TOTAL FATTY ACID QUANTIFICATION AS AN ESTIMATOR OF TOTAL BODY FAT CONTENT IN BROILERS FED UNSATURATED DIETS

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Abstract

An experiment was designed to determine the effect of dietary fat unsaturation level on the fat content of the body of broilers, measured as hydrolysed crude fat (CF) and total fatty acid (TFA) content. Ninety-six female broiler chickens were fed with 4 experimental diets (with 15, 34, 45 and 61 g of polyunsaturated fatty acids (PUFA)/kg of diet) for 6 weeks. As dietary PUFA increased from 15 to 61 g PUFA/kg the fat content of the animals decrease was 55% and 15% when measured as CF and TFA content respectively. As we did not find any differences between treatments in crude protein (CP) and ashes (A) content, the total chemical composition (CF, CP and A as a percentage of Dry Matter (DM)) was close to 100% in the animals fed the saturated diets, reaching only 80% when the dietary unsaturation level was maximum. When using TFA instead of CF, the total chemical composition was close to 95% of DM in all treatments.

Résumé

Une expérience a été effectuée pour déterminer l'effet du niveau de la graisse insaturée dans l'aliment sur le contenu de la graisse corporelle des poulets mesuré par la teneur en graisse brute hydrolysée (CF) et par la teneur en acides gras totaux (TFA). Quatre-vingt seize femelles broilers ont été alimentés avec 4 régimes expérimentaux (contenant 15, 34, 45 ou 61 g d'acides gras polyinsaturés (PUFA)/kg d'aliment) pendant six semaines. Quand la teneur en PUFA du régime augmente de 15 à 61 g/kg l'engraissement des animaux diminue de 55% et 15% quand il est mesuré par la teneur en CF et TFA respectivement. Comme on n'a pas trouvé de différences entre les traitements pour la teneur en protéines brutes (CP) et en cendres (A), la composition totale chimique (CF, CP et A exprimés en pourcentages de la matière

sèche (DM)) était près de 100% chez les animaux alimentés avec le régime riche en AG saturés, et seulement de 80% quand le niveau d'insaturation du régime était maximal. En utilisant le TFA au lieu de CF, la composition totale chimique était près de 95 % de la DM pour les 4 traitements.

Introduction

It is usual to include fat in poultry diets as a source of energy. Increasing concern about safety of animal fats has led to a higher use of vegetable oils, rich in unsaturated fatty acids, in animal nutrition. These fatty acids are better absorbed (Wiseman and Salvador, 1991) and thus provide more metabolizable energy to the animal. Some studies suggest that, once absorbed, saturated and unsaturated fatty acids are not used in the same way. Shimomura et al (1990) showed that rats fed safflower oil had less body fat content due to increased thermogenesis and higher lipolitic activity than rats fed tallow. In poultry, some authors found no effect of dietary PUFA on fat deposition (Pinchasov and Nir, 1992) but others (Sanz et al., 1999) reported lower fat content in broilers fed unsaturated fats. This study was designed to asses the effect of dietary PUFA on the fat content of broilers, measured as CF and as TFA content.

Material and Methods

Animals and diets

The trial received approval from the Animal Protocol Review Committee of the UAB. Ninety-six female broiler chickens of 1 day of age were randomly distributed into 4 dietary treatments (12 replicates). The animals were housed in 48 cages under standard conditions of temperature, humidity and ventilation. Four levels of dietary PUFA (15, 34, 45 and 61 g of PUFA/kg) were achieved by blending different amounts of tallow, linseed and fish oil, keeping the added fat at 9%. Composition of the diets is shown in table 1. Feed and water were provided *ad libitum*. Body weight and food consumption were measured at days 8, 18 and 44 to determine average daily gain (ADG), average daily intake (ADI) and food conversion ratio (FCR).

Slaughter and sample collection

At 44 days of age the animals were killed by lethal injection. The whole bodies of the animals (including feathers and blood) were frozen and minced. A representative sample was taken, freeze-dried, ground and stored at -20°C until further analysis.

Chemical analysis

The DM, A, CP, crude fibre and CF content of diets were determined (AOAC, 1995). The fatty acid amount of the diets was quantified by gas chromatography (GC) using nonadecanoic acid as internal standard (Sukhija and Palmquist, 1988). Whole body samples were analysed for gross energy (GE) with an adiabatic bomb calorimeter (IKA calorimeter C-4000) and for CP, CF and ash content (AOAC, 1995). Samples were subjected to acidic digestion before CF analysis to cause disruption of lipid-protein binding (AOAC, 1995). The fatty acid content was quantified by GC using nonadecanoic acid as internal standard (Carrapiso et al., 2000).

Table 1: Composition and chemical analysis of the experimental diets

Ingredients	%	Chemical analysis	%
Wheat	39,30	Dry matter	90,78
Soya 48	34,09	Crude protein	22,98
Barley	13,39	Crude fat	10,17
Added fat[1]	9,00	Crude fibre	3,47
Bicalcium phosph.	2,17	Ash content	6,08
Calcium carbonate	0,98	Crude Energy (Kcal/Kg)	4481
Salt	0,45	Estimated values	
Vitamin-mineral mix[2]	0,40	Metabolizable Energy (Kcal/Kg)	3100
DL – methionine	0,28	Lysine (%)	1,200
L – Lysine	0,04	Methionine (%)	0,597

[1] 100 % tallow (15 g PUFA/kg); 60 % tallow – 40 % linseed and fish oil (34 g PUFA/kg); 40% tallow – 60 % linseed and fish oil (45 g PUFA/kg); 100 % linseed and fish oil (61g PUFA/kg).

