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Effect of increasing amounts of a linoleic-rich dietary fat on the fat composition of four pig breeds. Part I: Backfat fatty acid evolution

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Abstract

Four diets prepared, respectively, with 0%, 2%, 4% and 8% of a high-linoleic added fat were administered (76 days of treatment) to a sample of 112 pigs of four breeds (Landrace, Large White, Duroc and a crossbreed Landrace>Duroc/>×>Duroc/>Duroc). The effects of diet and breed on the evolution of the fatty acid composition of backfat were examined by taking biopsies. Over time, a continuous increase in stearic, palmitic and oleic acids throughout the pig's life was observed. Oleic acid showed the smallest differences among the four diets at the end of the experiment, while stearic and palmitic acid showed higher differences according to the increase in the percentage of dietary fat. Stearic acid showed the highest rate of increase over time, according to the increasing intake of linoleic acid (diets 1–4). These increases were compensated by a decrease in linoleic acid, although this decrease tended to stabilize according to a higher percentage of added fat and also, for diet 4 (8% fat), an increase in linoleic acid was observed at the end of the experiment. Among the minor fatty acids, arachidonic acid showed a clear decrease over time, although higher levels at the end of the experiment were observed for diets including 4% and 8% of added fat, compared to the other two diets including lower amounts of linoleic acid. Moreover, a significant effect was observed for the factor breed. So, Duroc pigs showed the highest rate of deposit of linoleic acid and the lowest of stearic acid, while the other three breeds showed similar rates.
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Keywords: Pig; Backfat biopsy; Fatty acids; Linoleic acid intake; Dietary fat; Breed

1. Introduction

The effect of dietary fats on the fatty acid (FA) compositions of pork adipose and muscle tissues and the interactions between this factor and others, such as breed or feed energy level, is well known (Averette Gatlin, See, Hansen, Sutton, & Odle, 2002; Wood, Buxton, Whittington, & Enser, 1986). An increase in dietary linoleic acid leads to a higher content of this FA in the loin, but not to a significant increase in arachidonic acid (Ahn, Lutz, & Sim, 1996; Eder, Nonn, & Kluge, 2001; Scheeder, Gläser, Eichenberger, & Wenk, 2000) and some data are also available on the parallel increase in linoleic and arachidonic acids in fat tissues in response

Abbreviations: FA, fatty acids; PUFA, polyunsaturated fatty acids; MUFA, monounsaturated fatty acids; SFA, saturated fatty acids; FAME, fatty acid methyl esters; F1, crossbreed Landrace×Duroc.

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to an increase in dietary linoleic acid (D'Arrigo et al., 2002). Moreover, a few studies report results on repeated measures of FA during pig life (Camoes, Mourot, Kouba, Cherot, & Mounier, 1995; Fontanillas, Barroeta, Baucells, & Guardiola, 1998; Irie & Sakimoto, 1992; Warnants, Van Oeckel, & Boucqué, 1999). These studies have used various diets, some rich in *cis*-monounsaturated, others in *trans*-monounsaturated, and others in n-3 or n-6 polyunsaturated fatty acids. Their respective rate of deposit in backfat over time was quite variable and dependent on a number of factors, such as the FA concentration in feed, possible metabolisation of the FAs (arachidonic, eicosapentaenoic or docosahexaenoic acids), and the possibility of being synthesized by the pig (oleic acid). The best markers of diet influence seem to be linoleic and linolenic acids, because they are major FA and, also, *trans* FA because they are scarcely affected by lipid metabolism. But a minimum level of fat addition is always necessary to reach a significant deposit of these dietary FAs in the pig's backfat. Therefore, these kinds of studies can be useful for the formulation of diets aimed to control pig fat composition.

In this paper, we present the results and conclusions of the analysis of longitudinal data on the FA profile of pigs subjected to fat-enriched diets in order to examine progressive changes. Four diets with increasing amounts of added fat (0%, 2%, 4% and 8% of a high-linoleic acid fat blend) were administered to a sample of 112 pigs of four breeds and the effects of diet and breed on FA profile were examined. We studied the incorporation rate of dietary FA into backfat against time in order to determine an adequate level of a polyunsaturated dietary fat, and also the influence of weight and breed. We chose a high polyunsaturated diet, specifically a high-linoleic diet, to obtain a desirable amount of PUFA in backfat, from a human nutritional point of view. The detailed presentation of results in this paper is mainly focussed on the weight and the four main components of the FA profile, linoleic acid (C18:2 n-6) palmitic acid (C16:0), oleic acid (C18:1 n-9) and stearic acid (C18:0), since, on average, they accounted for 88% of the total FAs at the end of the experiment. Nevertheless, we also include relevant results about the effects on some minor FAs. The development curve of each variable, for the different breeds and diets, was also examined. In two further papers we will give results of fatty acid and triacylglycerol composition of four different tissues, obtained from the same animals after slaughter.

2. Materials and methods

2.1. Samples and experimental design

The experimental work was based on a 4×4 complete factorial design of two factors, diet and breed, with four levels per factor. The sample size was 112, i.e., seven pigs for each of the 16 diet-breed combinations. Castrated male pigs of four breeds were used: Large White, Duroc, Landrace and a commercial crossbreed Landrace×Duroc (F1). Duroc and F1 pigs came from the same farm, while Large White and Landrace pigs were from two other farms. At the beginning, mean weight of Duroc pigs was 15.40 ± 1.60 kg (age, 62.18 ± 3.01 days), that of F1 pigs was 16.10 ± 1.57 (age, 60.93 ± 2.11 days), that of Large White was 24.74 ± 2.12 kg (age, 69.33 ± 4.07 days), and that of Landrace was 21.11 ± 2.24 (age, 70.32 ± 6.24). Animals of each breed were distributed uniformly according to their weight and original litter (avoiding littermates inside the same group) and they were fed a conventional adaptation diet during a 7-d period, before the start of the experiment. The control group (diet 1) was fed a diet that consisted of a mixture of wheat, barley and soy flour. The other three diets were obtained by adding increasing amounts of fat as follows: 2% for diet 2 and 4% for diet 3 and 8% for diet 4. The additional fat was a commercial mixture of 50% animal fat and 50% soy/sunflower acid oil. Diets were formulated to obtain minimum differences in energy and protein. A complete description of the ingredients and the composition of the four diets is given in Table 1. The experiment was carried out under controlled conditions of temperature, light, and ventilation. Animals were given ad libitum access to feed throughout the experiment, and animal weight and feed consumption were recorded with the same periodicity that biopsies were taken, and at the end of the experiment. Also, *daily feed intake* (kg feed/day), *average daily gain* (kg live weight/day) and *feed conversion ratio* were calculated. After slaughter, the following carcass measurements were taken: *carcass weight*, *carcass yield*, *backfat thickness* measured at the 4th and last ribs (Fat-O-Meter, SFK Ltd., Denmark), and *percentage of lean*, calculated as proposed by Oliver, Gispert, Tibau, and Diestre (1991).

2.2. Biopsy procedure

Samples of subcutaneous adipose tissue were taken from the area between the 3rd and 4th dorsal vertebrae, on the level of the 10th rib. To take the biopsy, we used a Czech gun with an adapted cannula (PPB-2 Biotech, Nitra, Slovakia). Measurements were always taken from whole fat thickness. All the necessary measures were taken to prevent animal discomfort during and after the process. The first biopsy (day 0) was performed at the end of the adaptation period (start of the experiment) and successively on days 22, 37, 55 and 76. All samples were stored in plastic bags at −80 °C prior to analysis.

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