FATTY ACID COMPOSITION OF DIFFERENT PORK TISSUES LIPIDS

Veselinka Djordjevic, M. Bastic[1], G. Remberg[2], and J. Jovanovic[1], Beograd, 29 Novembar 111, Yugoslavia, [1]Faculty of Technology and Metalurgy, Beograd, [2]Institute of Organic Chemistry, University Götingen, D-3400 Götingen, F.R. Germany

SUMMARY

By comparative studies of muscle tissues, livers fatty tissues, brains and spinal cords of hogs, high differences in fatty acid composition of total lipids especially phospholipids of tested tissues were established. Polyunsaturated fatty acids amount 37.39% in spinal cord lipids, 37.13% in muscle tissue ones and 30.97% in brain ones but only 10.64% in livers and 0.64% in fatty tissues.

In phospholipids of spinal cords and brains, oleic and linolenic acids are predominant and in liver and fatty tissue - stearic and palmitic acids. Oleic and linolenic acids have high variation in glucolipids in brains and spinal cords compared to other glucolipids. Liver glucolipids are characterised by very high contents of stearic acid.

The data presented in the work are of interest not only for improving knowledge on lipid quality of tested tissues but they are useful in practice in the field of preventing undesirable tissue changes during processing and frozen storage.

INTRODUCTION

Fatty acid composition of meat lipids in relation to race, sex, age, feeding, anatomical location and other factors has been comprehensively studied. However, there are no precise data on fatty acid composition as well as on lipid ones of certain by-products which application has been growing more extensively for various purposes. Lipid studies are important not only from the nutrition point but also they are of interest in studying changes of individual raw materials and foods in the course of frozen storage.

The purpose of the work was to examine comparatively the fatty acid composition of lipids of muscle tissues, livers, fatty tissues, brains and spinal cords of hogs paying special attention to studies of fatty acid composition of total lipids as well as of phospholipids and glucolipids.

MATERIALS AND METHODS

Muscle tissue (M. longissimus dorsi in the region of the 12th-14th vertebra), livers, fatty tissues, brains and spinal cords of five Landrace race hogs, carcass mass about 81 kg, were taken from the slaughter line and immediately studied.

Total lipids were extracted by a procedure according to Folch et al. (1957) at about 10°C. The lipid fractions were then fractionated by column chromatography - Silica Gel 60 (70-230 mesh) to neutral lipids, glucolipids and phospholipids by the procedure after Johnston (1983). The composition of these fractions was determined gravimetrically upon evaporating the solvent in a stream of nitrogen and expressed as percentage of total lipids.

The methyl esters of fatty acids of total lipids, phosphlipids and glucolipids were prepared with diazomethane (De Boer and Backer 1956). The identification and the quantitative analysis were performed using Varian 3400 capillary gas chromatograph on a SE 54 fused silica capillary stationary phase on deactivated siloxane, column length 24 m, inner diameter 0.25 mm with a FID detector. Carrier gas N_2, flow rate 1.18 ml/min. The injector and detector temperatures were 300°C. The analyses were performed at a program heating rate of 4°C/min from 100° to 290°C. Methyl esters of C10 to C20, C22 and C24 saturated and unsaturated fatty acids were used as identification standards. The percentages of total surface area in quantitative analysis, obtained by Spectra Physics System I Computing Integrator, were converted to percent mass by comparing with mixtures of acid methyl esters of known composition.

RESULTS AND DISCUSSIONS

The results shown in Table 1 indicate high differences not only in quantities of total lipids but also in relative proportion of certain lipid fractions in muscle tissues, livers, fatty tissues, brains and spinal cords. It was found that neutral lipids ranged from 29.67% in brain, very close

Table 1. The mean composition of lipids isolated from tested tissues

Tissue	Total lipids[x]	Neutral lipids[xx]	Gluco-lipids[xx]	Phospho-lipids[xx]
Muscle tissue	2.47	74.89	0.74	24.37
Liver	3.49	31.03	4.80	64.16
Fatty tissue	87.48	99.64	0.09	0.27
Brain	8.65	29.67	9.54	60.79
Spinal cord	20.45	39.00	4.42	56.58

[x]on the whole tissue basis

[xx]on the total lipid basis

Table 2. Relative proportions of saturated (S), monounsaturated (M) and polyunsaturated (PUFA) fatty acids in total lipid extracts from tested tissues

Tissue	S	M	PUFA	PUFA/S
Muscle tissue	47.28	15.43	37.13	0.79
Liver	84.42	4.94	10.64	0.13
Fatty tissue	34.45	59.90	0.64	0.02
Brain	56.65	12.39	30.97	0.55
Spinal cord	35.06	27.55	37.39	1.07

