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THE EFFECTS OF SOYBEAN PRESS CAKE ON PRODUCTIVE TRAITS AND MEAT QUALITY OF ITALIAN HEAVY PIGS INTENDED FOR PARMA HAM PRODUCTION

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ABSTRACT

Sixty castrated male pigs (initial average body weight (BW) of 26 kg) were allotted to two experimental groups, one of which was fed a diet containing solvent extracted (SE) soybean meal, whereas the other received a diet in which SE soybean meal was entirely replaced by soybean press cake (CAKE). Pigs were slaughtered at about 160 kg body weight, according to the rules for Parma Ham production. The soybean source did not significantly ($P > 0.05$) affect the growth traits (average daily gain (ADG) and feed conversion ratio (FCR), slaughtering parameters (dressing out, lean meat percentage and lean cuts yields) or meat quality (pH, colour and water holding capacity). From a human nutrition standpoint, soybean press cake favourably influenced fatty acids composition of the subcutaneous fat of the thighs. Heavy pigs receiving soybean press cake showed, in fact, a significantly ($P < 0.001$) lower relative content of saturated fatty acids (SFA) and an increased ($P < 0.05$) level of polyunsaturated fatty acids (PUFA) in comparison with animals fed the diet containing SE soybean meal. No negative effects were noted with respect to ham attitude for long-term curing.

Key words: soybean cake / Parma Ham / fatty acids / heavy pigs

1 INTRODUCTION

Due to its higher percent crude protein, better quality protein and highly digestible amino acids when compared with other plant source proteins, soybean meal has long been used as animal feed and remains the primary protein source in diets of poultry and swine (Nahashon and Kilonzo-Nthenge, 2011). Soybean meal, i.e. the defatted meal resulting from the solvent extraction, is the primary by-product of soybean oil extraction. In organic agriculture, the use of soybean meal is not allowed, since no feed materials which have been processed with chemically synthesized solvents shall be used (EC, 2007), therefore soybean press cake (i.e., the cake resulting from crushing whole soybeans to press out the oil mechanically) could represent a valuable strategy to fulfill the nutritional requirements of animals raised according to the organic method without resulting in possible dietary (mainly aminoacidic) imbalances (Sundrum *et al.*, 2006). Conversely, the use of press cakes is presently not allowed in PDO (protected designation of origin) Italian cured hams production because of their high linoleic acid content (Consortium for Parma Ham, 1992). This latter could, in fact, negatively impact on the oxidative stability of ham during its long (12-month) dry-curing period.

In this paper, locally grown soybean press cake was used to replace soybean meal in diets fed to Italian heavy pigs intended for Parma Ham production. The effects on growth and slaughter parameters, meat and fat quality were studied to assess the feasibility of that feeding strategy.

2 MATERIAL AND METHODS

The University of Bologna Ethical Committee on the care and use of laboratory animals reviewed and approved the experimental protocol. The experiment was

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Table 1: *Ingredient composition (%) and chemical characteristics of the diets*

	25–50 kg BW (0–55 days of trial)		50–80 kg BW (56–118 days of trial)		80–160 kg BW (119–251 days of trial)	
SOYBEAN	SE MEAL	CAKE	SE MEAL	CAKE	SE MEAL	CAKE
Cereals products and by-products	69.0	69.4	75.03	75.28	79.87	79.85
Soybean meal SE 44%	15.0	-	15.0	-	12.0	-
Soybean cake	-	15.0	-	15.0	-	12.0
Faba bean meal	5.0	5.0	5.0	5.0	5.0	5.0
Maize gluten feed	5.0	5.0	-	-	-	-
Fish meal	1.0	1.0	-	-	-	-
Hydrogenated palm oil	1.69	1.25	1.6	1.35	-	-
Mineral-vitamin premix	3.18	3.18	3.25	3.25	3.05	3.05
L-Lysine HCl	0.13	0.17	0.1	0.12	0.08	0.1
Chemical composition:						
Crude protein (%)	15.89	15.73	14.72	14.49	13.62	13.43
Ether extract (%)	4.31	4.59	4.21	4.66	2.69	3.25
Crude fibre (%)	5.01	4.94	4.68	4.59	4.45	4.36
Digestible energy (kcal/kg)	3204	3204	3207	3217	3158	3177
Lysine (%)	0.90	0.90	0.81	0.80	0.72	0.71
Linoleic acid (%)	1.30	1.68	1.28	1.69	1.34	1.64

