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Dietary vitamin A restriction affects adipocyte differentiation and fatty acid composition of intramuscular fat in Iberian pigs

M. Ayuso [a,*], C. Óvilo [b], A. Rodríguez-Bertos [c,d], A.I. Rey [a], A. Daza [e], A. Fenández [b], A. González-Bulnes [f], C.J. López-Bote [a], B. Isabel [a]

[a] Departamento de Producción Animal, Facultad de Veterinaria, Universidad Complutense, 28040 Madrid, Spain
[b] Departamento de Mejora Genética Animal, INIA, 28040 Madrid, Spain
[c] Departamento de Medicina y Cirugía, Facultad de Veterinaria, Universidad Complutense, 28040 Madrid, Spain
[d] Animal Health Surveillance Center (VISAVET), Complutense University of Madrid, 28040 Madrid, Spain
[e] Departamento de Producción Animal, ETSIA, Universidad Politécnica de Madrid, 28040 Madrid, Spain
[f] Departamento de Reproducción Animal, INIA, 28040 Madrid, Spain

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ABSTRACT

The aim of this study was to investigate whether dietary vitamin A level is associated with differences in adipocyte differentiation or lipid accumulation in Iberian pigs at early growing (35.8 kg live weight) and at finishing (158 kg live weight). Iberian pigs of 16.3 kg live weight were allocated to two feeding groups, one group received 10,000 IU of vitamin A/kg diet (control); the other group received a diet with 0 IU of vitamin A (var) for the whole experimental period. The dietary vitamin A level had no effect on growth performance and carcass traits. The early suppression of vitamin A increased the preadipocyte number in *Longissimus thoracis* (LT) muscle in the early growth period ($P < 0.001$) and the neutral lipid content and composition (higher MUFA and lower SFA content) at the end of the finishing period ($P < 0.05$). Vitamin A restriction in young pigs increases their lipogenic potential without affecting carcass traits.

1. Introduction

Adipocyte differentiation is an important factor for fat accumulation in the body. Adipocytes are derived from fibroblast-like preadipocytes and grow in size by accumulation of lipids in the cytoplasm in association with terminal differentiation (Hausman, Campion, & Martin, 1980). In the early stage of adipocyte differentiation, many adipocyte characteristic genes are sequentially activated and play established roles in promoting the differentiation process (Ntambi & Kim, 2000).

Adipocyte differentiation is regulated by various kinds of hormones (Boone, Gregoire, & Remacle, 2000; Gregoire, Smas, & Sul, 1998). Furthermore, it is well known that fat-soluble vitamins, especially metabolites of vitamin A and D, modulate adipocyte differentiation in cultured cells in mammals (Kawada et al., 1990). All-*trans* retinoic acid (RA, the active metabolite of vitamin A) and 1,25-dihydroxyvitamin D3 (1,25(OH)2D3) inhibit adipocyte differentiation in cultured cells at a supraphysiological concentration (Kawada et al., 1990; Sato & Hiragun, 1988; Suryawan & Hu, 1997). However, very low concentration (1 pM — 10 nM) of RA stimulates adipocyte differentiation (Safonova et al., 1994).

Due to its role in reproduction, growth, development and immune response, commercial pig diets in the European Union contain vitamin A concentrations approximately six- to ten-fold higher than NRC recommendation (1317 IU/kg diet) (Fraga and Villamide, 2000). However, studies in vivo showed that a dietary level of 1300 IU of vitamin A for 11 weeks was associated with a higher intramuscular fat (IMF) content in *Longissimus thoracis* (LT) muscle than a diet with 13,000 IU in pigs (Olivares, Reya, Daza, & Lopez-Bote, 2011). However, in another experiment, Olivares, Daza, Rey, and Lopez-Bote (2009a) found no effect of dietary vitamin A on IMF content in pigs. Thus, the effect of vitamin A on body fat accumulation in swine remains unclear. Also, previous studies have found that dietary vitamin A concentration alters fatty acid composition of adipose tissue in sheep (Daniel, Salter, & Buttery, 2004), beef (Siebert et al., 2006) and pigs (Olivares, Daza, Rey, & Lopez-Bote, 2009b; Olivares et al., 2009a, 2011) but no effect was found on the fatty acid composition of IMF in pigs (Olivares et al., 2011). These experiments have been performed with different animals (ruminant vs. non-ruminant), genotypes (Duroc vs. lean pigs) and different times of supplementation or restriction of vitamin A. Both, IMF content and fatty acid composition are determinant factors affecting meat quality (Wood et al., 2008) and they are of special interest in high quality meat products, such as those obtained from Iberian pigs. Moreover, the effects of dietary vitamin A level have never been

* Corresponding author. Tel.: +34 913943781.
E-mail address: mayuso@ucm.es (M. Ayuso).

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