Journal of Animal and Feed Sciences, 13, 2004, 429–443

Performance, fatty acids digestibility, carcass and muscle composition of pigs fed diets enriched with vitamin E and differing in their MUFA/PUFA ratio*

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(Received 27 October 2003; revised version 26 March 2004; accepted 16 June 2004)

ABSTRACT

The effect of dietary vitamin E supplementation (20 vs 200 mg α-tocopheryl acetate/kg) and different MUFA/PUFA ratio on pig performance, digestibility of fatty acids, and carcass and muscle chemical composition was studied. The feed containing higher concentration of C18:2 led to a more ($P<0.01$) efficient feed utilization (FCR) in boars and gilts. An effect ($P<0.05$) of dietary fat on C16:1, C18:0, C18:1 and C18:2 apparent digestibility was found. Apparent digestibility of C16:1 and saturated fatty acids was lower at higher vitamin E supplementation, indicating a possible competition for absorption. The partial substitution of dietary PUFA by MUFA produced a higher proportion of intramuscular fat ($P=0.04$), and a decrease in total fatty acid apparent digestibility only in the case that a basal level of vitamin E was added to the diet.

KEY WORDS: vitamin E, pigs, fatty acid, digestibility, monounsaturated fatty acids

INTRODUCTION

Pigs require a certain amount of polyunsaturated fatty acids (PUFA) for optimum health and performance. The Agricultural and Food Research Council (1981) indicated that C18:2 minimum dietary concentration in growing pigs from 30 to 90 kg should be 1.5% of dietary digestible energy (DE), which is approximately

* Supported by the Interministerial Committee of Science and Technology, ALI98-0707
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equivalent to 7 g/kg diet. The National Research Council (1998) of the United States recommends a minimum concentration of 10 g/kg diet in the same weight range. Whittemore (1993) indicated an ideal concentration of 4% of the gross energy for optimum growth (which is equivalent to 14 g C18:2/kg feed approximately). It might be also that modern pig genotypes with very high growth potential require a higher concentration of essential fatty acids than conventional pigs.

Due to availability and relative low cost in some productive circumstances, it is common that some practical diets for growing pigs provide a level of C18:2 above 15 g/kg. However, increasing the degree of polyunsaturation in animal tissues by dietary manipulation may accelerate oxidative deterioration in pig meat (Monahan et al., 1992) and produce undesirable flavour (Larick et al., 1992). For this reason, there is growing interest in the utilization of high level of vitamin E in swine nutrition, particularly in combination with dietary unsaturated oils (Asghar et al., 1991; Lopez-Bote, 2000; Rey et al., 2001). Practical recommendations of dietary vitamin E supplementation are approximately 3-6 mg vitamin E/g of PUFA (Putnam and Comben, 1987). In previous researches, it has been reported a negative effect of dietary polyunsaturated fatty acids on α-tocopherol accumulation (Renerre et al., 1999). However, there is little information of the possible interactions between dietary fatty acids and vitamin E concentrations on digestibility in pig nutrition.

The use of vegetable oils high in monounsaturated fatty acids (MUFA) as an alternative to those rich in PUFA (Miller et al., 1990; Myer et al., 1992) has reached an increased interest. This was due to the favourable publicity that monounsaturated fats have received in regard to human health (Grundy, 1986), because of its possibility of decreasing saturated and n-6 fatty acids and its low oxidation rate (Rey et al., 2004). MUFA, not only are coming from the diet but also can be newly synthesised by the animal from saturated fatty acids, as opposite to PUFA which belongs to essential fatty acids. However, dietary PUFA (Warnants et al., 1999) and MUFA (Klingenberg et al., 1995) show different degrees of inhibition of the stearyl-CoA desaturase activity and consequently, affect the synthesis of MUFA in the organism.

The objectives of this research were to evaluate the effect of the utilization of different MUFA/PUFA ratios (maintaining the same concentration of saturated fatty acids) and two levels of vitamin E (20 vs 200 mg/kg) in pig diets, on fatty acid digestibility, pig performance, and carcass and *M. longissimus lumborum* composition.