BW – body weight

conducted in accordance with Directive 2008/120/EC on the protection of pigs (EC, 2008).

Sixty crossbred (Landrace × Large White) castrated males with an initial average BW of 26 kg were used. Pigs were kept in 12 collective pens on a totally slatted floor. Each pen (i.e. replicate) contained 5 pigs and was equipped with a bite drinker and a collective stainless steel feeder. Environment was enriched by providing steel hanging chains. Pens were placed in temperature-controlled rooms (22 °C) equipped with a forced-air ventilation system. Water was available *ad libitum*. Feed was offered twice a day (at 08:30 and 16:30) and pigs were fed at 9% of their metabolic body weight ($BW^{0.75}$) up to a maximum of 2.9 kg dry matter (DM) per pig per day. The trial lasted up to the 251st day, when pigs reached a BW of approximately 160 kg according to Consortium for Parma Ham (1992) rules.

Pigs were allocated (on the basis of litter and BW) into two experimental groups, each containing 6 replicates of 5 pigs. The two groups were fed as follows: control group received a diet containing solvent extracted soybean (SE) meal, treatment group was fed a diet containing soybean cake. Considering that soybean meal and soy cake are different in terms of protein content (43.1 *vs.* 39.6% CP, respectively), diets were supplemented with L-lysine HCl in different amounts. To meet the pigs' requirements at different periods of growth and fattening, three different formulations were used (see Table 1). In order to make the diets isoenergetic, hydrogenated palm oil was added in different amounts until 80 kg of BW. No lipid supplementation was given afterwards (i.e. during the last 133 days of trial).

Table 2: *Growing and slaughtering parameters*

SOYBEAN			SE MEAL	CAKE	RMSE
FI		kg/day	2.11	2.09	0. 02
ADG	1-251d	kg	0.533	0.548	0.09
FCR	1-251d		3.88	3.80	0.35
Dressing out		%	81.78	81.74	1.48
Lean meat		%	50.24	49.98	3.01
Backfat thickness		mm	24.43	24.66	5.68
Ham subcutaneous fat thickness		cm	2.67	2.80	0.72
Loin (% carcass weight)		%	10.83	10.69	0.89
Thigh (% carcass weight)		%	25.68	25.58	0.93

FI – feed intake; ADG – average daily gain; FCR – feed conversion ratio; RMSE – residual mean squared error;
No significant differences (P > 0.05) were observed between the experimental groups

Table 3: *Meat quality*

SOYBEAN			SE MEAL	CAKE	RMSE
pH 45' LD			6.36	6.24	0.31
pH 45' SM			6.20	6.01	0.26
pH 24h SM			5.61	5.63	0.09
Colour of thigh	L*		50.50	50.75	2.52
	Hue		0.78	0.77	0.11
	Chroma		9.21	8.98	1.54
Drip loss		%	3.42	3.31	0.78
Cooking loss		%	20.41	20.29	3.22

No significant differences (P > 0.05) were observed between the experimental groups

To calculate the ADG, pigs were individually weighed at the beginning of the trial, after 42 days, after 118 days and at the end of the trial (251 days). The feed intake (FI) of every replicate was recorded daily in order to calculate the FCR. The recording of fattening performance (FI, ADG and FCR) ended on the 251st day of the trial, when pigs attained the required BW (of about 160 kg).

