# Effect of dietary conjugated linoleic acid on pork quality and fatty acid composition in Pietrain-sired pigs

**C.E. Realini[1*], M. Fonti Furnols[1], J. Reixach[2], M. Gispert[1], J.A. García Regueiro[1], I. Diaz[1] & M.A. Oliver[1]**

[1]IRTA. Finca Camps i Armet E-17121 Monells (Girona), Spain.
[2]Selección Batallé S.A., 17421 Riudarenes (Girona), Spain.

## Abstract

Forty six pigs (Pietrainx(LandracexDuroc)) slaughtered at 115 kg LW were fed CONTROL vs CLA (1.0%) diets during 38 d to evaluate the effect of dietary CLA on pork quality and fatty acid composition. CLA feeding did not alter (P>0.05) *Longissimus thoracis* (*LT*) and *Semimembranosus* (*SM*) 24h pH, *LT* 24h electrical conductivity, drip loss, muscle L* and a* and subcutaneous fat (SUBFAT) L*, a* and b* values or intramuscular fat (IMF) percentage of *LT* and *Gluteus medius* (*GM*) muscles. CLA fed animals showed lower *SM* electrical conductivity and higher muscle b* value compared with CONTROL (4.7 vs 5.8 mS and 2.4 vs 1.9, respectively P<0.05). *Longissimus* and *GM* muscles and ham SUBFAT of pigs fed CLA contained more saturated fat (35.8 vs 33.8%, 35.1 vs 33.1% and 32.9 vs 30.6%, respectively P<0.05) compared with CONTROL. Pigs fed CLA accumulated more (P<0.05) CLA c9t11 in the *LT* (0.4 vs 0.0%), *GM* (0.5 vs 0.0%), and SUBFAT of the ham (0.5 vs 0.0%) than did pigs fed CONTROL, respectively. CLA feeding had limited effects on pork quality and had no influence on IMF. CLA supplementation resulted in enriched content of CLA in ham and loin and more saturated adipose tissue leading to processing benefits.

**Keywords**: pigs, fatty acids, conjugated linoleic acid, meat quality
[#]Corresponding author. E-mail: carolina.realini@irta.es

## Introduction

The interest in CLA is focused on several biological properties related to animal growth (increased rate and efficiency of gain, reduced fat deposition; Thiel et al. 2001), technological quality of meat products (increased fat firmness; Eggert et al. 2001) and health (anticarcinogenic, anti-obesity, anti-atherogenic and immunomodulatory functions; Ip et al. 1994). A number of studies have been conducted aimed at increasing the CLA isomers in animal products for production of fresh meat and meat products with an added value for human health. The objective of this study was to evaluate the effect of feeding dietary CLA during 38 d prior to slaughter on fresh pork quality and tissue fatty acid composition in Pietrain-sired pigs.

## Materials and methods

Forty six pigs (Pietrainx(LandracexDuroc)) were fed CONTROL vs CLA (1.0%) diets during 38 d prior to slaughter. Pigs were slaughtered when they reached approximately 115 kg live weight and all procedures were approved by IRTA's Animal Care and Use Committee. Muscle pH and electrical conductivity were measured at 24 h postmortem in the *LT*, *GM* and *SM* muscles using a Crison portable meter and a Pork Quality Meter (PQM-I, INTEK Aichach, Germany), respectively. Instrumental colour measurements were recorded at 24 h postmortem for L*(lightness), a*(redness), and b*(yellowness) on the exposed cut surface of the *LT* muscle and the subcutaneous fat at the last rib level, using a Minolta Chromameter (CR-400, Minolta Inc., Osaka, Japan) in the CIELAB space (CIE, 1976). Drip loss was determined following the procedure of Honikel (1997). Intramuscular fat content was determined by Near Infrared Transmittance (NIT, Infratec® 1265, Tecator, Höganäs, Sweden) in the *LT* and *GM* muscles. Instrumental tenderness was measured on *LT* pork chops (1.5 cm thick). Six pieces 3x1.5x1.5 cm were removed per chop and each piece was sheared using an Alliance RT/5 texture analyzer (MTS Systems Corp., Eden Prairie, MN, USA) equipped with a Warner-Bratzler blade. Lipids were extracted from *LT* and *GM* muscles and from *GM* subcutaneous fat following the chloroform-methanol procedure of Folch et al. (1957), converted to fatty acid methyl esters following the method of ISO 5509-1978 (E) and analyzed using GC (BP70-SGE, USA).