MATERIAL AND METHODS

Experimental design

Thirty male and thirty female Large White × Yorkshire pigs of 70 days age, weighting approximately 25 kg, were randomly located in individual cages and

TABLE 1

Ingredients and chemical composition of experimental diets[1] (with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fatty acids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium)

Dietary fat	Mono		Medium		Poly	
Indices	basal	supl.	basal	supl.	basal	supl.
Ingredients, g per kg of diet						
wheat	159	159	159	159	159	159
barley	591	591	591	591	591	591
soyabean meal	183	183	183	183	183	183
lard	22	22	22	22	---	---
olive oil	8	8	---	---	---	---
sunflower oil	---	---	8	8	22	22
hydrogenated fat[2]	---	---	---	---	8	8
sodium chloride	4	4	4	4	4	4
calcium carbonate	7	7	7	7	7	7
dicalcium phosphate	13	13	13	13	13	13
lys supplement (20%)[3]	8	8	8	8	8	8
vitamin and mineral premix[4]	5	5	5	5	5	5
α-tocopheryl acetate (50%)[5]	---	0.4	---	0.4	---	0.4
Proximate analysis, per kg dry matter						
crude protein, g	173	172	167	173	178	168
crude fat, g	61	60	57	60	57	57
crude fiber, g	43	41	44	41	44	44
ash, g	62.3	61	62	61	63	62
α-tocopherol, mg	25	279	30	251	31	237

[1] calculated concentration of digestible energy, Ca and P were 14.1 MJ, 7 g and 5 g, respectively per kg diet

[2] from palm oil (<0.3% trans fatty acids)

[3] Lys supplement = 20% L-Lysine + 80% carrier

[4] vitamin mineral premix provided (per kg diet): retinol, 7500 IU; cholecalciciferol, 1500 IU; mg: dl- α -tocopheryl acetate, 20; menadione, 0.80; thiamine, 0.50; riboflavin, 3; pyridoxine, 0.5; cobalamine, 0.02; pantothenic acid, 8; folic acid, 0.25; niacin, 15; biotine, 0.05; choline, 200; Co, 0.43; Cu, 22.5; Fe, 11.21; Mg, 15.3; Zn, 88.8; Se, 0.045 and I, 0.573

[5] α-tocopheryl acetate supplement = 50% α-tocopheryl acetate+ 50% carrier

fed a conventional pig diet until they had approximately 60 kg liveweight. At this moment six experimental diets were randomly assigned to ten pigs (5 male and 5 females). All pigs were fed *ad libitum* with the appropriate diet, which were formulated to contain three levels of PUFA and MUFA (but maintaining invariable the concentration of saturated) fatty acids. Ingredients, chemical composition and fatty acids of experimental diets are shown in Table 1. Within each dietary

fat treatment, one group was fed a basal level of vitamin E (20 mg α-tocopheryl acetate/kg diet; Hoffman La Roche, Switzerland) and the other group received a supplemented level (200 mg α-tocopheryl acetate/kg diet). The feed offered to the pigs was daily weighted and pig weights and feed consumptions were recorded every 3 weeks.

For the digestibility measurement, a parallel experiment using 30 boars (5 per dietary treatment) was carried out. Pigs weighting approximately 65 kg (thus equivalent to the first experimental period) were introduced in metabolic cages for 10 days and offered *ad libitum* the experimental diets containing 3 g/kg chromic oxide. After a period of accommodation (5 days), faeces were daily collected and storaged at -20°C until analysis. Analysis were carried out within 8 weeks.

Slaughter, sample collection and chemical analysis

Pigs were slaughtered at a local slaughterhouse at an average weight of 97.3 kg. Feeders were emptied 24 h prior to slaughter.

