INTEREST OF USING SYNTHETIC AMINO ACIDS, INCLUDING L-VALINE FOR FORMULATING LOW CRUDE PROTEIN PIG DIETS BASED ON RAPESEED MEAL

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Abstract

One hundred forty-four group-housed growing-finishing pigs were allocated to one of the three experimental feeding strategies. Diets S were formulated with soybean meal and their dietary crude protein (CP) content averaged 15.9 and 15.0%, respectively during the growing and the finishing periods. In diets C, CP levels were reduced at 15.0 and 14.1%, respectively, and soybean meal was replaced partially or completely by rapeseed meal and balanced with L-Lysine, DL-Methionine, L-Threonine and L-Tryptophan. In diets CV, L-Valine was also incorporated (0.3 g/kg) allowing an additional reduction of CP content (14.5 and 13.2%, respectively). All diets were formulated on the same net energy basis (9.7 MJ NE/kg) and on minimum ratios between digestible lysine and other amino acids following the ideal protein profile. Over the 27-111 kg BW range, no significant differences were observed between treatments on average daily gain, feed intake, feed conversion ratio or carcass fatness. These results indicate that it is possible to replace soybean meal by rapeseed meal in association with available free amino acids for a long time without any consequence on growth performance. They also show that an additional reduction of dietary CP content can be achieved with L-Valine utilisation without any consequence on growth performance, when diets are formulated on the NE basis and in agreement with the ideal protein concept. Reduced dietary CP performed through the C and CV strategies were associated with a reduction of N output by 400 and 650 g /pig, respectively.

Introduction

Rapeseed meal produced from low erucic acid and glucosinolates species (i.e., 00 rapeseed) is a feedstuff produced locally in numerous European countries. Taking into account the increased production of biofuel, available amounts of rapeseed meal are presently increasing. Its nutritional values are well known, thus this feedstuff can apply as a solution toward a reduction of soybean meal utilization in pig diets. When incorporation rates of protein sources are reduced, dietary amino acid balance is often adjusted to the ideal protein profile through incorporation of crystalline amino acids in the formula. Incorporation of L-Valine, in addition to L-Lysine, L-Threonine, L-Tryptophan and DL-Methionine can help to design diets toward much more lower soybean meal incorporation rate and more generally to reduce the crude protein level without impairing the amino acid balance. The present trial was carried in order to evaluate the rapeseed meal utilization, as an alternative to soybean meal incorporation in pig diets, in association with a concomitant reduction of the dietary crude protein content.

Material and methods

The trial was performed with 144 crossbred gilts and barrows in the IFIP experimental unit located at Villefranche de Rouergue (Aveyron, France). Pigs from the two genders were bred separately and group-housed (6 per pen) during the fattening period. They were allocated to one of the eight replicates of six pens each (3 treatments $\times$ 2 genders). Thereafter, the pens within each replicate were allocated to one of the treatments. Within each treatment, two diets were formulated corresponding to the 27-65 kg (growing phase) and the 65-111 BW ranges (finishing phase). Diets were formulated with soybean meal (without rapeseed meal nor valine) in treatment S; with rapeseed meal but no valine in treatment C, and with rapeseed meal and L-Valine in treatment CV (Table 1). The incorporation rates of wheat and barley were modulated amongst experimental treatment in order to obtain iso-energy diets (9.7 MJ NE/kg). Bicalcium phosphorus was used in order to obtain 2.8 and 2.3 g digestible phosphorus per kg during the growing and

Table 1: Nutritional characteristics of the experimental diets.

