Digestibility and nitrogen balance of diets containing non conventional vegetable proteins fed to pigs of genetic strains suitable for outdoor systems

L. Rizzi, G. Martelli, R. Paganelli, M. Simioli, L. Sardi

Dipartimento di Morfofisiologia Veterinaria e Produzioni Animali. Università di Bologna, Italy

Corresponding author: Luca Sardi. Dipartimento di Morfofisiologia Veterinaria e Produzioni Animali. Facoltà di Medicina Veterinaria, Università di Bologna. Via Tolara di Sopra 50, 40064 Ozzano Emilia (BO), Italy - Tel. +39 051 2097376 - Fax: +39 051 2097373 - Email: luca.sardi@unibo.it

ABSTRACT: The study was carried out to evaluate on growing pigs kept in metabolism crates, either belonging to a "traditional" cross-breed (Duroc x Large White – DLW) or a local breed (Cinta Senese – CS), the digestibility and the nitrogen balance of non-conventional vegetable protein sources (field beans, pea and sunflower cake) when compared to soybean meal. The four diets were formulated so as to supply the same crude protein amount. CS pigs showed lower apparent digestibility coefficients (ADCs) for crude protein (81,38% vs 82,65%) and crude fibre (35,97% vs 40,65%). Nitrogen balance was more favourable in DLW pigs (32,12% vs 19,67%) which showed a higher nitrogen retention (+69%). With respect to the protein source, no differences were observed for nitrogen balance. Sunflower diet showed the higher ADC for ether extract (+20% compared with soybean diet). Crude fibre digestibility was lowered in sunflower (-33%) and field beans (-13%) diets. Sunflower and field beans diets showed the lowest gross energy digestibility coefficients. Field pea diet had the highest ADC for crude fibre (+ 12%) leading to ADCs for organic matter and gross energy comparable to those of soybean meal. It is concluded that field bean, sunflower cake and field pea could be considered as valuable non-conventional protein sources in swine nutrition.

Key words: Pig, Non-conventional protein source, Apparent digestibility, Nitrogen balance.

INTRODUCTION – The interest for outdoor rearing of pigs (according both to organic and traditional methods) has recently grown. To this aim rough and indigenous breeds, as well as skin-coloured breeds and animals deriving from specific crossbreeds must be preferred to "traditional" pigs (Franci *et al.*, 1998; Campodoni *et al.*, 2003). Due to the fact that the European Community is not self-sufficient for protein-feedstuffs production, economic incentives are supplied to produce protein and oil crops (solvent-extracted meals have, in fact, a high protein content). Solvent extracted meals cannot be used in organic systems (EC Reg. 1804/99). Apart from soybean, the most common protein crops suitable for animal feeding are pea (*Pisum sativum*), lupin (*Lupinus luteus, albus, angustifolius*) and sunflower (*Helianthus annuus*). In Italy the production of these latter vegetables has recently grown together with the production of crops that are particularly apt to Italian climate such as field beans (*Vicia faba*) and chickling-vetch (*Lathyrus cicera)*. Legume seeds contain several anti-nutritional factors (ANF) which could interfere in the digestive process of dietary component (Huisman *et al.*, 1990). From these considerations it may be concluded that researches on indigenous pig breeds fed non-traditional protein crops are of particular interest. As above mentioned, protein crops that can be easily produced in non-intensive areas are preferable.
The trial was aimed to investigate the digestibility and the nitrogen balance of diets containing different protein sources (field beans, pea and sunflower cake) fed to pigs either belonging to a "traditional" (Duroc x Large White) or local (Cinta Senese) breed.

MATERIAL AND METHODS – Eight barrows (4 Cinta Senese – CS, and 4 Duroc x Large White - DLW), aged of 6 months, were used. Due to the different growth capacity, the initial body weight differed between the two genotypes (65 kg CS pigs and 95 kg DLW pigs). Four different iso-nitrogenous diets were tested. The main protein source of each of these diets was: 1) soybean meal; 2) field bean meal (*Vicia faba*); 3) sunflower cake (*Helianthus annuus*); 4) field pea meal (*Pisum sativum*) (table 1). Diets were supplied on a basis of 90 g/kg of metabolic weight.

Table 1. Percent and chemical composition of the diets.

Diet		Soybean meal	Field bean cake	Sunflower meal	Field peas meal
Cereals and cereal by-products	%	84.6	74.6	71.6	71.6
Soybean meal	"	10.0	-	-	-
Field bean meal	"	-	20.0	-	-
Sunflower cake	"	-	-	23.0	-
Field peas meal	"	-	-	-	23.0
Potato protein	"	2.5	2.5	2.5	2.5
Premix	"	2.90	2.90	2.90	2.90
Crude protein	% as fresh	13.27	13.33	13.39	13.35
Ether extract	"	2.94	2.92	4.90	2.93
Crude fibre	"	4.35	4.57	6.88	4.46
Gross energy	Kcal/kg	4247	4243	4429	4201

Pigs belonging to the same genotype were kept, in turn, in metabolism cages and fed the different diets according to a "Latin square" design. Each in-cage period lasted of 7 days and it was preceded by a 7-day adaptation period. Feed intake was recorded daily both during the adaptation period and the experimental phase. Faeces and urines collection was carried out twice a day over a 5-day period. The total daily faecal yield was immediately frozen. To avoid nitrogen volatilisation, 15 ml of an acid solution (sulphuric acid) were added to each litre of urine as suggested by Sardi *et al.* (1998). Urines were sub-sampled (10% of the total daily yield) and immediately frozen. Apparent digestibility coefficients (ADCs) and nitrogen retention were calculated from nutrients intake and excretion in faeces and urines. Data were analyzed by MIXED procedure (SAS, 1999), where diets and genetic type were the fixed effect and subject within breed the random effect. Breed x Diet interaction was not significant and it was removed from the model.