Proximate composition of the dietary ingredients and faeces was carried out according to the AOAC (1990). α-Tocopherol was extracted from feed as previously described by Rey et al. (2001). The analysis was carried out by HPLC (Hewlett Packard 1050, with a UWD, HPIB 10 detector and a RP-18 end-capped column; Waldbronn, Germany). The eluting solvent was methanol: water (97:3) at a flow rate of 2 ml/min. Chromic oxide concentrations in the diet and faeces were determined according to the procedure of Fenton and Fenton (1979).

Fatty acids of diets and faeces were extracted and quantified as by the one-step procedure described by Sukhija and Palmquist (1988) in lyophilized samples. Pentadecanoic acid (C15:1) (Sigma, Alcobendas, Madrid) was used as internal standard. Fatty acid methyl esters were identified by gas chromatography using a 6890 Hewlett Packard (Avondale, PA, USA), gas chromatograph equipped with a flame ionization detector and a capillary column HP-Innowax (30 m × 0.32 mm × 0.25 μm cross-linked polyethylene glycol) as described by Rey and Lopez-Bote (2001). Concentration of trans fatty acids in fats used in this experiment (hydrogenated palm fat, lard, olive oil and sunflower oil) was quantified by gas chromatography using a 6890 Hewlett Packard (Avondale, PA, USA) gas chromatograph equipped with a flame ionization detector and a capillary column (Supelco SP2340 60 × 0,25 mm × 0,2 μm film thickness). The carrier gas (helium) flow rate was 2,5 ml/min. The injector and detector temperature were 200°C and the oven was maintained at 200ºC.

Chemical and major fatty acid compositions of experimental diets are shown in Tables 1 and 2. All diets were formulated to contain the same concentration of saturated fatty acids (15±0.2 g/kg diet) but differed in the concentration of

TABLE 2

Fatty acid composition of experimental diets (with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fatty acids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium), g per kg DM

Dietary fat	Mono		Medium		Poly	
	basal	supl.	basal	supl.	basal	supl.
C12:0	0.6	0.7	0.9	0.2	1.0	1.0
C14:0	0.4	0.4	0.4	0.4	0.3	0.3
C16:0	10.6	10.2	9.7	10.3	8.2	8.4
C16:1	0.6	0.6	0.5	0.5	0.1	0.2
C17:0	0.1	0.1	0.1	0.1	0.0	0.0
C17:1	0.1	0.1	0.1	0.1	0.1	0.1
C18:0	3.3	3.6	3.5	3.9	5.4	5.0
C18:1 (n-9)	16.8	16.8	12.9	14.2	8.0	9.6
C18:1 (n-7)	1.1	1.1	0.9	1.0	0.4	0.5
C18:2 (n-6)	14.7	14.0	17.4	18.0	22.0	19.7
C18:3 (n-3)	1.1	1.1	1.1	1.1	0.9	1.0
C20:0	0.1	0.1	0.1	0.1	0.2	0.2
C20:1 (n-9)	0.4	0.4	0.4	0.5	0.2	0.3
C20:3 (n-9)	0.1	0.1	0.1	0.2	0.0	0.1
C20:5 (n-3)	0.1	0.1	0.1	0.1	0.1	0.2
C22:4 (n-6)	0.1	0.0	0.1	0.0	0.0	0.0
C22:5 (n-3)	0.1	0.1	0.2	0.2	0.2	0.2
C22:6 (n-3)	0.1	0.1	0.1	0.1	0.0	0.1
Total fatty acids	50.4	49.6	48.4	50.9	47.3	46.9
Σ SFA[1]	15.1	15.0	14.7	15.1	15.1	14.9
Σ MUFA[2]	19.0	19.0	14.7	16.2	9.0	10.7
Σ PUFA[3]	16.3	15.6	19.0	19.6	23.2	21.3

[1] Σ SFA= saturated fatty acids

[2] Σ MUFA= monounsaturated fatty acids

[3] Σ PUFA= polyunsaturated fatty acids

MUFA and PUFA. Therefore, the estimated unsaturated/saturated (U/S) fatty acid ratio was constant in all cases. This fact allowed us to assume that DE was identical in all experimental diets (Powles et al., 1995). Concentration of trans fatty acids in hydrogenated fat was below 0.3% of total fatty acids. The concentration (g/kg) of C18:2 in the diets was 14±0.4, 18±0.4 and 21±1.6, which is above the requirements of this nutrient in growing pigs (NRC, 1998).