Pigs were slaughtered after a 12-h fast. Immediately after slaughtering, dressing out and lean meat yield of the carcasses were measured, the latter using a Fat-o-Meater (F-o-M) (SFK, Copenhagen, DK). At 45 minutes post mortem, the pH value of both the *Semimembranosus* (SM) and *Longissimus dorsi* (LD) muscles was measured in duplicate. Thereafter, each carcass was dissected and the main commercial lean cuts (thigh and loin) were weighted. At 24 h post mortem, a second reading of the pH value was taken (SM muscle). Meat colour (SM muscle) was measured according to the *L*a*b** system using a Minolta Chroma Meter CR-200 (Minolta Camera, Osaka, Japan). A 20-mm-thick slice (150 g) of LD muscle was taken at the last rib, packed and transported (4 °C) to the laboratory to assess drip loss and cooking loss (Honikel, 1998). The fatty acid composition of subcutaneous fat taken in the area overlying the *Biceps femoris* (BF) muscle was determined by gas chromatography (HRGC 8560 Series Mega 2 gas chromatograph; Fisons Instruments, Milan, Italy). The iodine number was assessed according to AOAC (2000). The experimental data obtained were submitted to analysis of variance (GLM procedure) with the diet assumed as the main effect (Statistica ver. 10.0, StatSoft Inc.).

3 RESULTS AND DISCUSSION

No health problems or mortality were recorded during the trial. The experimental diets (*i.e.* the soybean source) did not affect growth traits (FI, ADG and FCR), slaughtering parameters (dressing out, lean meat percentage and lean cuts yields; see Table 2) or meat quality (*post-mortem* glycolysis, colour and Water Holding Capacity; see Table 3).

The inclusion of soybean cake modified the acidic composition of subcutaneous fat (Table 4), significantly ($P < 0.001$) reducing its saturated fatty acid (SFA) content. Specifically, myristic and palmitic acid relative contents decreased in pigs on soybean cake diets, whereas the decrease of oleic acid content was not significant. On the contrary, due to linoleic, linolenic and arachidonic acid increases, polyunsaturated fatty acids (PUFA) relative content significantly ($P < 0.05$) raised, as well as the iodine number ($P < 0.001$). From a human nutritional standpoint, such modifications can be regarded as highly positive for consumers' health (Department of Health, 1994; Simopoulos, 2000). Overall the characteristics of the fat from the raw thighs appeared perfectly suitable (linoleic acid <15%, iodine number <70) for long dry curing, according to Parma Ham Consortium (1992) rules.

4 CONCLUSIONS

Soybean cake from locally grown soybean cultivations is generally regarded as a sustainable protein source for pigs suitable for organic farming; however no studies have been carried out in order to investigate its possible effect on long cured pork products such as Parma Ham. From our data it is suggested that the replacement of soybean meal (ether extracted) by soybean cake does not

Table 4: *Subcutaneous fat of thigh: fatty acid composition*

SOYBEAN		SE MEAL	CAKE	RMSE
C 14:0	%	1.75***	1.49	0.20
C 16:0	%	23.31***	22.05	1.00
C16:1	%	2.13**	1.81	0.35
C 18:0	%	12.29	11.74	1.05
C 18:1	%	43.25	42.75	2.47
C 18:2	%	13.01***	14.85	2.66
C 18:3	%	0.64*	0.96	0.17
C 20:4	%	0.65**	0.77	0.13
SFA	%	38.22***	36.23	1.57
MUFA	%	47.21	46.51	2.63
PUFA	%	14.57*	17.25	2.94
Iodine number		62.46***	66.70	3.58

RMSE – residual mean squared error; * P < 0.05; ** P < 0.01; *** P < 0.001

modify the main production parameters of heavy pigs intended for Parma Ham production. From a human nutritional standpoint, the use of soybean cake resulted in a more favourably fatty acids profile of the subcutaneous fat. Further studies are needed in order to investigate the possible effects of soybean cake on the main qualitative parameters of hams after the required long curing period.

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