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Effect of arginine supplementation on the productive performance of gestating sows: a meta-analysis

S. Virdis[1], D. Luise[1], P. Bosi[1], P. Trevisi[1]

[1] Department of Agricultural and Food Sciences, University of Bologna, Viale Fanin 46, 40127 Bologna, Italy

sara.virdis3@unibo.it

Background

This have led to increased litter size but consequently to a higher within-litter variation in birthweight and a higher proportion of low birthweight piglets (Foxcroft et al., 2009).

Arginine (Arg) (conditionally essential for pigs by NRC (2012)) → precursor of Proline, Ornithine (Barbul, 2008) and nitric oxide → placental angiogenesis (Wu et al., 2017; Elmetwally et al., 2022).

Sow prolificacy has markedly increased in recent decades due to genetic improvement (Knauer et al., 2012).

Nutritional strategies can help! Positive role of functional amino acids (AA) in improving sow productive performances (Le Floc'h et al., 2018).

Considering the evolution of the breed line and the increase in litter size occurring in recent years (Knauer et al., 2012), the Arg nutritional requirement may be greater than those suggested by NRC (2012) which are 5,55 g/kg of feed on average

Background

Hypotesis

It has been hypothesized that an increase of the dietary level of SID Arg could improve sow performance, including litter size and weight, colostrum and milk composition, placental efficiency (PE). Considering the discrepancies in terms of the effects of Arg supplementation during gestation, a meta-analytical approach was chosen.

Aim

The aim of the present meta-analysis was to organize and analyze the data available in the literature and to provide indications regarding the opportunity of revising the SID Arg requirement for gestating sows.

Materials and methods

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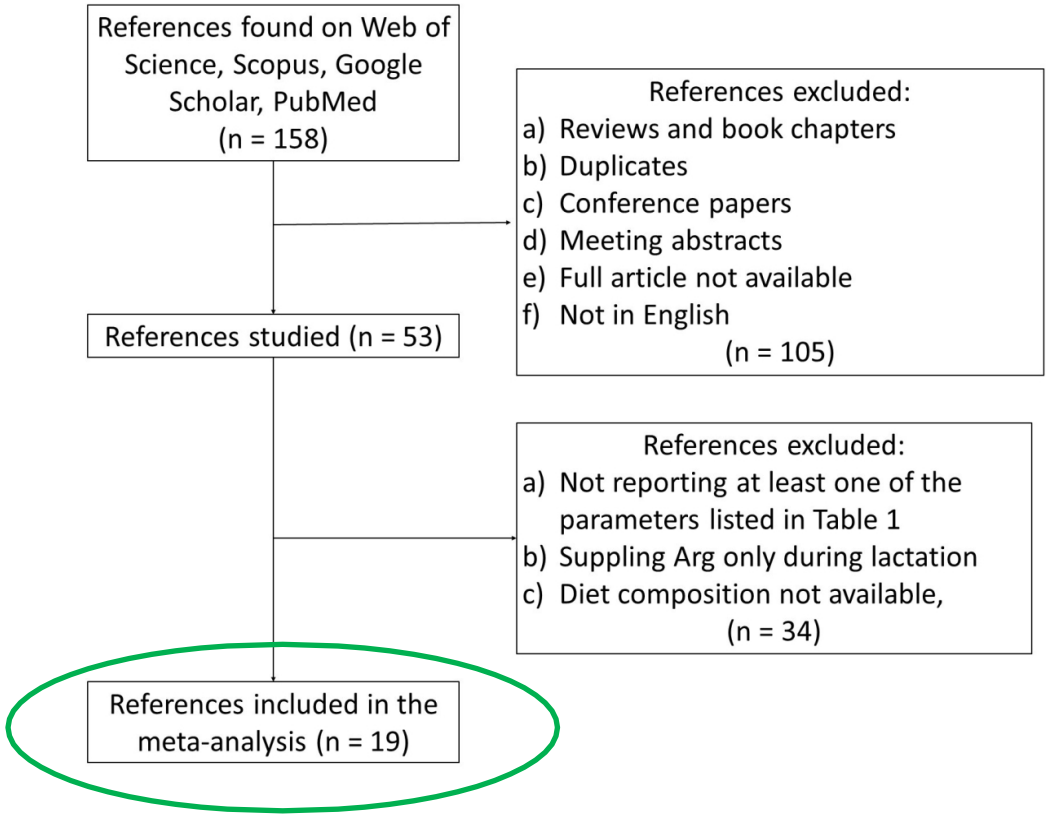

Table 1. The parameters required for inclusion of the study into the dataset for the meta-analysis.