Intramuscular neutral and polar lipids were extracted by consecutive solvent elution with dichloromethane and dichloromethane/methanol (90/10 v/v) according to the method proposed by Marmer and Maxwell (1981). Chromatographic conditions were similar to those described for feed.

Statistical analysis

The data were analysed using the general lineal model (GLM) procedure of SAS v.8 (SAS Institute., 1999). Source of added fat (3), dietary vitamin E level (2) and sex (2) were the effects studied. In addition, a linear regression procedure was carried out to quantify the effect of dietary fatty acid concentration on feed conversion ratio (FCR) during the first experimental period (21 days) and intramuscular fat content. Data are presented as the mean and standard error of the mean (SEM).

RESULTS

The effect of dietary treatment on growth, performance and carcass composition is shown in Tables 3 and 4. No effect of dietary fat was observed for weight gain or feed intake, although a significant effect of dietary fat was observed on FCR during the first three weeks of the experiment (P=0.034). The feed containing higher concentration of C18:2 led to a more efficient feed utilization. To quantify this effect, the following equation was calculated FCR (0-21 days)=2.74 (±0.208)-0.03 (±0.034) × dietary C18:2 (g/kg feed) ($P<0.05$) ($R^2= 0.21$) (n=10). Moreover, an interaction effect of dietary fat and vitamin E was also observed ($P<0.01$), in which the effect of dietary C18:2 concentration on feed efficiency was evident in pigs fed diets containing the basal level of vitamin E, but not in those receiving the supplemented diet (Figure 1). Boars showed a higher weight than gilts from the beginning of the experiment. Also boars showed a higher carcass length ($P<0.001$) and ham perimeter (P=0.011) (Table 4). A significant effect of dietary fat was also observed for ham perimeter (P=0.044). Since no significant effect of sex was found in chemical composition of muscle *Longissimus lumborum*, this was removed from the model.

No effect of dietary treatment was observed for dry matter digestibility (Table 5), but differences were found for C16:1, C18:0, C18:1 and C18:2 fatty acid apparent digestibility. Moreover, a significant effect of vitamin E supplementation was observed on C16:1 and saturated fatty acid digestibility. In both cases, apparent digestibility was lower at higher vitamin E supplementation. Apparent digestibility of total saturated fatty acids was lower in pigs receiving a diet containing supplemented level of vitamin E (P=0.042).

No significant effect of vitamin E or dietary treatment was observed on *Longissimus lumborum* muscle composition (Table 6), except for intramuscular fat content that was higher in pigs receiving a diet containing higher concentration of C18:1 (instead of C18:2). Moreover, a linear effect of dietary MUFA concentration was found, which could be fitted to the following equation: % in fat=0.35 (± 0.199)+0.17 (± 0.076) Dietary MUFA (g/kg) ($P<0.05$) ($R^2= 0.24$) (n=10).

TABLE 3

Weights (kg), average daily gain (ADG)(kg), daily feed intake (DFI, kg)and feed efficiency ratio (FCR=g intake/g gain) of boars and gilts fed on diets with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fatty acids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium), in each case with a basal (20 mg/kg diet) or supplemented level (200 mg/kg diet) of vitamin E

