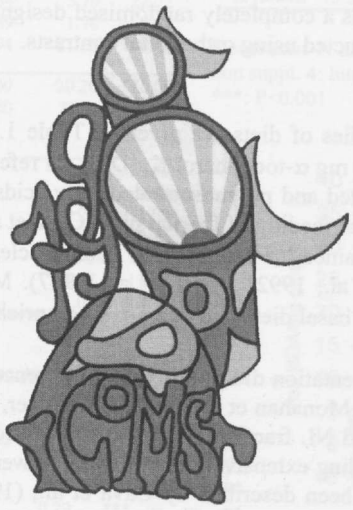
PS 7

Poster session and workshop 7

Natural antioxidants and meat quality



Tuesday, September 1st
17:15h-18:45h

α-TOCOPHEROL CONTENT, FATTY ACID PROFILES AND LIPID OXIDATIVE STABILITY IN IBERIAN PIGS MUSCLES AS AFFECTED BY DIET: EXTENSIVE SYSTEM AND MIXED FEEDS

Ramón Cava, Jorge Ruiz, Juan F. Tejeda, Teresa Antequera and Jesús Ventanas
Tecnología de los Alimentos. Facultad de Veterinaria. Universidad de Extremadura. 10071 Cáceres. Spain.

BACKGROUND

The Iberian pig breed has been raised traditionally in the South-western of Iberian Peninsula to produce meat to elaborate dry-cured hams. Lipids from pigs fed extensively are characterised by a high content of oleic acid and low content of saturated fatty acids reflecting fatty acid composition of feeds (Cava et al., 1997, Ruiz et al., 1998). Lipolysis and lipid oxidation are considered to be the major processes in the volatile flavour production of dry cured ham (López-Bote et al., 1990). So, this particular fatty acid profile is in part responsible of the sensory characteristics of dry-cured hams elaborated with thighs from pigs fed on acorns (López et al., 1992).

In pigs, fatty acid composition of dietary fat is deposited in fatty tissues with slight modifications due to particular digestive tract characteristics. This fact has brought out to the attempt to alter monounsaturated fatty acid composition of pig tissues by dietary means (St. John et al., 1987; Monahan et al., 1992). In addition , copper sulphate enrichment of feeds has been attempted to increase monounsaturated fatty acids in depot fat (Elliot and Bowland, 1968).

α-tocopherol acetate (α-TAc) supplementation in feeds has been used profusely in lean pigs, producing an increase in the lipid stability to oxidative processes both 'in vitro' and in storage conditions (Monahan et al., 1992; Jensen et al., 1997). However studies of the effect of vitamin E supplementation on oxidative stability of meat from pigs with a high content of intramuscular fat, as the Iberian pig has, are scarce.

OBJECTIVES

The objectives of this work were to study the effect of extensive feeding and of diets enriched with α-tocopherol acetate and copper sulphate supplementation on fatty acid composition, α-tocopherol level and oxidative status of Iberian pig meat.

METHODS

Twenty-five castrate males crossed breed pigs (Iberian x Duroc 75%) weighed about 105 kg were divided randomly into five groups of five animals each according to the feeding during the fattening period. One group were fed in extensive fattening system based on acorn and pasture (**extensive**). The other twenty pigs were feeding in confinement and fed on a control diet containing 20mg α-TAc/kg of feed (**control**), and diets enriched with 125mg SO_4Cu_2/kg of feed (**Cu**), 100mg α-TAc/kg of feed (**E**) and 125mg SO_4Cu_2 + 100mg α-TAc/kg of feed (**Cu+E**). Pigs were slaughtered after 8 weeks at 145-160kg of live weight.

M. *Biceps femoris* was dissected from thighs and intramuscular total lipids from muscle were extracted according to Bligh and Dyer method (1959). From the fat extracted, neutral lipids (NL) and polar lipids (PL) fractions were isolated according to the method developed by Garcia-Regueiro et al. (1994) determining fatty acid composition according to Cava et al., (1997). Determination of α-tocopherol was carried out by HPLC according to Mallarino (1992) for experimental diets; while α-tocopherol content in muscles was performed by the method of Rey et al., (1997a). The liability of muscle tissue homogenates to iron-induced lipid oxidation was determined by the method of Kornbrust and Mavis (1980).

The effects of diet on fatty acid composition, lipid-induced oxidation, and tocopherol concentration were analysed using the General Linear Model of SAS (1997). Data were analysed as a completely randomised design. When a significant P was detected ($P<0.05$), the comparative analyses between means were conducted using orthogonal contrasts.

RESULTS AND DISCUSSION

Data on chemical composition and fatty acid profiles of diets are given in Table 1. Regarding α-tocopherol, pasture showed the highest content all over the feeding analyzed (171.0 mg α-tocopherol/Kg DM). In reference to fatty acid profiles, acorns were higher in monounsaturated fatty acids and lower in saturated and polyunsaturated fatty acids, specifically C18:2 than mixed diets. Results agree with data reported in some papers involving the feeding of Iberian pigs (Cava et al., 1997; Rey et al., 1997b; Ruiz et al., 1998).