## Results and discussion

Pork quality characteristics from CONTROL and CLA fed pigs are shown in Table 1. CLA feeding did not alter (P>0.05) *LT* and *SM* 24h pH, *LT* 24h electrical conductivity, *LT* drip loss, muscle L* and a* and subcutaneous fat (SUBFAT) L*, a* and b* values. CLA fed animals showed lower *SM* electrical

conductivity and higher muscle b* value compared with CONTROL. Intramuscular fat percentage of *LT* and *GM* muscles as well as Warner-Bratzler shear force of *LT* did not differ (P>0.05) between CONTROL and CLA-fed pigs. Eggert et al. (2001) reported that dietary CLA did not affect 24-h pH, drip loss or subjective quality evaluations of the longissimus muscle. Lauridsen et al. (2005) also reported that dietary CLA had no effects on pH, temperature, water holding capacity and total content of IMF. On the other hand, Dunshea et al. (2005) reviewed studies that evaluated the effect of dietary CLA on pork quality and indicated that dietary CLA reduced drip loss by approximately 5%. In contrast with color data in the current study, slight but significant increases in L* and a* color values were found but there was no effect on b* color value of the loin (Dunshea et al., 2005).

**Table 1.** Meat quality characteristics from control-fed (n=23) and CLA-fed (n=23) pigs

| | *Diet* | |
|---|---|---|
| *Meat Quality Characteristics* | CONTROL | CLA |
| pH, SM$^{\delta}$ | 5.5 | 5.5 |
| pH, LT$^{\delta}$ | 5.5 | 5.5 |
| Electrical Conductivity (mS), SM$^{\delta}$ | 5.8$^{a}$ | 4.7$^{b}$ |
| Electrical Conductivity (mS), LT$^{\delta}$ | 3.9 | 3.6 |
| Drip Loss (%), LT$^{\delta}$ | 7.0 | 6.7 |
| *Instrumental color, LT*$^{\delta}$ | | |
| Minolta L* | 47.3 | 47.8 |
| Minolta a* | 7.3 | 7.2 |
| Minolta b* | 1.9$^{b}$ | 2.4$^{a}$ |
| *Instrumental color, ham subcutaneous fat* | | |
| Minolta L* | 72.8 | 73.3 |
| Minolta a* | 3.9 | 3.7 |
| Minolta b* | 4.8 | 4.8 |
| *Intramuscular fat (%)* | | |
| GM$^{\delta}$ | 1.3 | 1.4 |
| LT$^{\delta}$ | 1.1 | 1.2 |
| *Instrumental Tenderness (kg)* | | |
| Warner-Bratzler shear force | 4.0 | 4.0 |

$^{a,b}$Means within the same raw with different letters differ (P<0.05),
$^{\delta}$SM: *Semimembranosus*, LT: *Longissimus thoracis*, GM: *Gluteus medius*.

Composition of major fatty acids of *LT* and *GM* intramuscular fat and *GM* subcutaneous fat for CONTROL and CLA-fed pigs is shown in Table 2. CLA-fed pigs had higher percentage of myristic, stearic and total SFA compared with CONTROL in all tissues, except for myristic which did not differ (P>0.05) in subcutaneous fat between treatments. *Longissimus thoracis* from CLA-fed animals showed higher 18:3 and lower 20:4 and *n-6:n-3* ratio compared with CONTROL. *Gluteus medius* intramuscular and subcutaneous fat from CLA animals had lower 18:1% than CONTROL. In addition, MUFA% was lower in subcutaneous fat from CLA compared with CONTROL. There were traces of CLA c9t11 in all tissues of CONTROL animals, while CLA t10c12 was not detected. CLA percentage of both isomers increased significantly in CLA fed animals with the highest values obtained in ham subcutaneous fat followed by intramuscular fat of *GM* and intramuscular fat of *LT* which showed the lowest percentage. Eggert et al. (2001) also reported that dietary CLA is incorporated into intramuscular fat to a lesser extent compared with other tissues.