Indices	Dietary fat			Sex		Vitamin E		SEM	Probability of contrasts[1,2]						
	mono	medium	poly	female	male	basal	supl.		fat	vit. E	sex	fat × vit. E	fat × sex	vit. E × sex	fat×vit. E×sex
Initial weight	53.80	54.95	54.72	52.96	56.02	54.46	54.52	1.992	NS	NS	0.008	NS	NS	NS	NS
Weight at 21 d	74.25	76.78	76.16	72.73	78.73	76.40	75.06	2.392	NS	NS	0.001	NS	NS	NS	NS
Final weight, 41 d	94.93	98.04	96.77	93.23	99.93	97.55	95.61	3.190	NS	NS	0.001	NS	NS	NS	NS
ADG (0-21 d)	0.97	1.04	1.02	0.94	1.08	1.04	0.98	0.057	NS	0.042	0.001	0.030	NS	NS	NS
(21-41 d)	1.03	1.06	1.03	1.02	1.06	1.06	1.03	0.094	NS	NS	NS	NS	NS	NS	NS
(0-41 d)	1.00	1.05	1.03	0.98	1.07	1.05	1.00	0.059	NS	NS	0.009	NS	NS	NS	NS
DFI (0-21 d)	2.30	2.31	2.24	2.25	2.32	2.33	2.24	0.127	NS	NS	NS	NS	NS	NS	NS
(21-41 d)	2.48	2.58	2.45	2.43	2.58	2.54	2.47	0.153	NS	NS	0.072	NS	NS	NS	NS
(0-41 d)	2.39	2.44	2.34	2.34	2.45	2.43	2.35	0.116	NS	NS	0.084	NS	NS	NS	NS
FCR (0-21 d)	2.38	2.24	2.23	2.41	2.16	2.25	2.31	0.095	0.034	NS	0.001	0.003	NS	NS	NS
(21-41 d)	2.46	2.56	2.46	2.41	2.58	2.45	2.54	0.260	NS	NS	NS	NS	NS	NS	NS
(0-41 d)	2.41	2.35	2.30	2.39	2.32	2.33	2.37	0.107	NS	NS	NS	0.029	NS	NS	NS

[1] NS = not significant (P>0.05)

[2] not significant effect of fat × sex, vit. E x sex and fat × vit. E × sex was observed in any case

TABLE 4

Carcass composition of boars and gilts fed on diets with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fattya cids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium), in each case with a basal (20 mg/kg diet) or supplemented level (200 mg/kg diet) of vitamin E

Indices	Dietary fat			Sex		Vitamin E		SEM	Probability of contrasts[1,2]						
	mono	medium	poly	female	male	basal	supl.		fat	vit. E	Sex	fat × vit. E	fat × sex	vit. E × sex	fat×vit. E×sex
Carcass length, cm	81.56	81.99	82.28	80.23	83.65	82.42	81.46	1.264	NS	NS	0.001	NS	NS	NS	NS
Backfat last rib, mm	27.72	27.66	28.23	28.64	27.10	27.10	28.64	2.108	NS	NS	NS	NS	NS	NS	NS
Backfat P_2 mm	14.97	15.30	15.09	15.19	15.05	15.06	15.18	1.050	NS	NS	NS	NS	NS	NS	NS
Muscle depth, mm	67.04	70.41	70.50	70.62	68.02	70.04	68.60	2.786	NS	NS	NS	NS	NS	NS	NS
Ham perimeter, cm	67.61	69.09	68.76	67.79	69.18	68.84	68.13	0.838	0.044	NS	0.011	NS	NS	NS	NS

[1] NS = not significant (P>0.05)

[2] not significant effect of vit. E, fat × vit. E, fat × sex, vit. E × sex and fat × vit. E × sex was observed in any case

TABLE 5

Fatty acid and dry matter apparent digestibility (g/g) of boars fed on diets with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fatty acids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium), in each case with a basal (20 mg/kg diet) or supplemented level (200 mg/kg diet) of vitamin E

