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THE ENERGY VALUE OF OLIVE OIL SOAP STOCKS FOR IBERIAN CROSSBRED PIGS

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ABSTRACT

Twenty four Iberian × Duroc 50:50 barrows of 50 kg initial body weight (BW) were placed in individual pens and allotted to 4 dietary treatments in which olive oil soap stocks (OSS) replaced 0, 25, 50 and 75 g/kg of a basal diet based on barley, corn, soyabean meal and wheat middlings. The apparent digestibility of nutrients and the N balance were studied. In a second experiment, sixteen pigs in the finishing stage of growth were randomly allotted to two experimental diets containing 12.5 and 62.5 g of OSS/kg in replacement of the basal diet. Daily feed allowance was fixed at 0.90 × *ad libitum* intake, in two equal meals. The apparent digestibility of dry matter (DM), organic matter, crude protein (CP), crude fat (ether extract; EE) and gross energy (GE) was not altered by the level of OSS dietary inclusion, remaining at 0.793 ± 0.0078, 0.825 ± 0.0070, 0.767 ± 0.0131, 0.857 ± 0.0134 and 0.799 ± 0.0084, respectively. OSS contain 31.24 MJ ME/kg. No differences in N retention were found between the experimental diets, the average value being 23.2 ± 1.04 g N retained daily. The inclusion of OSS in the diet of the finishing pigs improved the average daily gain (924 ± 23.9 *vs.* 838 ± 23.9 g; $P < 0.05$), and showed a tendency to improve the feed conversion ratio (3.78 ± 0.125 *vs.* 4.11 ± 0.125; $P = 0.077$). However, Gain:ME intake (g/MJ) remained unchanged at 19.6 ± 0.40 on average.

Key words: olive oil soap stocks / energy value / Iberian pigs

1 INTRODUCTION

Olive oil soap stocks (OSS), a by-product of the olive oil extraction industry, is a valuable source of oleic acid highly appreciated as a supplement in diets for fattening Iberian pigs reared on intensive feeding systems (González and Tejeda, 2007; González *et al.,* 2012). Their use is limited by the content of unsaturated fatty acids (FA), due to the negative effect these FA may have on meat quality (FEDNA, 2003). Due to the high proportion of free FA, their digestibility tends to be comparatively lower than that of the oils they come from (Powles *et al.,* 1995). Estimations of their energy value are currently made based on chemical parameters (free FA content, degree of unsaturation) by equations derived from studies carried out with other fat resources (Powles *et al.,* 1995). Furthermore, in spite of their extensive use, no systematic evaluation has been carried out on the effects of the use of OSS as ingredient of the feed mixture on feed efficiency, digestibility of nutrients and on protein accretion. The purpose of the present work was to determine the effects of the inclusion of OSS in the diet on growth performance, nutrient digestibility and N utilization of crossbred growing Iberian pigs.

2 MATERIALS AND METHODS

A digestibility and balance trial was performed in Iberian (IB) × Duroc (DU) 50:50 barrows of app. 50 kg body weight (BW). The pigs were individually housed in 2 m^2 pens located in an environmentally controlled room

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at 20 ± 2 °C and randomly assigned to 4 homogeneous groups of 6 or 7 pigs each. Each group was offered one experimental diet. Four diets were prepared by replacing 0, 25, 50 and 75 g/kg of a basal diet, based on barley grain, corn grain, soyabean meal and wheat middlings (analysed composition (g/kg): CP, 145; acid detergent fibre, 52.4; total ash, 68.3. GE, 16.17 MJ/kg) with OSS to provide 4 different dietary fat contents [EE: 20.8, 46.2, 56.2 and 86.6 g/kg]. The amino acid (AA) pattern of the dietary protein followed the ideal protein concept (BSAS, 2003). The analysed composition of OSS was (g/kg): DM, 971; EE, 966; total N, 0.63; total ash, 1.34; GE, 38.77 MJ/kg. Main fatty acid relative profile in the crude fat fraction was (%): C16:0, 13.3; C18:0, 3.39; C18:1 cis 9, 67.4; C18:1 cis 11, 2.04; C18:2 n6 (cis 9, cis 12), 9.99; C18:3 n3 α, 0.911. The SFA/USFA ratio was 0.22. Iodine and saponification indexes were 85 and 190, respectively. The feed mixtures were offered as pellets at 0.90 × *ad libitum* intake (estimated as described by Nieto *et al.*, 2001), in 2 equal daily meals. Feed refusals were daily collected, dried and weighed to calculate actual feed intakes.