RESULTS AND CONCLUSIONS – Feed intake did not differ among the diets; due to the higher live weight (126.4 vs 89.4 kg), DLW pigs had a higher feed intake (3.3 vs 2.7 kg; $P<0.01$). This is the reason why data on nitrogen balance have been expressed on the basis of animals' metabolic weight. Nitrogen balance and apparent digestibility coefficients are shown in table 2. CS pigs showed a higher ($P<0.05$) urinary nitrogen excretion leading to a lower ($P<0.01$) ratio between N retained and N ingested when compared to DLW pigs. These findings are only partially consistent with those reported by Acciaioli *et al.* (2003) who found significant differences for all the parameters involved in the nitrogen balance of swine. Nevertheless is worth to note that these authors utilized CS and Large White pigs at a markedly lower body weight (about 60 kg) than animals used in the present trial. With respect to nutrient digestibility, ADCs for protein and crude fibre were higher ($P<0.05$) in DLW pigs.

Regardless of the genetic type, the four diets did not result in any significant difference for nitrogen utilization while, with the exception of crude protein, the comparison among the diets showed significant difference for all the remaining ADCs. Although the diet containing sunflower cake had the highest ($P<0.01$) ADC for ether extract (this fact could probably be tied to the high lipid content of such ingredient), the low ADC for crude fibre ($P<0.01$) resulted in lower ADCs for both organic matter and gross energy ($P<0.01$).

Also crude fibre utilization of field bean diet was lower than that of soybean meal; according to Acciaioli *et al.* (2003) it is instead possible that the tannin content of field bean was responsible for the reduction of fibre digestibility.

Diet containing field pea meal showed the highest ADC for crude fibre leading ADCs values for organic matter and gross energy comparable to those of soybean meal. According to Mariscal-Landin *et al.* (2002), this fact could be related to the low level of ADL of pea meal fibre.

From our data it is concluded that, regardless of genotype (either "conventional" or local breed), field pea meal, field bean meal and sunflower cake can be used in swine formulations tacking into account differences on fibre digestibility of such ingredients.

Table 2. Nitrogen balance (g/d/kg $pv^{0.75}$) and apparent digestibility coefficients (%) of the diets.

	Genotype		Diet				
Diet	CS	DLW	Soybean meal	Field bean meal	Sunflower cake	Field pea meal	SE
N intake	1.83	1.89	1.73	1.84	1.96	1.92	0.04
Faecal N	0.34	0.33	0.31	0.34	0.34	0.35	0.01
Digested N	1.48	1.56	1.41	1.50	1.62	1.57	0.04
Urinary N	1.13^{a}	0.95^{b}	0.97	1.01	1.10	1.09	0.04
N in excreta	1.47^{a}	1.28^{b}	1.28	1.35	1.44	1.44	0.03
Retained N	0.36^{B}	0.61^{A}	0.45	0.49	0.52	0.48	0.03
N retention / N intake	19.67^{B}	32.12^{A}	25.58	26.37	26.76	24.88	1.38
ADCs:							
Organic matter	82.83	83.65	83.97^{AB}	83.39^{B}	80.16^{C}	85.46^{A}	0.42
Crude protein	81.38^{b}	82.65^{a}	81.98	81.61	82.77	81.70	0.32
Ether extract	55.60	56.21	53.55^{B}	54.75^{B}	64.22^{A}	51.12^{B}	1.06
Crude fibre	35.97^{b}	40.65^{a}	41.84^{AB}	36.58^{B}	28.01^{C}	46.79^{A}	1.65
Gross energy	81.64	81.33	82.32^{Aa}	81.68^{Ab}	78.59^{Bc}	83.35^{Aa}	0.39

A, B, C: P<0.01; a, b, c: P<0.05.

The research was supported by MIUR (PRIN 2003).

REFERENCES – **Acciaioli, A.,** Pianaccioli, L., Campodoni, G., Bozzi, R., Pugliese, C., Franci, O., 2003. Total apparent digestibility and nitrogen bilance in Cinta Senese pigs: utilization of field bean (Vicina faba l.). Ital. J. Anim. Sci. 2, 107-114. **Campodoni, G.**, Fabbio, G., Franci, O., 2003. Valorizzazione delle risorse boschive con l'allevamento suino. Atti Convegno Nazionale "Parliamo di … allevamenti alternativi e valorizzazione del territorio", Cuneo, 25/09/2003, pp 27-40. **Franci, O.,** Acciaioli, A., Pugliese, C., Bozzi, R., Campodoni, G., Gandini, G., 1998. Performance di scrofe di razza Cinta Senese allevate al brado e a stabulazione. Atti IV Congr. Naz. Biodiversità. Carlo Delfino Ed. 1113-1116. **Huisman, J.**, van der Poel, A.F.B., Versteegen, M.W.A., van Weerden, E.J., 1990. Antinutritional factors (ANF) in pig production. World Rev. Anim. Prod. 25: 77-82. **Mariscal-Landin, G**., Lebreton, Y., Seve, B., 2002. Apparent and standardized true ileal digestibility of protein and amino acids from faba bean, lupin and pea, provided as whole seeds, dehulled or extruded in pig diets. Anim. Feed Sci. Technol., 97: 183-198. **Sardi, L**., Martelli, G., Parigini, P., Scipioni, R., 1998. Influenza del metodo di raccolta e di conservazione degli excreta sul bilancio azotato del suino. Zoot. Nutr. Anim. 24: 163-170. **SAS**, 1999. User's Guide: Statistics, Version 8.2. SAS Institute Inc., Cary, NC, USA.