Indices	Dietary fat			Vitamin E		SEM	Probability of contrasts[1]		
	mono	medium	poly	basal	supl.		fat	vit. E	fat × vit. E
Dry matter	0.809	0.808	0.811	0.810	0.809	0.007	NS	NS	NS
C14:0	0.825	0.843	0.840	0.833	0.839	0.013	NS	NS	0.070
C16:0	0.847	0.831	0.818	0.844	0.820	0.017	NS	NS	NS
C16:1	0.933	0.925	0.889	0.931	0.900	0.014	0.022	0.027	0.063
C18:0	0.333	0.361	0.531	0.450	0.366	0.055	0.010	NS	NS
C18:1	0.922	0.914	0.895	0.907	0.913	0.009	0.034	NS	0.048
C18:2	0.971	0.976	0.982	0.977	0.975	0.004	0.074	NS	NS
C18:3	0.950	0.951	0.956	0.951	0.954	0.008	NS	NS	NS
C20:0	0.633	0.623	0.744	0.703	0.631	0.094	NS	NS	NS
Total saturated[2]	0.721	0.708	0.711	0.737	0.689	0.024	NS	0.042	NS
Total unsaturated[3]	0.944	0.948	0.955	0.949	0.949	0.0047	NS	NS	0.009
Total fatty acids[4]	0.878	0.876	0.880	0.885	0.870	0.009	NS	0.062	0.028

[1] NS = not significant (P>0.05)

[2] total saturated (C14:0, C16:0, C18:0, C20:0)

[3] total unsaturated (C16:1, C18:1, C18:2, C18:3)

[4] total fatty acids (C14:0, C16:0, C16:1, C18:0, C18:1, C18:2, C18:3, C20:0)

TABLE 6

Longissimus lumborum composition (g/100 g weight) from pigs fed on diets with a high concentration of monounsaturated fatty acids (19 g/kg dry matter, mono), a high concentration of polyunsaturated fatty acids (21.3-23.2 g/kg, poly) or an intermediate concentration (14.7-16.2 g monounsaturated and 19.0-19.6 g polyunsaturated fatty acids/kg, medium), in each case with a basal (20 mg/kg diet) or supplemented level (200 mg/kg diet) of vitamin E

Indices	Dietary fat			Vitamin E		SEM	Probability of contrasts[1]		
	mono	medium	poly	basal	supl.		fat	vit. E	fat × vit. E
Ash	1.17	1.07	1.08	1.2	1.1	0.069	NS	NS	NS
Protein	19.01	19.36	20.11	19.7	19.3	0.342	NS	NS	NS
Moisture	74.65	75.13	74.45	74.9	74.6	0.362	NS	NS	NS
Intramuscular fat	3.89	2.29	2.31	2.7	3.0	0.338	0.040	NS	NS

[1] NS = not significant (P>0.05)

DISCUSSION

Sex differences in weight gain and carcass composition are in agreement with previous researches (Lopez-Bote et al., 1997). The significant effect of dietary fat on FCR in the initial phase of the experiment is in agreement with results from Morgan et al. (1992), who reported a more efficient feed utilization in pigs fed a diet containing higher concentration of C18:2. A possible explanation for this effect could be due to the higher digestibility or/and different metabolic utilization of PUFA than MUFA to obtain energy, particularly at young ages (Soares and Lopez-Bote, 2001). According to Sanz et al. (2000a,b), saturated fats are used less for yielding energy in broiler chickens than unsaturated fats. On the other hand, Eder et al. (2001) found no effect of altering the oleic to linoleic acid ratio on weight gain and feed utilization in growing pigs.

Considering the whole experimental period, no effect of dietary supplementation with vitamin E was observed in the growth or feed intake of pigs, which is in agreement with Monahan et al. (1992). However, during the initial phase of the experiment (3 weeks), daily gains of pigs fed the vitamin E supplemented diets were lower than in those receiving a basal diet (P=0.042). These results disagree with those of Asghar et al. (1991), who reported improved average daily gain and feed efficiency during the early phases of growth for pigs supplemented with vitamin E and diets with a high content of PUFA (C18:2) (soyabean oil). According to the results of Table 3, when using pigs of high productivity in a healthy environment, vitamin E supplementation may impair productivity, probably because it interfere absorption of other lipo soluble compounds. On the other hand, the interaction between dietary fat and vitamin E on feed efficiency during the first experimental period (Figure 1) suggest that high dietary vitamin E concentration may interfere with the absorption or metabolic utilization to obtain energy of PUFA, thus counteracting the effect of C18:2 concentration on pig performance.