Parameters required
Backfat thickness of sows
Placental weight and efficiency
Total number of piglets born
Total number of live born piglets
Number of stillborn piglets
Litter birth and weaning weight
Piglet birth and weaning weight
Colostrum or milk composition
Free AA or urea concentration in the sow plasma

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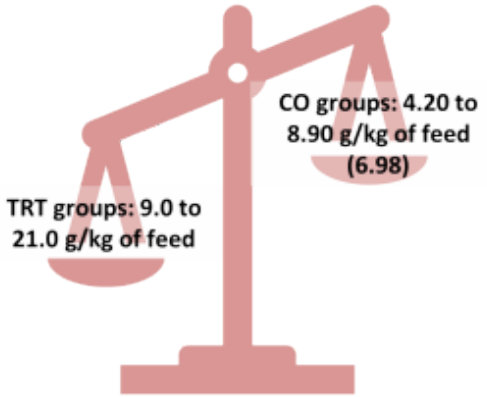
Materials and methods

Diets were recalculated on the bases of a single database (Luise et al., 2020; Camargo et al., 2023)

1. some article does not report the nutrient composition of the diet

2. to deal with the error in estimating the nutrient composition of the diets

$$Additional\ SID\ Arg = \frac{SID\ Arg\ Treated - SID\ Arg\ Control}{SID\ Arg\ Control}\ x\ 100$$



NRC → 5,55 g/kg of feed

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1= first 60 days of gestation

2= between days 61 and 114

3= during all gestation

Period of Arg supplementation

Class of parity

A= multiparous sows

B= primiparous sows

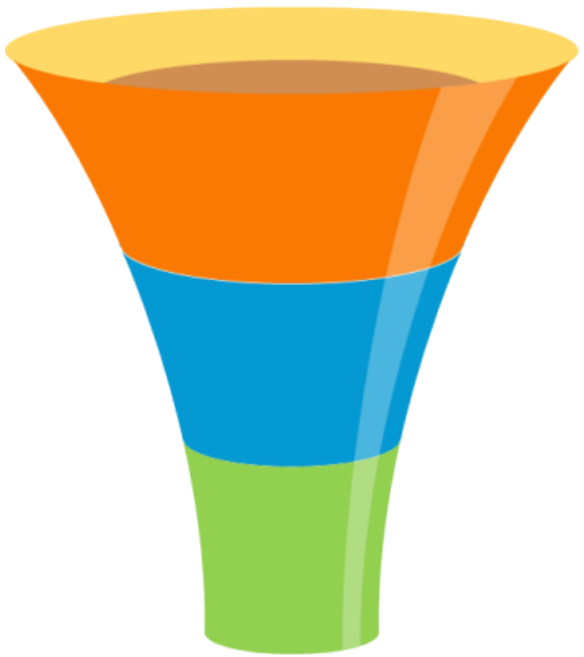
L= ≤ 2 Kg of feed/day

H= > 2kg of feed/ day

Class of feed intake

All the response parameters were expressed as ratio of the treated group to the control group.