A feeding experiment was performed at the finishing stage of growth. Sixteen pigs were randomly allotted to two homogeneous groups of eight pigs each. Two experimental diets were prepared containing 12.5 and 62.5 g of OSS/kg in replacement of the basal diet. The daily feed allowance was fixed at 0.90 × *ad libitum* intake, given in two equal meals.

The experimental protocol was reviewed and approved by the Bioethical Committee of the Spanish National Research Council (CSIC).

Average daily feed intake, BW gain, feed efficiency, total tract apparent digestibility (TTAD) of DM, organic matter (OM), crude protein (CP), crude fat (ether extract, EE) and gross energy (GE), and the N balance were measured. The digestibility trial was initiated when the pigs attained 52.9 ± 0.58 kg BW after a period of 7 days on the restricted feed allowance. Total collection of faeces and urine was performed daily for 5 days. Aliquots were kept at −20 °C until analyses. Urine was collected into 50 ml 4 M-H_2SO_4. The feeding experiment began when the pigs weighed 90.2 ± 0.93 kg BW. The pigs were individually housed in 5 m^2 pens located in a room at 19.0 ± 1.5 °C.

The following analytical procedures were carried out according to AOAC (2003): DM content of diets, OSS and freeze-dried faeces (#934.01); ether extract and total ash of diets, OSS and freeze-dried faeces (#920.39 and #942.05), and total N in diets, OSS and urine, by the Kjeldahl procedure (#984.13). In freeze-dried faeces total N was determined according to the Dumas' method, by total combustion in TruSpec CN equipment (Leco Corporation, USA). Gross energy (GE) of diets, OSS and freeze-dried samples of faeces and urine was measured in an isoperibolic bomb calorimeter (Parr Instrument Co., Moline, IL). The FA content of OSS were extracted and quantified according to Sukhija and Palmquist (1988). Pentadecanoic acid (C15:0; Sigma-Aldrich, Madrid, Spain) was used as internal standard. Fatty acid

Table 1: *The effects of increasing proportions of olive soap stocks (OSS) in the diet on nutrient digestibility and N balance of IB × DU 50 : 50 growing pigs*

	Experimental diet						
OSS, g/kg	0	25	50	75		P-value	
Basal diet : OSS, g/g	1000 : 0	975 : 25	950 : 50	925 : 75	SEM	Linear	Quadratic
Coefficients of TTAD							
Dry matter	0.791	0.799	0.785	0.797	0.0039	NS	NS
Organic matter	0.825	0.831	0.817	0.826	0.0035	NS	NS
Crude protein	0.773	0.774	0.760	0.760	0.0065	NS	NS
Ether extract	0.865	0.859	0.857	0.846	0.0067	NS	NS
Gross energy (GE)	0.803	0.803	0.791	0.800	0.0042	NS	NS
ME/GE	0.772	0.780	0.768	0.779	0.0042	NS	NS
ME/DE	0.971	0.971	0.971	0.975	0.0011	NS	NS
N balance							
Retained N, g/day	24.8	23.6	22.7	21.8	1.04	NS	NS
Retained N/N intake	0.412	0.412	0.402	0.394	0.018	NS	NS
Retained N/N apparently absorbed	0.540	0.536	0.527	0.518	0.024	NS	NS

TTAD – total tract apparent digestibility

methyl esters were identified by gas chromatography as described elsewhere (López-Bote *et al*., 1997).