Muscles from pigs α-tocopherol supplemented contained 1.5 times higher than muscles from pigs fed on basal level of α-TAc (Table 2) in agreement with others authors (Monahan et al., 1992; Jensen et al., 1997). Muscles from pigs raised in extensive feeding showed higher concentrations of α-tocopherol than basal diets and even α-TAc-enriched diets as consequence of the high content of α-tocopherol of pasture (171mg/kg DM).

Copper supplementation and α-tocopherol supplementation did not produce differences in the percentages of fatty acids in total i.m. fat or in NL and PL agreeing with data reported by Monahan et al., (1992). However, great differences were found due to feeding in extensive. Fatty acid composition of total lipids and NL fraction of pigs raised in acorns showed higher percentages of MUFA and lower of SFA than pigs receiving mixed diets. Feeding extensively resulted in a lower content of PUFA in PL compared to PL from pigs raised in mixed feeds. Similar findings have been described by Cava et al., (1997) in M. Masseter from Iberian pigs fed on extensive feeding and on concentrate feeds.

Muscle homogenates from Iberian pigs raised α-TAc supplemented diets showed lower susceptibility to induced lipid oxidation than those from pigs fed on α-TAc basal level diets as have been widely reported by numerous authors in lean pigs (Monahan et al., 1992; Morrissey et al., 1996). Muscle homogenate TBA-RS values of extensive raised pigs during the experiment were significantly lower than in those from pigs raised on commercial feeds. Differences in susceptibility of muscle homogenates to lipid oxidation in commercial feeds pigs were clearly related to muscle levels of α-tocopherol, meanwhile the intensity of lipid oxidation in extensive pigs muscle homogenates seemed to be associated to both fatty acid composition, particularly of polar lipids, and α-tocopherol content of muscles.

CONCLUSIONS

α-tocopherol acetate supplementation in Iberian pigs feeds has been showed as an effective method to increase vitamin E content of muscles and increase their stability against to oxidative reactions.

Differences in fatty acid profiles and lipid oxidative susceptibility in muscles from pigs raised on extensive and mixed feeds could be the factors responsible of the sensory quality of hams elaborated with their meat.

PERTINENT LITERATURE

AOAC (1984). Official methods of analysis (ed. S. Williams). Association of Official Analytical-Chemists, Arlington, VA.

Bligh, E.G. and Dyer, W.J. (1959). *Can. J. Biochem. Biophysiol.*, **37**, 911.

Buckley, D.J., Morrissey, P.A. and Gray, J.I. (1995). *J. Anim. Sci.*, **73**, 3122.

Cava, R., Ruiz, J., López-Bote, C., Martín, L., García, C., Ventanas, J. and Antequera, T. (1997). *Meat Sci.*, **45**: 263.

Elliot, J.I. and Bowland, J.P. (1968). *J. Anim. Sci.*, **27**, 956.

García, C., Ventanas, J., Antequera, T., Ruiz, J., Cava, R. and Alvarez, P. (1996). *J. Food Quality*, **19**, 397.

García-Regueiro, J.A., Gilbert, J. and Díaz, I. (1994). *J. Chromatography A*, **667**, 225.

Gray, I. A. and Pearson, A.M. Rancidity and warmed-over flavor. (1987). Chpt. 6 In 'Advances in Meat Research. Vol. 3. Restructured Meat and Poultry Products,' ed. A.M. Pearson and T.R. Dutson, p. 219. Van Nostrand Reinhold Co., New York.

Jensen, C., Guidera, J., Skovgaard, I.M., Staun, H., Skibsted, L.H., Jensen, S.K., Møller, A.J., Buckley, J. and Bertelsen, G. (1997). *Meat Sci.*, **45**: 491.

Kornbrust, D.J. and Mavis, R.D. (1980). *Lipids*, **15:** 315.

López-Bote, C., Antequera, T., Córdoba, J.J., García, C., Asensio, M.A. and Ventanas, J. (1990). Proc.36th ICoMST, Havana, Cuba.

Mallarino, E.G. (1992). Effect of dietary sunflower meal, fish meal, and vitamin E on turkeys uninfected and infected with stunting syndrome. Doctoral thesis, Iowa State University, Ames, Iowa.

Monahan, F.J., Buckley, D.J., Morrissey, P.A., Lynch, P.B. and Gray, J.I. (1992). *Meat Sci.*, **31**: 229.

Morrissey, P.A.; Buckley, D.J.; Sisk, H.; Lynch, P.B. and Sheehy, P.J.A. (1006). *Meat Sci.*, **44**: 275.

Rey, A., López-Bote, C., Soares, M. and Isabel., B. (1997a). *Grasas y Aceites*, **47**: 331.

Rey, A., López-Bote, and Sanz Arias, R. (1997b). *Animal Sci.*, **65**: 515.