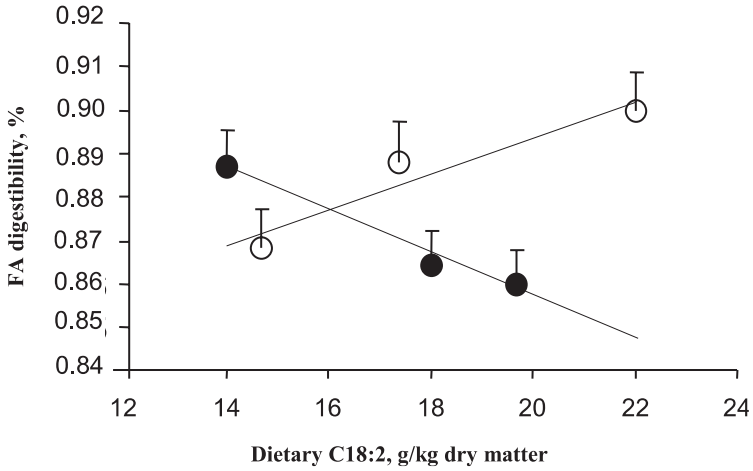

Figure 1. Effect of dietary C18:2 concentration on feed conversion ratio (FCR) in pigs fed a basal (○) or supplemented (●) level of vitamin E during the first three weeks of the experiment

In order to explain the effect of dietary α-tocopheryl acetate supplementation on fatty acids absorption, a parallel experiment was carried out. Fatty acid digestibility was measured (Table 5). As expected, we found marked differences in the apparent digestibility of individual fatty acids. C18:2 showed higher values than C18:1 and this, higher digestibility than C18:0 and other saturated fatty acids. This is in agreement with literature (Soares and Lopez-Bote, 2001) and may be a possible reason for the higher efficiency in feed utilization of pigs fed diets containing higher concentration of C18:2. The negative effect of vitamin E supplementation on fatty acid digestibility mainly affects on saturated fatty acids. It might be that tocopherol molecules compete with dietary fatty acids (mostly saturated) for micelle incorporation. We also observed an interaction effect of dietary fat source and vitamin E supplementation on total fatty acid digestibility. An increase in C18:2 concentration produced an increase in total fatty acid apparent digestibility only in the case that a basal level of vitamin E was incorporated in the diet (Figure 2). This result reinforce the hypothesis that dietary vitamin E supplementation may interfere with fatty acid absorption when both vitamin E and C18:2 are included at high dietary concentrations. Meluzzi et al. (2000) reported a reduction in α-tocopherol concentration in egg yolk as the dietary n-3 polyunsaturated fatty acids rises, indicating a possible competition for absorption and/or distribution. Also, King et al. (1995) reported a muscle α-tocopherol lowering effect of dietetic β-carotene. According to these results, vitamin E supplementation in pigs could interfere with fatty acid digestion, particularly at high C18:2 dietary concentration, thus reducing the feed efficiency during the initial periods of growth.

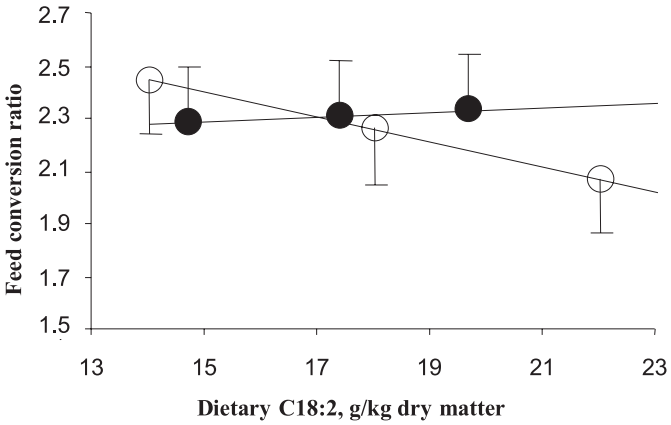

Figure 2. Effect of dietary C18:2 concentration on total fatty acid apparent digestibility in pigs fed a basal (○) or supplemented (●) level of vitamin E