**Table 2.** Fatty acid composition of intramuscular fat of *LT* and *GM* and subcutaneous fat of *GM* from control and CLA-fed pigs

| | Intramuscular fat, *LT* | | Intramuscular fat, *GM* | | Subcutaneous fat, *GM* | |
|---|---|---|---|---|---|---|
| Fatty acid, % | CONTROL | CLA | CONTROL | CLA | CONTROL | CLA |
| 14:0, *myristic* | 0.08 | 0.10 | 0.09 | 0.10 | 0.16 | 0.17 |
| 16:0, *palmitic* | 20.92$^{b}$ | 21.99$^{a}$ | 19.94$^{b}$ | 21.14$^{a}$ | 20.48 | 20.60 |
| 18:0, *stearic* | 11.65$^{b}$ | 12.53$^{a}$ | 11.74$^{b}$ | 12.62$^{a}$ | 8.95$^{b}$ | 11.03$^{a}$ |
| 18:1, *n-9 oleic* | 35.03 | 33.87 | 33.00$^{a}$ | 31.00$^{b}$ | 39.98$^{a}$ | 36.87$^{b}$ |
| 18:2, *n-6 linoleic* | 18.27 | 18.25 | 20.80 | 21.35 | 20.73 | 21.32 |
| CLA$^{\delta}$ *c9t11* | 0.01$^{b}$ | 0.38$^{a}$ | 0.03$^{b}$ | 0.47$^{a}$ | 0.02$^{b}$ | 0.53$^{a}$ |
| CLA$^{\delta}$ *t10c12* | 0.00$^{b}$ | 0.16$^{a}$ | 0.00$^{b}$ | 0.18$^{a}$ | 0.00$^{b}$ | 0.29$^{a}$ |
| 18:3, *n-3 linolenic* | 0.69$^{b}$ | 0.76$^{a}$ | 0.91 | 0.96 | 1.56 | 1.59 |
| 20:4, *n-6 arachidonic* | 4.40$^{a}$ | 3.82$^{b}$ | 4.83 | 4.32 | 0.44 | 0.39 |
| SFA$^{\delta}$ | 33.78$^{b}$ | 35.76$^{a}$ | 33.08$^{b}$ | 35.06$^{a}$ | 30.60$^{b}$ | 32.93$^{a}$ |
| MUFA$^{\delta}$ | 41.80 | 40.01 | 39.10 | 36.56 | 46.56$^{a}$ | 42.92$^{b}$ |
| PUFA$^{\delta}$ | 24.41 | 24.07 | 27.76 | 28.44 | 22.93 | 24.25 |
| *n-6:n-3* | 20.6$^{a}$ | 18.9$^{b}$ | 17.52 | 16.70 | 13.21 | 13.39 |

$^{a,b}$Means within the same row and tissue with different letters differ (P<0.05). $^{\delta}$CLA: conjugated linoleic acid, SFA: saturated fatty acids, MUFA: monounsaturated fatty acids, PUFA: polyunsaturated fatty acids.

## Conclusions

CLA (1.0%) feeding during 38 days prior to slaughter had limited effects on pork quality and had no influence on intramuscular fat percentage of *Longissimus thoracis* and *Gluteus medius* muscles. CLA supplementation resulted in enriched content of CLA in ham and loin and more saturated adipose tissue leading to processing benefits. CLA c9t11 and t10c12 were incorporated most efficiently in subcutaneous adipose tissue.

## References

Eggert, J.M., Belury, M.A., Kempa-Steczko, A., Mills, S.E. & Schinckel, A.P., 2001. Effects of conjugated linoleic acid on the belly firmness and fatty acid composition of genetically lean pigs. J. Anim. Sci. 79, 2866-2872.

Folch, J., Lees, M. & Sloane Stanley, G.H., 1957. A simple method for the isolation and purification of total lipids from animal tissues. Journal of Biological Chemistry 226, 497–509.

Dunshea, F.R., D'Souza, D.N.D., Pethick, D.W., Harper, G.S. & Warner, R.D., 2005. Effects of fietary factors and other metabolic modifiers on quality and nutritional value of meat. Meat Science 71, 8-38.

Honikel, K.O., 1997. Reference methods supported by OECD and their use in Mediterranean meat products. Food Chemistry 59, 373-582.

Ip, C., Singh, M., Thompson, H.J. & Scimeca, J.A., 1994. Conjugated linoleic acid suppresses mammary carcinogenesis and proliferative activity of the mammary gland in the rat. Cancer Res. (Oxf.). 54, 1212-1215.

Lauridsen, C., Mu, H. & Henckel, P., 2005. Influence of dietary conjugated linoleic acid (CLA) and age at slaughtering on performance, slaughter- and meat quality, lipoproteins, and tissue deposition of CLA in barrows. Meat Science 69, 393-399.

Thiel-Cooper, R.L., Parrish, Jr, F.C., Sparks, J.C., Wiegand, B.R. & Ewan, R.C., 2001. Conjugated linoleic acid changes swine performance and carcass composition. J. Anim. Sci. 79, 1821-1828.