Ruiz, J., Cava, R., Antequera, T., Martín, L., Ventanas, J. and López-Bote, C. (1998). *Meat Sci.*, (In Press).

Statistical Analysis Systems Institute (1997). SAS User's guide: statistics. SAS Institute Inc., Cary, NC.

St.John, L.C., Young, C.R., Knabe, D.A., Thompson, L.D., Schelling, G.T., Grundy, S.M. and Smith, S.B. (1987). *J. Anim. Sci*, **64**: 1441.

Acknowledgements: This work was supported by supported by the AIR2-CT94 1577 contract (Dietary treatment and oxidative stability of muscles and meat products: DIET-OX)

Table 1.- Analyzed composition of experimental diets, acorn and pasture[1].

	Mixed diets				Extensive	
	Control	E	Cu	E-Cu	Acorn	Pasture
Dry matter	89.01	89.95	90.47	90.78	67.05	26.35
Crude protein (% DM)	13.62	13.56	12.19	13.39	4.71	13.72
Fat (% DM)	4.47	4.75	4.84	4.24	6.34	6.26
Crude fiber (% DM)	4.92	4.32	4.39	4.54	5.70	22.22
Ash (% DM)	6.92	5.08	4.80	4.89	1.70	7.31
NFE (% DM)	70.07	72.29	73.78	72.94	81.55	50.49
α-tocopherol (mg/kg DM)	19.50	125.40	21.60	108.00	20.20	171.00
Copper (mg/kg DM)	17.40	15.60	46.60	41.80	ND	ND
Fatty acid (g/100g)						
16:0	23.72	23.93	23.51	24.03	12.59	15.57
18:0	9.37	9.74	8.99	10.01	3.22	2.03
Others SFA	1.16	1.17	1.13	1.15	0.25	1.09
16:1 (n-7)	1.33	1.27	1.38	1.35	0.09	0.35
18:1 (n-9)	30.31	30.18	30.44	29.55	66.06	9.35
18:2 (n-6)	28.82	29.00	28.65	27.89	14.67	11.82
18:3 (n-3)	3.18	3.08	3.28	2.92	1.01	44.94

[1] Analyzed according AOAC methods (1984).

Table 2.- α-tocopherol content (μg g^{-1} DM) of muscles from pigs raised in extensive or in mixed diets.

		Mixed diets					Contrasts			
	Extens	Control	E	Cu	E-Cu	Pooled SD	1	2	3	4
B. femoris	15.55	5.85	9.38	5.68	7.83	0.77	***	ns	***	ns

Contrasts: 1: Extensive vs others, **2**: Cu suppl. vs non suppl. **3**: E suppl. vs non suppl. **4**: Interaction Cu x E

***: P<0.001

Table 3.- Fatty acid profiles (%) of intramuscular fat, neutral lipids (NLs) and polar lipids (PLs).

		Mixed diets				Pooled	Contrasts			
	Extens	Control	E	Cu	E-Cu	SD	1	2	3	4
Total SFA	33.58	36.34	35.97	36.49	36.06	0.30	***	ns	ns	ns
Total MUFA	58.97	56.49	55.88	56.87	56.10	0.29	***	ns	ns	ns
Total PUFA	7.46	7.17	8.16	6.64	7.84	0.27	ns	ns	ns	ns
NLs SFA	33.99	37.18	36.32	36.69	36.75	0.30	***	ns	ns	ns
NLs MUFA	59.00	56.17	56.41	56.24	56.32	0.32	***	ns	ns	ns
NLs PUFA	7.01	6.66	7.26	7.07	6.94	0.29	ns	ns	ns	ns
PLs SFA	29.55	28.38	28.74	27.21	27.79	0.30	*	ns	ns	ns
PLs MUFA	18.44	16.50	14.54	16.86	16.93	0.42	*	ns	ns	ns
PLs PUFA	52.01	55.12	56.72	55.93	55.28	0.55	**	ns	ns	ns

*: P<0.05; **: P<0.01; ***: P<0.001

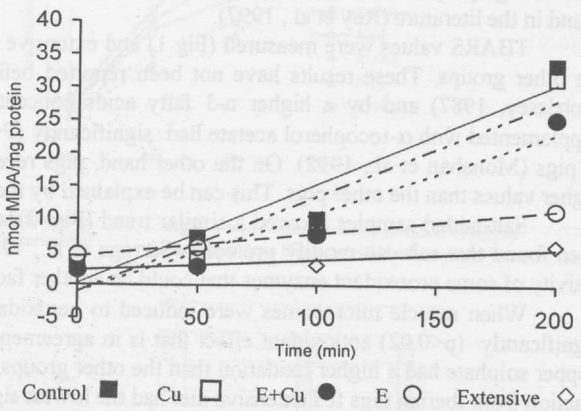


Figure 1.- Iron-induced lipid oxidation in muscle homogenates of Iberian pigs.