LIPID AND PUFA CONTENTS OF MUSCLE AND SKIN OF CHICKEN. INFLUENCE OF ANATOMICAL LOCATION.

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SUMMARY : Lipid and fatty acid compositions were determined from the following tissues of 4 broilers: breast, thigh and drumstick muscles, breast and leg (thigh + drumstick) skin. The results showed
1) Whatever the tissue, samples dissected out from left and right sides of the carcass exhibited no difference in lipid and fatty acid compositions.
2) Lipid content in breast meat is lower than in drumstick ones (1.1 and 3.3g/100g respectively), thigh meat exhibited highest amounts (4.1g/100g).
3) Polar lipid content in thigh muscle was close to drumstick muscle ones (0.83g/100g), but breast meat contained a smaller amount (0.54g/100g).
4) Skin presented a high proportion of lipids (33-36g/100g) weakly related to anatomical location.
5) Fatty acid composition of neutral and polar lipids from muscles and skin did not differ between the different locations.
6) Skin lipids showed a low proportion of PUFA as compared to muscles. The meat polar lipids contained a high amount in PUFA with 22 carbon backbones and 4,5 or 6 double bonds, these fatty acids were almost absent in skin polar lipids.

INTRODUCTION

Poultry meat consumption is increasing in the world. In France, it reached 18.6 kg per capita in 1983. A rate of increase of 2% per year is expected in the future. This is mainly due to the development of the poultry cuting industry.

Lipids are know to take a prominent part in meat quality. Recents advanced in poultry production, e.g. selection of lean strains or/and animals with high growth rate which are slaughtered very young (6-8 weeks old), are supposed to affect lipid composition of poultry meat. Except few recent publications (1-2), most of the data available were obtained 20 year ago (3-5).

This study was conducted to update the lipid composition of the main cuts of chicken meat. The lipid content, relative amount of polar and neutral lipids and the fatty acid composition of the lipid fractions were determinated in muscle and skin from the main edible parts of the broilers. The influence of anatomical location on these lipid characteristics were discussed.

MATERIALS AND METHODS

ANIMALS : Four broilers of different grades were purchased at a local market in order to have a broad range in meat quality. They were selected to have similar eviscerated weight (1.200 + 44g). Breast, thigh and drumstick cuts were dissected out from both sides of the carcass. Muscle and skin were separated from each cut. Skin obtained from thigh and drumstick cuts were pooled. The lipid analysis were performed on the following samples : breast muscle (white meat), thigh and drumstick muscles (dark meat), breast and leg (thigh + drumstick) skins. Muscles and skin were ground, immediately analysed or stored at -20°C until analysis.

LIPID ANALYSIS : Lipids were extracted in duplicate from 4-5 g of meat or 1-2 g of skin with chloroform/methanol (2/1 V/V) as described by FOLCH and al. (1957) (6). Total lipid extracts were fractionated into neutral and polar lipids on silica cartridges according to JUANEDA and ROCQUELIN (1985) (7). Total and neutral lipid extracts were dried under vacuum and weighed to determine the total and neutral lipid proportions in the samples. The amount of polar lipids obtained by this procedure is to weak to be weighed precisely. Consequently, the polar lipid content of the sample were determined by measuring the phosphorus in total lipid extracts according to BARTLETT (1959) (8). The phosphorus were converted into polar lipids using a 25 amount factor.

Total, neutral and polar lipid contents of samples were expressed as g/100g of fresh tissue.

FATTY ACID ANALYSIS : Fatty acid composition of the lipid fractions were determined by methyl esters gas chromatography using a DI 700 chromatography (DELSI INSTRUMENTS, FRANCE) equiped with a split/splitless injector and flame ionization detector and connected with an electronic integrator (CR 3A, SHIMATZU). The analysis were performed on a 50m x 0.32mm fused silica capillary colunm coated with carbowax 20 M (CP WAX 52 CB, chrompack). The column temperature was set at 180°C, these of the detector and injector at 240°C. Peaks were identified as described previously (9). Hydrogen is used as carrier gas at a pressure of 0.6 bar. Results are expressed as % of the total methyl esters.

STATISTICAL ANALYSIS : The results were analysed using t test after pairing the data obtained from the same bird as described by SNEDECOR and COCHRAN (1981).

RESULTS

LIPID CONTENT IN MUSCLES (TABLE 1) : The total, neutral and polar lipid contents of each muscle were reported in the table 1. Whatever the anatomical location, there were no significant differences in the three lipid fraction contents between left and right muscles. Consequently, as the lipid composition from left and right sides at a given anatomical location were similar, their averages were used for the comparison of the different muscles and skin portions.