Materials and methods

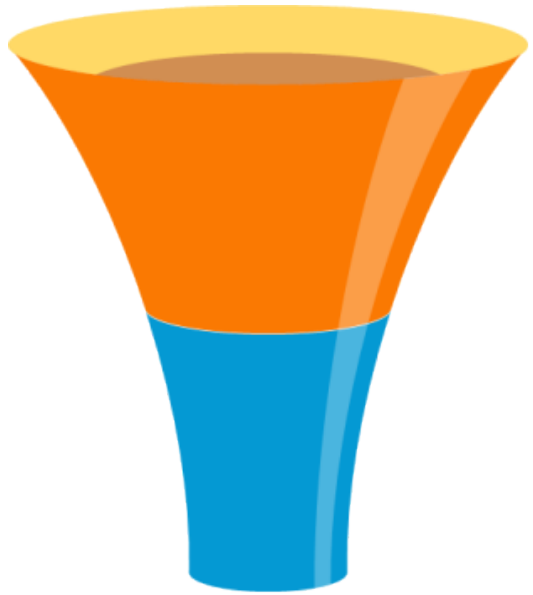


FIXED FACTORS
- Additional SID Arg
- Class of parity
- Period of Arg suppl
- Class of feed intake

COVARIATES
- SID Lys in CO groups
- SID Arg in CO groups

RANDOM FACTOR
- Reference

Sow performance at farrowing



FIXED FACTORS
- Additional SID Arg
- Class of parity
- Period of Arg suppl
- Class of feed intake

COVARIATES
- Piglet birthweight
- Nr of live born piglets

Sow performance at weaning

Data were fitted using a linear and quadratic ANOVA mixed model on Minitab®18 Statistical Software (2018).
After a first analysis, non-significant factors (the period of Additional SID Arg administration, SID Lys and SID Arg levels in the control diet, reference) were removed.
The quadratic model were removed when explained less than the linear.

Materials and methods

To apply a quadratic model, the Additional SID Arg^2 factor was created as follows:

$$Additional\ SID\ Arg^2 = Additional\ SID\ Arg * Additional\ SID\ Arg$$

The data were analyzed to estimate the Additional SID Arg level needed to maximize sow performance at farrowing and weaning by regression analysis using the quadratic models. To determine the level of Additional SID Arg needed to maximize sow performance, the following equation was utilized:

$$Additional\ SID\ Arg\ optimum\ dose = (-b)/(2*a)$$

where ***b*** was the coefficient of the linear effect and ***a*** was the coefficient of the quadratic effect.

Both coefficients were obtained using statistical analysis for each response parameter.

Results and discussion

Table 2. Effects of Arginine supplementation on sows' productive performance at farrowing.

	n	R^2 Adj, %	P-value					Coefficients	
								b	a
			Additional SID Arg	Additional SID Arg ^{2}	Parity	Feed Intake	Number of piglets born	Additional SID Arg	Additional SID Arg^2
PE	7	60.16	**0.004**	**0.003**	0.366	--	--	-0.237	0.0019
Backfat loss	8	41.49	**0.038**	**0.057**	0.586	0.252	--	-0.519	0.0029
Total number of piglets born	17	39.85	**0.005**	**0.027**	0.372	0.120	--	0.094	-0.0003
Total number of live born piglets	16	38.20	**0.001**	**0.005**	0.904	0.244	--	0.145	-0.0006
Litter birthweight	17	82.86	**0.024**	--	0.056	0.639	<0.001	0.019	--
Piglet birthweight	18	20.85	0.682	0.487	0.278	0.051	--	-0.009	0.000

PE: placental efficiency.

0.6-fold — 4.19 g/kg

0.86-fold — 6.00 g/kg

1.125-fold — 7.85 g/kg

1.25-fold — 8.73 g/kg

Results and discussion

Table 3. The effects of Arginine supplementation on the concentration of free amino acids and urea in the plasma of sows during the final period of Arg supplementation.

Item	*n*	R^2 Adj, %	P-value		Coefficient b
			Additional SID Arg	Gestation period	Additional SID Arg
Proline	8	35.34	**0.004**	0.657	0.120
Ornithine	7	38.61	**0.002**	0.438	0.284
Arginine	7	53.66	**0.001**	0.505	0.425
Urea	8	51.02	**0.037**	0.005	-**0.063**

The negative relationship between dietary Arg and the urea levels in sow plasma could be due to an improvement in the efficiency of nutrient utilization for enhancing tissue protein synthesis (Kim et al., 2004).
The same negative correlation between Arg supplementation and urea levels in plasma has been observed in piglets (Kim et al., 2004).