Orthogonal polynomial contrasts were used to determine linear and quadratic effects of dietary proportion of OSS on digestibility and N balance variables. The StatGraphics software Centurion XV, version 15.2.06, StatPoint Inc was used. The pig was the experimental unit for all the variables studied. Experimental data were also analysed by a one-way ANOVA. Statistical significance was assessed by the Tukey test, and the level of significance was established at 5%.

3 RESULTS

The coefficients of TTAD of DM, OM, CP, EE and GE were not altered by the level of OSS inclusion in the diet (Table 1). Also, the coefficient of metabolizability of GE and the ME:DE ratio remained unchanged The energy density of the diets increased linearly ($P < 0.001$) from 14.56 to 15.82 MJ of digestible energy (DE)/kg DM and from 13.99 to 15.42 MJ of ME/kg DM on increasing the proportion of OSS in the diet. The ME content of the experimental diets, corrected for N retention equal to zero: MEn = 0, increased linearly from 13.67 to 15.14 MJ/kg DM with increasing proportions of OSS in the diet ($P < 0.001$). The energy value of OSS, estimated from the linear regression relating the proportion (g/kg) in which OSS replaces basal diet and the dietary ME content (kJ/g), was 31.24 MJ ME/kg. No differences in N retention were found between treatments. The average level of N retention was 23.2 ± 1.04 g/d, corresponding to average efficiencies of utilization of total N (retained N/N intake) and N apparently absorbed (retained N/apparent digestible N) of 0.405 ± 0.018 and 0.530 ± 0.024, respectively.

In the feeding experiment performed in the finishing stage of growth, average daily gain improved (924 ± 23.9 *vs.* 838 ± 23.9 g; $P < 0.05$), and feed conversion showed a tendency to improve (3.78 ± 0.125 *vs.* 4.11 ± 0.125; $P = 0.077$). in pigs fed the diet containing the highest dietary proportion of OSS. However, the ratio Gain:ME intake (g/MJ) remained unchanged at 19.6 ± 0.40 on average.

4 DISCUSSION

In the production of the crossbred IB pig, the incorporation of OSS to the feed mixture as provider of oleic acid is usually practiced to enhance the presence of this FA in animal tissues, thereby upgrading meat quality (González *et al*., 2012). The present experiment was designed to cover the range of usual levels of incorporation of OSS in the diet for fattening and finishing pigs to validate the practical application of the experimental observations. Growth performance improved in finishing pigs fed the diet containing 62.5 g OSS/kg compared to those fed 12.5 g OSS/kg. Atteh and Leeson (1985) studied the effects of supplementing the diets of weaner pigs with 0, 5 or 10% acidulated soapstock for a period of 6 wk. No significant effect of the dietary soapstock level on feed intake and on the apparent digestibility of protein and fat was found, although there was a decrease ($P < 0.05$) in average daily gain when dietary soapstock level increased to 10%. Feed:gain ratio was not influenced by diet.

The conversion factor ME/ED = 0.97 determined in the present study, allows us to estimate the DE content of OSS as 33.13 MJ/kg DM (32.14 MJ ME/0.97), practically equal to the value of 33.07 (7.900 Mcal × 4.184) MJ DE/kg DM tabulated by FEDNA (2003). We have not observed any significant negative effect of OSS incorporation on TTAD of nutrients and energy or on N balance. Our results differ from those of Woerfel (1981), who observed decrease in DM, CP, and digestibility of certain AA following the addition of soybean oil soap stock to the diet. Also, Bruce *et al.* (2006) found in growing pigs a quadratic decrease in the apparent ileal digestibility of DM, CP and 5 AA (Ile, Phe, Trp, Gly, and Ser) when increasing concentrations of soybean oil soap stocks were included in semi-purified diets containing soybean meal.

In conclusion, the inclusion of olive oil soap stocks in the diet of fattening crossbred Iberian pigs up to 75 g/kg did not affect the apparent digestibility of nutrients or body protein accretion. Olive oil soap stocks contained 32.14 kJ ME/g DM. In finishing pigs, OSS dietary inclusion improved average daily gain and tended to improve feed conversion.

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