Within the 3 muscles, breast muscles exhibited the lowest amount of total lipids as well as neutral and polar lipids (1.1, 0.6 and 0.54 g/100g of fresh meat respectively). Thigh muscles contained less total lipids than drumstick muscles (3.4 and 4.5 g/100g respectively) but this difference is not significant ($P < 0.05$), because the muscles of birds taken into account was low (n=4). But, neutral lipid contents in drumstick muscles was higher than in thigh muscles (3.7g and 2.6g/100g respectively, $p < 0.05$). These muscles showed a similar polar lipid content (0.82-0.86g/100g).

LIPID CONTENT IN SKIN (TABLE 2) : Compared to muscles, skin contained a high amount in lipids (32-33g/100g of fresh skin). In contrast to meat, lipid composition of skin seemed not affected by the anatomical location.

FATTY ACID COMPOSITION IN MUSCLES : Fatty acid composition of the intramuscular lipids from breast, drumstick and thigh were largely dependent, on the anatomical location (TABLE 3). This result was primary explained by differences in neutral/polar lipid ratio between muscles, because the fatty acid compositions of neutral and polar lipids

were weakly affected by the anatomical location of the muscle.

Neutral lipids of the 3 muscles showed no significant differences in their fatty acid composition (TABLE 4). The relative proportions in saturated, monounsaturated and polyunsaturated fatty acids were 33.1-35%, 44.8-47.6% and 19.4-19.5% respectively. Linoleic acid accounted for at least 90% of the total PUFA. P/S ratio was 0.5-0.6 in this fraction.

Fatty acid composition of polar lipids were similar in the 3 muscles (TABLE 5). As compared to neutral lipids, polar lipids presented almost the same saturated fatty acid content (34.8-38.9%). Whereas their PUFA content was higher (40.2-43.7%) and their monounsaturated fatty acid proportion was lower (20.8-23.4%). The PUFA profiles of the polar lipids showed a high amount of PUFA with 20-22 carbon backbones. Arachidonic acid (20:4n-6) was a predominant long chain PUFA, such as 22:4n-6, 22:5n-6, 22:5n-3 and 22:6n-3 were present at a level varying from 0.4 to 4.0% each. P/S ratio in polar lipids exceeded 1.0 in all the 3 muscles.

FATTY ACID COMPOSITION IN SKIN : Fatty acid composition of total, neutral and polar lipids from breast and leg skin were similar. Compared to muscles, the 3 lipid fractions of skin contained more monounsaturated fatty acids and less PUFA. The most interesting result is the typical fatty acid composition of skin polar lipids. They showed a very high percentage of saturated fatty acids and about a half of the PUFA content of the same fraction in muscle (20.0% versus 37.41%). This difference could be explained by the absence of 22 carbon PUFA in skin polar lipids and the dramatic reduction of the level of arachidonic acid compared to muscle.

DISCUSSION

LIPID CONTENT OF MEAT AND SKIN : As expected, breast muscles contain less intramuscular fat than thigh and drumstick ones. Our data are close to these reported earlier (1, 4, 5). In addition, breast muscles (white meat) exhibit a low polar lipid amount as compared with thigh and drumstick muscles (dark meat). This difference between muscles could be associated with the metabolic type of the muscular fibers. In pork and beef, it is well know that muscles with high content in red fibers always present a higher amount in polar lipids than muscles containing mainly white fibers (11). It is obvious, that this explaination can be extended to poultry meat.

33% of the wet weight from skin are lipids. They are mainly neutral lipids, polar ones account only for 0.6-0.7g/100g of skin. These results are in a good agreement with the data published by PIKUL and al. (1985) and KATZ and al. (1966). However, lipid content of skin depends largely on strain. In lean strains, skin contains 25-35% of fat; whereas lipid content in skin from fatty strains is generaly up to 40%.

FATTY ACID COMPOSITION : As usually admitted, chicken meat presents a high amount in PUFA located in both neutral and polar lipids (16-20% and 37-40% respectively). However, long chain PUFA (20-22C) have been found mainly in polar lipids. In addition, besides arachidonic acid, a classical component of all meat polar lipids, N-3 long chain fatty acids with 5 or 6 double bonds are present in an appreciable proportion (10% of PUFA) in chicken polar lipids. Polar lipids from chicken meat do not differ in fatty acid composition according to the anatomical location. This result extends the one achieved previously in pork muscles (9).

Skin lipids exhibit a low PUFA content as compared to muscle. It is primarily due to low proportion of PUFA in polar lipids from skin.

From the nutritional point of view, chicken appears as a lean meat since intramuscular lipids do not exceed 5% of the wet weight. Moreover, chicken meat lipids show a high PUFA percentage with both N-6 and N-3 long chain fatty acids and a P/S ratio close to that advised by the physicians. On an other hand, skin must be looked on as a fatty tissue in which the nutritional quality of lipids are lower.

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TABLE 1 : TOTAL, NEUTRAL AND POLAR LIPID CONTENTS OF CHICKEN MEAT AT DIFFERENT ANATOMICAL LOCATIONS.