Results and discussion

Table 4. The effects of Arginine supplementation on piglet productive performance at weaning.

	n	R-sq Adj, %	P-value					Coefficients	
								b	a
			Additional SID Arg	Additional SID Arg ^{2}	Piglet birth weight	Parity	Live born Piglets	Additional SID Arg	Additional SID Arg^2
Litter size	6	11.66	0.369	0.376	--	0.609	0.912	0.034	-0.000
Pig weight	7	5.46	0.202	0.283	0.333	0.736	--	0.073	-0.000
Litter weight	5	18.59	0.748	0.563	0.599	0.669	--	-0.053	0.001
Piglet ADG	5	17.34	0.903	0.918	--	0.727	0.775	0.060	-0.000

Conclusions

Additional investigation on the effects on colostrum and milk quality and piglets' performance at weaning is required

Care should be taken for the results about placental efficiency (PE) and backfat thickness because of the low number of studies included in the model

The results underline the importance and relevant role that Arg may have in pregnant sows

Arg supplementation improved the productive performance of sows and piglets, especially in terms of litter size at birth, confirming its key role in supporting the physiological modification of the sows during pregnancy

Finally, there was no complete correspondence between the SID Arg requirements reported by the NRC (2012) and the amount of SID Arg used in the control groups of the studies included in the meta-analysis. Moreover, the results about the doses of SID Arg needed to maximize sows' productivity highlighted the need to revise sows' requirements of SID Arg during gestation.

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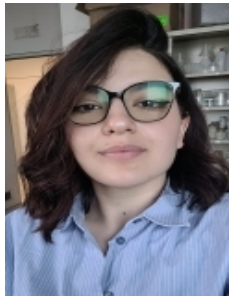
Thanks for your attention







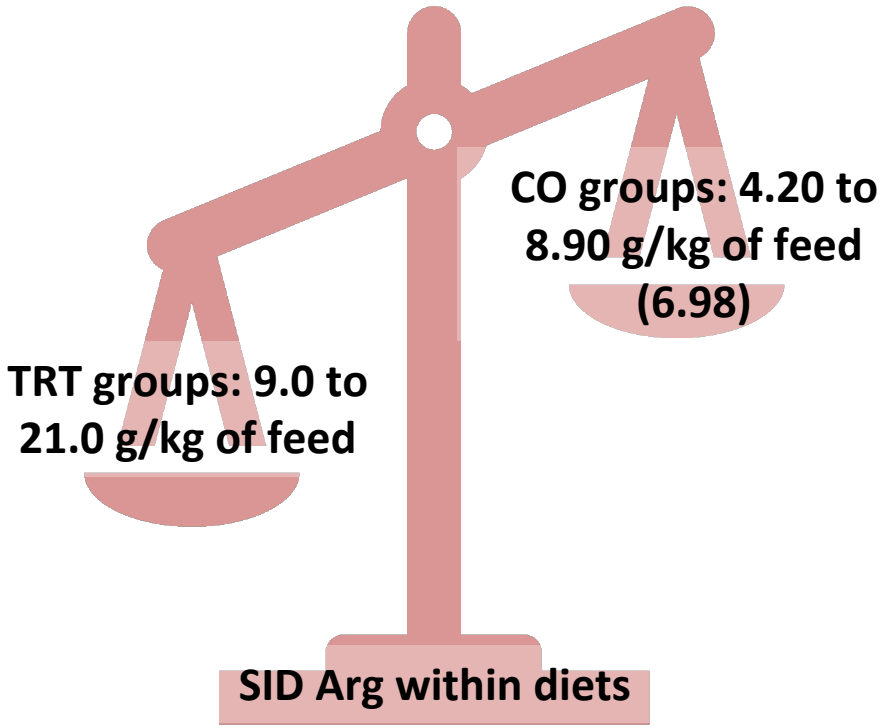



Department of Agricultural and Food Sciences, University of Bologna, Viale Fanin 46, 40127 Bologna, Italy

sara.virdis3@unibo.it
paolo.trevisi@unibo.it

www.unibo.it

Results – descriptive statistics



Minimum Additional SID Arg: 0.115-fold

Median Additional SID Arg: 1.33-fold

Maximum Additional SID Arg: 2.452-fold

Results and discussion