[2]Vitamin and mineral mix per kg of feed: Vitamin A: 12000 UI; Vitamin D_3: 2400 UI; Vitamin K_3: 3 mg; Vitamin B_1:2.2 mg; Vitamin B_2: 8 mg; Vitamin B_6: 5 mg; Vitamin B_{12}: 11 □g; Folic acid: 1.5 mg; Biotin: 150 □g; Calcium pantotenate: 25 mg; Nicotinic acid : 65 mg; Mn: 60 mg; Zn: 40 mg; I: 0,33 mg; Fe: 80 mg; Cu: 8 mg; Se: 0.,5 mg.

Statistics

Data were analysed by ANOVA using the GLM procedure of SAS statistical package (SAS® Institute, 1996). Dietary PUFA was the factor included in the model. Differences between treatment means were tested using SNK test. The level of significance was pre-set at $P < 0.05$.

Results and discussion

ADI and FCR (data not shown) were significantly affected by the dietary degree of unsaturation (P<0.05). As dietary PUFA increased, ADI decreased (from 111,72 to 104,56 g/day for the 15 and 61 g PUFA/kg diets respectively, P<0.05). There were no differences in ADG, thus FCR was worse for the animals fed with the more saturated diet (P<0.05). There were no differences between treatments on final body weight. Unsaturated fats had better digestibility and therefore, have a higher metabolizable energy concentration available for the animal. The lower consumption of the diets including this type of fat can be due to a regulation of feed intake depending on the dietary metabolizable energy (NRC, 1994).

The chemical composition of the whole animal is shown in table 2. CP and ash content were not affected by treatment. CF and GE were both affected negatively with dietary unsaturation, but while GE decrease was 10%, CF decrease was 55% when dietary PUFA increased from 15 to 61 g/kg of feed. Moreover, the sum of the three major components on a DM basis (CP, CF and A contents, as carbohydrate content of the whole body was negligible) was around 100% only for the animals fed with the saturated diets. This fact, added to the difference existing between GE and CF reduction, suggests that the CF content reduction due to dietary PUFA might be overestimating reality.

Table 2: chemical composition (% of DM) and gross energy content of the whole body of broilers (44 days of age).

	g PUFA/ kg of diet				P	RSD
	15	34	45	61		
Water %	62,55	61,63	62,73	63,16	0,282	2,605
CP	52,21	53,02	53,41	54,51	0,246	3,787
CF	40,75 ^{a}	38,21 ^{a}	33,30 ^{b}	18,23 ^{c}	**<0,001**	4,682
U:S[1]	2,02^{a}	2,45^{b}	2,67^{c}	3,48^{d}	**<0,001**	0,196
A	6,63	6,63	7,02	7,22	*0,091*	0,828
DM %[2]	99,63	97,86	93,73	79,96		
GE (Kcal/kg)	6510^{a}	6318^{b}	6223^{b}	5857^{c}	**<0,001**	221,5

[1] U:S is the ratio between unsaturated and saturated fats in the whole animal body.
[2] DM% is the sum of CP, CF and ash content on a dry matter basis.
[a,b,c] Means within a row with different superscript letters were statistically different (p<0.001).

Using the TFA content as an estimator of the fat content, as shown in table 3, we can still see a reduction (15 %) in the body fattening as dietary PUFA raised from 15 to 61 g/kg. The total chemical composition (CP, TFA and ash content) was in all cases around 95%. TFA content did not include all the fat-soluble molecules in the body and did not include either the glycerol moiety of triglycerides.

Some authors have found a lower body fattening of broilers when fed PUFA-enriched diets. Thus, Sanz et al. (2000a) found higher body fat and energy content in broilers fed tallow than those fed on diets containing vegetable oils, and suggest that the unsaturation degree of dietary fat affects its metabolic use. In a posterior work, Sanz et al. (2000b) observed that broilers fed unsaturated fats show higher ß-oxidation and lower fatty acid synthesis. Crespo and Esteve-Garcia (2002a, 2002b), when studying the different fat depots of broilers fed different dietary fats, show that the weight of separable fat depots (like abdominal fat pad) is more reduced in animals fed sunflower and linseed oil than those fed tallow. However, these authors found a higher fatty acid synthesis in the animals fed unsaturated fats, and attribute the lower fat depots to a higher ß-oxidation rate.

Our work showed a reduction of the energy storage (mainly body fat) as the PUFA intake increased. Otherwise TFA can be an acceptable estimator of the whole body fat content, and is even more precise than hydrolised CF determination in the case of highly unsaturated meats.

Table 3: TFA content (% of DM) of the whole body of broilers (44 days of age).

	g PUFA/ kg of diet				P	RSD
	15	34	45	61		
TFA	37,48 [a]	35,09 [a] [b]	34,94 [a] [b]	31,82 [b]	**0,002**	4,674
Sum	96,32	94,74	95,37	93,55		

[1] DM% is the sum of CP, TFA and ash content on a dry matter basis.

[a,b] Means within a row with different superscript letters were statistically different ($p<0.001$).

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