

Effect of ω 3 or saturated dietary fatty acids on lipid metabolism parameters in broiler chickens

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Abstract

The effect of dietary fat on lipid metabolism in broiler chickens at 36 days of age was evaluated. The parameters studied were triglyceride, non-esterified fatty acid, glycerol, thyroid hormones in blood and LPL, G6PD, ME and L3HOAD enzymatic activities in liver, heart and abdominal fat pad. Twenty-four (1d) broilers were assigned to one of the three treatments: control diet, without additional fat (C) and tallow (T) or linseed oil (LO) at 10% inclusion level. Animals fed LO had lower abdominal fat deposition. The highest T3 serum level was observed in chicks fed LO (LO: 2.35 vs. T: 0.82 pmol/m). A lower ingestion of fat (C) decreased LPL activity in the abdominal fat depot. The L3HOAD activity was significantly higher in LO than T or C diets (LO: 15.38 vs. T: 7.77 and C: 9.01 mIU/mg protein). Other enzyme activities were not significantly affected. In conclusion, a 20% of abdominal fat reduction in LO respect to T, could be due to an increase in the metabolic rate, especially to an increase of β -oxidation. In contrast, lipogenesis was not affected.

Introduction

Previous studies related to the pattern of broilers lipid deposition have shown that diets rich in ω 3 or ω 6 lead to a lower total body fat (Sanz 2000a), abdominal, mesenteric, neck fat (Crespo & Esteve-García, 2002) and skin (Ferrini et al, 2004), compared with a diet rich in saturated or monounsaturated fatty acids. The aim of the present experiment was to determine the relation between different sources of dietary fat and some parameters of lipid metabolism in broiler chickens.

Materials and Methods

Twenty-four 1-d-old female broilers chickens (Ross strain) were fed *ad libitum* a control diet based on wheat and soybean meal (C: without additional fat) or 10% of tallow (T: rich in saturated fatty acids) or linseed oil (LO: rich in polyunsaturated fatty acids) at the expense of wheat. On day 36, serum was frozen for analysis of triglycerides (TAG), non-esterified fatty acid (NEFA), glycerol and total thyroid hormones (T4: thyroxine; T3: triiodothyronine) by chemiluminescence. Liver, heart and abdominal fat pad were weighed and, were frozen for analysis of specific activity of lipoprotein lipase (LPL) (Burgaya et al., 1989), glucose-6-phosphate dehydrogenase (G6PD), malic enzyme (ME) and L-3-hydroxyacyl-Coa dehydrogenase (L3HOAD) (Menoyo et al., 2003). Total fatty acids by direct transesterification (Carrapiso et al., 2000) were analyzed in liver samples. The SAS® (2001) General Linear Models (GLM) procedure was used for the statistical analysis of data.

Results and discussion

A lower body weight was observed for diet C compared to T and LO, while liver and heart weight did not differ significantly (Table 1). The weight of abdominal fat depot was significantly lower in birds fed LO than in those fed T diet. NEFA and glycerol levels in serum were higher in T than those found in C and LO. At the same time, higher total fatty acid deposition in the liver of broiler fed T was found (T: 124.43 vs. C: 95.97 y LO: 85.61 g/kg body weight; $P \leq 0.01$). High levels of NEFA and glycerol contribute to form lipid

deposits in the liver (Geoffrey et al., 1999). Regarding 10% added fat treatments no significant differences were found in T4 serum level, but T3 serum level were higher for LO diet than for T. T3 inhibits lipogenesis in chicken (Rosebrough et al., 1992) and this could contribute to the lowered fat deposition found in LO animals.