No effect of dietary treatment was observed on carcass characteristics (Table 4), except for ham perimeter (P=0.044), which is an indirect measurement of lean content in the carcass. Therefore, this results indicate a tendency to higher muscle mass in carcasses from pigs receiving diets with higher concentration of C18:2.

The effect of dietary fat composition on intramuscular lipids (Table 6) is a matter of interest because lean meat with a high content of intramuscular fat has better sensory properties and higher palatability than meat with low fat content (Bejerholm and Barton-Gade, 1986). However, as far as the authors are aware, there is little information of the dietary fat type effect on intramuscular fat content. Miller et al. (1990) and Madsen et al. (1992) reported a significant effect of dietary fatty acids on intramuscular fat content, but the relationship between concentration of individual fatty acids and intramuscular fat concentration seems complicated. On the other hand, Eder et al. (2001) found no effect of altering the dietary oleic to linoleic fatty acid ratio on intramuscular lipids, although they utilized a different experimental design than the one used in this experiment, and varied the dietary concentration of short chain saturated fatty acids, which could have a possible effect also. Enhanced fat catabolism and reduced fat synthesis have been reported to occur in rats (Shimomura et al., 1990) and broiler chickens (Sanz et al., 2000a) fed PUFA enriched diets when compared to rats fed diets enriched with MUFA or saturated fatty acids. Moreover, Sanz et al. (2000b), recently evidenced in broilers that blood circulating PUFA are preferentially taken up by muscle tissue as an immediate energy source rather than being stored in intramuscular lipids.

In conclusion, a higher MUFA/PUFA ratio in pig diets may produce a decrease on fatty acid digestibility, a higher feed conversion ratio (FCR) during the initial period of fattening, and a higher concentration of intramuscular fat at slaughter.

Vitamin E supplementation may affect mainly the apparent digestibility of saturated fatty acids, and total fatty acids (P=0.062) when diets have higher C18:2 proportion.

ACKNOWLEDGEMENTS

Authors are thankful to Remedios Prieto for technical assistance and Manuel Sanz, Antonio Flores and Carlos Cadórniga for their assistance.

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STRESZCZENIE

Wyniki produkcyjne, strawność kwasów tłuszczowych, skład chemiczny tuszy i mięśni świń otrzymujących dawki pokarmowe wzbogacone witaminą E i różniące się stosunkiem MUFA/PUFA

Badano wpływ dodatku witaminy E (20 vs 200 mg oktanu α-tokoferolu) oraz różnego stosunku MUFA/PUFA w dietach dla świń na wyniki produkcyjne, strawność kwasów tłuszczowych oraz skład chemiczny tuszy i mięśni. Przy większej koncentracji kwasu C12:2, wykorzystanie paszy przez knurki i maciorki było gorsze ($P<0,01$). Stwierdzono także wpływ ($P<0,05$) tłuszczu dawki na pozorną strawność kwasów: C16:1, C18:0, C18:1 oraz C18:2. Pozorna strawność C16:1 i kwasów nasyconych była mniejsza przy skarmianiu dawek zawierających większy dodatek witaminy E, co może wskazywać na konkurencję z absorpcją kwasów. Częściowe zastąpienie w dawce PUFA przez MUFA spowodowało zwiększenie udziału tłuszczu międzymięśniowego ($P=0,04$) i obniżenie pozornej strawności sumy kwasów tłuszczowych tylko w przypadku, gdy do dawek dodano witaminę E w ilości 20 mg.