flow to mammary gland and milk production.

lactating sows is summarised and compared with NRC (2012). Lactating sows also have much higher arginine requirements as compared to NRC (2012) recommendations.

Piglets

Neonatal pigs are very sensitive to arginine deficiency. Arginine deficiency can easily result in hyperammonia in neonatal pigs. Sows milk is very deficient in arginine and can only provide 0.40g arginine per kg of body weight per day.

Thus, piglets fed with 0.2 and 0.4% arginine had an improvement in body weight gain. Supplementation of 0.2 and 0.4% L-arginine to piglets enhanced average daily weight gain by 28 and 66%, and body weight by 15 and 32%, respectively. Yang et al. (2016) also reported that 0.4 and 0.8% arginine supplementation to a milk replacer increased body weight gain of piglets by 19 and 22%, respectively.

Arginine is known to enhance

Feeding arginine at 0.5 and 1.0% to lactating sows increased arginine content of plasma and milk. Arginine also increased insulin and IGF-1 hormones which are underlying factors to improve milk production and composition. Consequently, piglets grew better and sows were in a better body condition.

In Table 5, arginine requirement of

Table 2. Effect of dietary L-arginine on the reproductive performance of sows.

Items	Control	Arginine	Pooled SEM
Number of piglets per litter			
Total born	12.46	13.77*	0.35
Born alive	11.25	12.35*	0.51
Stillborn and mummified	1.21	1.42	0.36
Birth weight (kg)			
All piglets born per litter	16.43	17.79*	0.68
Piglets born alive per litter	15.82	17.52*	0.72
Average for piglets born alive	1.41	1.45	0.06
Placental weight for all live born piglets (kg)	3.04	3.53*	0.17
Placental weight per live -born piglets (kg)	0.240	0.259	0.011
Birth weight variation of all piglets born alive (kg)	0.229	0.239	0.014

Data are means with pooled SEM, n=108; * P<0.05 versus the control group; A variation in birth weights of piglets based on the total number of piglets born alive. Adapted from Gao et al. (2012).

Authors	Parity of sow	Supplemental arginine (% of diet or g per sow per day)	Period of arginine supplementation	Feed intake per day (kg)	Dietary CP (%)	Dietary Energy (ME; MJ)/kg	Arginine in basal diet (%)	Lysine in basal diet (%)	Placental weight; early to mid-gestation or at birth	Litter size of viable foetuses or live born piglets	Litter wt. of viable foetuses or live born piglets
Berard and Bee (2010)	1	0.87% 21.7g	d 14-28	3.0	14.3	11.5	1.07	0.88	No effect	up by 3.7 per litter	up by 32% per litter
Campbell (2009)	1 and MP	1% 25g	d 14-28	ND	ND	ND	ND	ND	ND	up by 1 per litter	up by 6.4% per litter
De Blasio et al. (2009)	1	1% 25g	d 17-33	2.5	ND	ND	ND	ND	ND	up by 1.2 per litter	ND
Gao et al. (2012)	1 and MP	0.83% 16.6g	d 22-114	2.0 (d 22-90) 3.0 (d 90-114)	13.2	13.0	0.88	0.65	by 16%	up by 1.1 per litter	up by 11% per litter
Li (2014)	1	0.40% 8.0g	d 14-25	2.0	12.0	12.9	0.70	0.57	by 34%	up by 2.2 per litter	No effect
Li (2014)	1	0.80% 16.0g	d 14-25	2.0	12.0	12.9	0.70	0.57	by 21%	up by 3.7 per litter	up by 32% per litter
Mateo et al. (2007)	1	0.83% 16.6g	d 30-114	2.0	12.2	13.0	0.70	0.58	ND	up by 2.0 per litter	up by 24% per litter
Ramaekers (2006)	1 and MP	1% 25g	d 14-28	ND	ND	ND	ND	ND	ND	up by 1.0 per litter	ND
Wu et al. (2012)	MP	0.83% 16.6g	d 90-114	2.0	14.7	13.5	0.80	0.78	ND	No effect	up by 16% per litter

ME = metabolisable energy; ND = not determined; MP = multiparous; Adapted from Wu et al. (2018).

Table 3. Effect of maternal arginine supply during pregnancy on litter size and piglet weight.

blood flow in piglets and concentration of arginine in plasma. An increase in insulin and glucagon concentrations in plasma, as mentioned already in sows, is also observed in piglets.

Thus, extra arginine is beneficial to piglets indicating an arginine deficiency condition in piglets fed without supplementary arginine.

Thus, the arginine requirement of

piglets (Table 5) is also higher than the NRC 2012 recommendations.

Conclusion

The optimum arginine requirement in pigs is often neglected and arginine is deficient in most of the production phases. Thus, the swine industry needs to revisit the arginine

specifications in sows and in piglets. Currently, arginine is available commercially in high volumes.

Arginine has also been registered as a feed grade amino acid by the European commission.

Current arginine prices make it possible to include supplementary

arginine in swine diets to meet requirements and to improve the survivability and growth rate in piglets and the reproductive performance in sows. ■

References are available from the author on request

Table 4. Arginine requirements in pregnant sows – a comparison of NRC 2012 recommendations and recent trials.

Arginine	Gestation	Parity	g/day		Arg/Lys ratio
			D 22-90	D 91-114	
			%		
NRC 2012	1		6.5	10.0	0.32/0.42
NRC 2012	4		4.0	6.8	0.21/0.29
Trial 1	1.6		34	51	1.7
Trial 2	1		14.2	21.3	0.71
Trial 3	4.5		22	26.4	0.88

Item	Parity	g/day	%	Arg/Lys ratio
NRC 2012	2+	30.5	0.48	0.54
Trial 1	2.5	65.4	1.23	1.26
Trial 2	4.5	61.1	0.91	0.90

Table 5. Arginine requirements in lactating sows – a comparison of NRC 2012 recommendations and recent trials.

Table 6. Requirements of arginine in piglets – a comparison of NRC 2012 recommendations and a recent trial.

Arginine	Parity	g/day	%	Arg/Lys ratio
NRC 2015	5-7kg	2.0	0.75	0.44
Trial	2-6kg	2.09	1.12	0.51