Stage	**Growing phase**						**Finishing phase**					
Diet	**S**		**C**		**CV**		**S**		**C**		**CV**	
Barley	517		256		277		629		300		470	
Wheat	289		564		556		200		540.4		396.7	
Soybean meal 46	161		50.6		28.5		144.5		0		0	
Rapeseed meal	0		95		103		0		132		104	
L -Lysine HCl	2.7		4.5		5.0		1.9		4.1		4.5	
DL-Methionine	0.4		0.4		0.4		0.2		0.2		0.3	
L-Threonine	0.8		1.4		1.6		0.5		1		1.3	
L-Tryptophan	0		0.2		0.3		0		0.2		0.2	
L-Valine	0		0		0.3		0		0		0.3	
Salt	3.5		3.5		3.5		3.5		3.5		3.5	
Dicalcium phosphate	4.8		3.9		3.9		0.7		0		0	
Limestone	12.9		12.6		12.6		11.8		10.7		11.3	
Rapeseed oil	5.0		5.0		5.0		5.0		5.0		5.0	
Vitamin and trace mineral mixture and phytases	2.9		2.9		2.9		2.9		2.9		2.9	
Nutritional values[1]												
Dry mater, g	880	*889*	874	*879*	875	*880*	882	*889*	873	*881*	876	*885*
Crude fibre Weende, g	33		38		39		35		40		41	
Starch, g	449	*465*	477	*487*	483	*487*	455	*457*	486	*477*	490	*495*
Ashes, g	50	*47*	46	*41*	46	*43*	45	*44*	41	*38*	41	*37*
Calcium, g	7.4		7.5		7.5		5.9		5.9		5.9	
Phosphorus (P), g	4.6		4.8		4.8		3.9		4.3		4.1	
Digestible P (as mash), g	2.8		2.8		2.8		2.3		2.4		2.3	
Ether extract, g	22	*22*	21	*21*	21	*22*	22	*23*	21	*22*	22	*23*
Crude protein, g	159	*162*	150	*149*	145	*149*	150	*158*	141	*146*	132	*139*
Digestible protein, g	132		122		117		123		111		103	
Lysine, g	9.4	*9.1*	9.4	*9.2*	9.4	*9.6*	8.4	*8.5*	8.5	*8.4*	8.4	*8.6*
Digestible amino acids												
Lysine, (LYSd), g	8.3		8.3		8.3		7.3		7.3		7.3	
Methionine, % LYSd	31		31		30		31		32		31	
Met+cystine, % LYSd	62		65		64		65		71		66	
Threonine, % LYSd	65		66		66		66		65		65	
Tryptophan, % LYSd	20		20		21		21		22		20	
Isoleucine, % LYSd	67		58		55		71		59		54	
Valine, % LYSd	78		70		70		84		74		73	
Leucine, % LYSd	116		105		100		125		110		101	
Histidine, % LYSd	40		37		35		43		39		35	
Digestible energy, MJ	13.56		13.33		13.27		13.53		13.26		13.22	
Net energy (NE), MJ	9.7		9.7		9.7		9.7		9.7		9.7	
LYSd / NE, g/MJ	0.85		0.85		0.85		0.75		0.75		0.75	

1. Normal characters: expected values, characters in italic: results of the chemical analyses.

the finishing phases, respectively. The following minimum ratio between the ileal standardised digestible lysine (LYSd) and other essential amino acid were used: methionine: 30%, methionine + cystine: 60%, threonine: 65%, tryptophan: 20%, valine: 70%, isoleucine: 55%, leucine: 100%, histidine: 35%, and the ratio between digestible tryptophan and digestible large neutral amino acids was at least 5%. Experimental diets were sampled periodically in order to check in the accordance with the formula. The pigs were weighed individually every two or three weeks after 16h fasting. The cumulated feed intake per pen was measured between two BW recording in order to calculate the average daily feed intake (ADFI). Pigs were slaughtered in a commercial slaughterhouse in three groups every seven days depending on the time they reached the minimum expected slaughter weight (i.e., 107 kg). At slaughter, backfat (G34) and muscle (M34) thicknesses between the 3^{rd} and 4^{th} last ribs were measured and used to calculate the carcass lean content: 62.19 – 0.729 G34 + 0.144 M34. Data were submitted to an analysis of variance with the treatment (T, n=3), the gender (G, n=2), the interaction between T and G and the replicate as the main effects (proc GLM, SAS, version 8.02, SAS Institute Inc., USA). Individual data were analysed with the pen as the experimental unit. Average growth performance per gender and treatment were used in order to parameterise growth profiles under the InraPorc® software and to assess the N and P output per pig.