Table 1. Body weight (g), organ weights (g/100 g of body weight), serum lipids concentration and total thyroid hormones in broiler chicken given experimental diets for 36

Dietary type¹	Control	Tallow	Linseed	SD	P value
Body weight ²	1788 ^b	1990 ^a	1938 ^a	108.0	0.0146
Liver ³	2.42	2.42	2.57	0.346	NS
Heart ³	0.52	0.51	0.58	0.070	NS
Abdominal fat pad ³	0.84 ^c	1.51 ^a	1.22 ^b	0.236	0.0007
Triglycerides (mg/dl) ³	83.59	48.91	56.51	28.950	NS
NEFA (mmol/L) ³	0.48 ^b	0.85 ^a	0.51 ^b	0.276	0.0612
Glycerol (g/L) ³	0.02 ^b	0.07 ^a	0.03 ^b	0.020	0.0054
T3 (pmol/ml) ⁴	1.39 ^{ab}	0.82 ^b	2.35 ^a	0.840	0.0397
T4 (pmol/ml) ⁴	2.03	3.89	2.10	2.222	NS

¹ Control: without added fat; Tallow and Linseed: with 10 % added fat

² Values are lsmeans and model standard deviation (SD); n=8; ³ n=6; ⁴ n=5

^{a, b, c} Value the same row not sharing a common superscript differ significantly (P value ≤ 0.05);

Table 2. Specific activity of liver, heart and abdominal fat pad Lipoprotein Lipase (LPL) mU/100 g body weight of broiler chicken given experimental diets for 36 d¹

Dietary type²	Control	Tallow	Linseed	SD	P-value
Liver	30.1	74.4	81.6	41.33	NS
Heart	320.9	267.3	301.6	93.21	NS
Abdominal fat	578.5 ^b	1073.5 ^a	941.6 ^a	190.29	0.0012
LPL total	929.5 ^b	1415.2 ^a	1324.8 ^a	183.45	0.0008

¹ Values are lsmeans and model standard deviation (SD); n=6

² Control: without added fat; Tallow and Linseed: with 10 % added fat

^{a, b} Value the same row not sharing a common superscript differ significantly (P value ≤ 0.05)

The LPL enzyme catalyzes hydrolysis of TAG from VLDL and portomicrons in peripheral tissues and is a rate-limiting step in lipid metabolism. The LPL activity found in liver (Table 2) probably comes from extra hepatic tissues since liver is the organ where LPL is catabolized (Vilaro et al. 1988). Abdominal fat LPL activity was much higher than heart LPL in all treatments. Diets with added fat (T and L) showed higher LPL values than control diet (C), although no differences were found between added fats. These results are in agreement with the study of Sato et al. (1999a) who found that LPL activity in abdominal adipose tissue was not significantly modified after feeding chickens with diets rich in 18:1, 18:2 or 18:3. However, other studies using force feeding of fat emulsion or *in vitro* methodologies showed that LPL synthesis and activity decreased with increasing fatty acid insaturation (Sato et al. 1999b). From that, we can consider that only extreme nutritional conditions provoke modifications in LPL activity. The G6PD and ME enzymes which provide reduced equivalents to support the novo lipogenesis in the liver. At the same time, L3HOAD was chosen as an indicator of mitochondrial fatty acid β -oxidation in the heart. The L3HOAD activity was significantly higher in birds fed LO than T or C diet (Table 3). In contrast, no statistical differences between treatments were found in lipogenesis. These results, conform to Sanz et el. (2000b), and show that a high dietary linolenic acid concentration may induce an increase in the rate of β -oxidation in heart. In conclusion, diets rich in fatty acids ω -3 in

contrast to saturated, reduce abdominal fat depots in broilers that can be due to an increase in metabolic rhythm, specifically an increase of β -oxidation rate. In contrast, lipogenesis was not affected. A lower ingest of fat decrease LPL activity in abdominal fat depot.

Table 3. Specific activity (mIU/mg protein) of liver glucose-6-phosphate dehydrogenase (G6PD), malic enzyme (ME) and heart L-3- hydroxyacyl-Coa dehydrogenase (L3HOAD) of broiler chicken given experimental diets for 36 d¹

Dietary type²	Control	Tallow	Linseed	SD	P-value
G6PD	5.95	5.24	4.77	1.607	NS
EM	34.82	35.05	28.23	10.473	NS
L3HOAD	9.01 ^b	7.77 ^b	15.38 ^a	2.945	0.0014

¹Values are Ismeans and model standard deviation (SD); n=6

² Control: without added fat; Tallow and Linseed: with 10 % added fat

^{a, b} Value the same row not sharing a common superscript differ significantly (P value \leq 0.05)

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