LIPIDS (g/100g of fresh meat)	BREAST		DRUMSTICK		THIGH	
	RIGHT	LEFT	RIGHT	LEFT	RIGHT	LEFT
TOTAL	1.1 ±0.1	1.2 ±0.2	4.6 ±1.0	4.5 ±1.1	3.4 ±0.2	3.3 ±0.2
NEUTRAL	0.6 ±0.1	0.6 ±0.2	3.8 ±1.0	3.7 ±1.1	2.6 ±0.2	2.5 ±0.2
POLAR	0.53 ±0.08	0.55 ±0.07	0.86 ±0.13	0.82 ±0.08	0.83 ±0.11	0.82 ±0.10

TABLE 2 : TOTAL, NEUTRAL AND POLAR LIPID CONTENTS OF CHICKEN SKIN AT TWO ANATOMICAL LOCATIONS.

LIPIDS (g/100g of fresh meat)	BREAST		LEG	
	RIGHT	LEFT	RIGHT	LEFT
TOTAL	32.8 ±7.2	32.3 ±6.6	36.5 ±5.3	36.2 ±4.8
NEUTRAL	29.9 ±7.5	31.5 ±6.6	35.8 ±5.4	35.4 ±4.8
POLAR	0.79 ±0.06	0.75 ±0.06	0.70 ±0.05	0.71 ±0.03

TABLE 3 : RELATIVE PROPORTIONS OF SATURATED (S), MONOUNSATURATED (M) AND POLYUNSATURATED (PUFA) FATTY ACIDS IN TOTAL LIPID EXTRACTS FROM CHICKEN MEAT AND SKIN AT DIFFERENT ANATOMICAL LOCATIONS.

FATTY ACIDS	MEAT			SKIN	
	BREAST	DRUMSTICK	THIGH	BREAST	LEG
S	35.8 ±1.9	32.9 ±2.0	33.8 ±1.4	35.2 ±1.9	33.5 ±1.7
M	36.9 ±4.9	44.6 ±3.5	41.9 ±3.8	46.2 ±1.2	51.9 ±2.1
PUFA	27.6 ±3.6	22.5 ±2.7	24.4 ±3.1	18.5 ±2.8	14.6 ±0.7
N-6 PUFA	25.4 ±3.2	21.2 ±2.6	22.4 ±3.0	17.7 ±2.8	13.9 ±0.6
N-3 PUFA	2.1 ±0.6	0.8 ±0.1	1.4 ±0.3	0.9 ±0.1	0.7 ±0.1

TABLE 4 : RELATIVE PROPORTIONS OF SATURATED (S), MONOUNSATURATED (M) AND POLYUNSATURATED (PUFA) FATTY ACIDS IN NEUTRAL LIPIDS FROM CHICKEN MEAT AND SKIN AT DIFFERENT ANATOMICAL LOCATIONS.

FATTY ACIDS	MEAT			SKIN	
	BREAST	DRUMSTICK	THIGH	BREAST	LEG
S	35.5 ±2.9	35.1 ±1.8	33.1 ±1.9	34.3 ±2.3	36.1 ±1.5
M	44.8 ±3.9	47.6 ±2.7	46.6 ±3.9	49.5 ±3.4	47.7 ±1.9
PUFA	19.6 ±2.6	17.3 ±1.7	20.3 ±2.7	16.3 ±1.3	16.2 ±2.4
N-6 PUFA	18.7 ±2.5	16.5 ±1.7	19.4 ±2.6	15.6 ±1.3	15.5 ±2.2
N-3 PUFA	0.9 ±0.1	0.8 ±0.1	1.0 ±0.2	0.7 ±0.1	0.7 ±0.2

TABLE 5 : RELATIVE PROPORTIONS OF SATURATED (S), MONOUNSATURATED (M) AND POLYUNSATURATED (PUFA) FATTY ACIDS IN POLAR LIPIDS FROM CHICKEN MEAT AND SKIN AT DIFFERENT ANATOMICAL LOCATIONS.

FATTY ACIDS	MEAT			SKIN	
	BREAST	DRUMSTICK	THIGH	BREAST	LEG
S	35.9 ±2.1	34.8 ±1.9	38.9 ±1.2	51.4 ±7.6	45.9 ±1.5
M	23.4 ±3.5	21.4 ±3.7	20.9 ±3.8	31.7 ±3.1	31.9 ±1.4
PUFA	40.7 ±3.0	43.7 ±2.9	40.3 ±3.9	16.9 ±5.8	22.1 ±2.3
N-6 PUFA	37.0 ±1.8	40.8 ±2.2	37.0 ±2.6	16.4 ±5.8	22.1 ±2.3
N-3 PUFA	3.6 ±1.4	2.9 ±1.0	3.2 ±1.6	0.6 ±0.1	0.1 ±0.1