Results and discussion

No significant interaction was observed between the treatment and the gender on growth performance or carcass characteristics (Table). Neither the AGD, FCR nor carcass leanness are influenced by the treatment. A lower N intake was observed with diets C and CV (-7 and -11% than with diets S, respectively). However, this reduction did not compensate for the lower N digestibility for diets C and CV that resulted from the lower crude protein digestibility from rapeseed meal. Therefore the faecal N output was increased with these two later diets (+7 and +6%, respectively). In spite of this, the overall N output was reduced by 10% with diets C and by 16% with diets CV before of the important reduction of urinary N output (-16 and -24%, respectively). As far as P was concerned, the lower P digestibility from rapeseed meal resulted in a higher P intake (+0.07 and +0.05 kg/pig for C and CV pigs, respectively), which was almost completely found in faeces. However, as phytases were incorporated in all diets, this P excretion remained below the expected level without phytases addition.

Conclusion

The current trial was performed with diets designed on the same NE basis and ratio between amino acids in agreement with the ideal protein concept. In such conditions, our results demonstrate simultaneously the possibility to reduce the dietary CP content and to replace soybean meal by rapeseed meal and crystalline amino acids (L-Lysine, DL-Methionine, L-Threonine, L-Tryptophan, L-Valine) without any consequence on growth performance and carcass value. Subsequently, N output was considerably reduced. At least, incorporation of another protein source such as peas associated with rapeseed meal and available synthetic amino acids or the choice of a lower dietary NE level should help to remove completely the soybean meal from pig diets.

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Table 2: Growth performance over the 27 to 111 kg body weight range and carcass characteristics.

	Treatment						Statistics			
	S		C		CV		RSD	T	G	R
N. obs	47		47		48					
Body weight, kg[1]										
Initial	27.4		27.4		27.5		0.5			***
Transition	65		65		65		3		***	*
Slaughter	111		111		111		3			
Fattening duration, j[1]										
Before transition			← 42 →							
After transition	103		105		105		5	T×G**	***	***
ADG, g/d[1]	818		801		801		52		***	
Before transition	900		897		900		58		***	***
After transition	763		738		735		59		*	
N. pens	8		8		8					
ADFI, kg/d[2]	2.33		2.34		2.38		0.10		***	
Before transition	2.07[b]		2.15[a]		2.18[a]		0.07	*	***	
After transition	2.51		2.46		2.51		0.13		***	
FCR, kg/kg[2]	2.87		2.94		2.97		0.10			
Before transition	2.33		2.39		2.42		0.09			
After transition	3.31		3.38		3.43		0.14			
Carcass, kg[1]	91.4		90.9		91.3		2.9			
Dressing percentage[3]	82.0		81.8		82.0		1.2			
Backfat G34, mm[3]	13		13		14		3		***	
Muscle M34, mm[3]	63		62		62		4			
Carcass leanness, %[3]	61.8		61.3		60.9		2.0		***	
Nitrogen, kg/pig[4]										
Intake	6.06	*(100)*	5.65	*(93)*	5.40	*(89)*				
Retained	2.03	*(100)*	2.02	*(99)*	2.03	*(100)*				
Output	4.03	*(100)*	3.63	*(90)*	3.37	*(84)*				
in faeces	1.07	*(100)*	1.15	*(107)*	1.13	*(106)*				
in urine	2.96	*(100)*	2.49	*(84)*	2.24	*(76)*				
Phosphorus, kg/pig[4]										
Intake	1.03	*(100)*	1.10	*(107)*	1.08	*(105)*				
Retained	0.43	*(100)*	0.42	*(100)*	0.43	*(100)*				
Output	0.60	*(100)*	0.67	*(112)*	0.65	*(108)*				
in faeces	0.41	*(100)*	0.47	*(115)*	0.46	*(112)*				
in urine	0.19	*(100)*	0.20	*(106)*	0.19	*(100)*				

1. Model 1: split-plot variance analysis with the treatment (T, n=3), gender (G, n=2), interaction T×G and replicate (R, n=8) as main effects. The pen was considered as the experimental unit.

2. Model 2: variance analysis from average data per pen with T, G, TxG and R as the main effects.

3. Model 3: the slaughter body weight was introduced as a covariate in the statistical Model 1.

4. Assessed using InraPorc software.