Table 3. Relative proportions of saturated (S), monounsaturated (M) and polyunsaturated (PUFA) fatty acids in phospholipids from tested tissues

Tissue	S	M	PUFA	PUFA/S
Muscle tissue	48.03	30.91	21.06	0.44
Liver	73.36	7.21	19.43	0.26
Fatty tissue	78.46	5.69	15.85	0.20
Brain	24.18	28.28	47.54	1.96
Spinal cord	12.95	31.91	55.24	4.29

Table 4. Relative proportions of saturated (S), monounsaturated (M) and polyunsaturated (PUFA) fatty acids in glucolipids from tested tissues

Tissue	S	M	PUFA	PUFA/S
Muscle tissue	51.68	11.77	36.55	0.71
Liver	81.36	6.24	12.40	0.15
Fatty tissue	58.24	7.37	34.39	0.59
Brain	17.98	37.39	44.63	2.48
Spinal cord	44.14	16.67	39.19	0.89

to it were in livers (31.03%) and in spinal cords (39.0%) and up to as high as 99.64% in fatty tissues. There are particularly great differences in proportions of glycolipids and phospholipids in total lipids among individual tissues. While the participations of phospholipids are 64.16% in liver lipids, 60.70% in brains and 56.88% in spinal cord ones, muscle tissues show to contain 24.37% and fatty tissues 0.27%. The highest quantities of glucolipids are found in brains (9.54%), less in livers (4.80%) and in spinal cords (4.42%) and in muscle tissues they lowered to as low as 0.74% and in fatty tissues - 0.09%.

Therefore, besides the comparative study of the fatty acid composition of total lipids, the work was orientated to the comparative fatty acid composition study of phospholipids and glucolipids having in mind availability of details on fatty acid composition of phospholipid fractions and glucolipid ones of tested by-products.

Comparative studies of fatty acid composition of total lipids indicate great differences among tested tissues.

In muscle tissues, saturated fatty acid participation is 46.28%, monounsaturated is 15.4% and polyunsaturated ones is 37.13% (Table 2). Saturated fatty acids have the highest quantities of palmitic acid (28.38%) and stearic acid (16.50%); monounsaturated acids have the highest quantities of palmitooleic acid 2.68% and oleic (8.42%) whereas in polyunsaturated acids the highest participations have linolenic acid (31.59%); arachidonic acid is found to be as high as 1.68%.

Livers in comparison to other tissues are characterised by the highest quantities of saturated acids (84.42%), the lowest participation of monounsaturated acids (4.94%); polyunsaturated acids in livers amount 10.64%. Steric acid (24.48%) and palmitic acid (15.20%) are the main ones among saturated fatty acids; the same establishments for those acids are for total lipids of all examined tissues; among monounsaturated acids, oleic acid is in the highest quantities (2.12%) and among polyunsaturated ones, it is linolenic acid (8.93%).

In fatty tissues, polyunsaturated acids participate with 0.64%, monounsaturated acids with 59.90% and oleic acid itself with 58.05%.

The chromatograms of fatty acid composition of brain lipids show a more complex fatty acid composition than it is in the case of muscle tissue lipids and liver ones but no one is so complex as fatty acid composition of spinal cord lipids. The fatty acid composition of fatty tissue lipids is considerably less complex.

Brain characteristics are the following: in total lipids there are 56.65% saturated fatty acids, 12.38% unsaturated acids and 30.97% polyunsaturated ones; the highest participation in saturated acids show steric acid (14.68%) and palmitic acid (10.18%), in monounsaturated acids - oleic acid (4.43%) and in polyunsaturated acids - linolenic acid (14.01%). For brains and spinal cords, it was found that they contained long-chain fatty acids (20C, 22C, 24C) - saturated, monounsaturated and especially polyunsaturated.

In the fatty acid composition of spinal cord lipids, the total participation of unsaturated, monounsaturated (27.55%) and polyunsaturated (37.39%) acids, is 64.94%; at the same time, the highest ratio of polyunsaturated and saturated (35.06%) is 1.06. The ratio for brain lipids of 0.55, for muscle tissue 0.79, for liver 0.13 and for fatty tissue 0.02. Among saturated fatty acids, the participation of steric acid is 7.46% and of palmitic acid 4.64%. Among monounsaturated acids, oleic acid is present in the highest quantities (3.30%) whereas among polyunsaturated acids there is a series of acids especially of long-chain ones participating in quantities higher than 1%.

Data on relative participations of saturated, monounsaturated and polyunsaturated fatty acids in phospholipids of the tested tissues (Table 3) show high quantities of polyunsaturated fatty acids in brains (47.54%) and particularly in spinal cords (55.24%) that are two and a half to three times higher than in phospholipids of other tested tissues. So, brain PUFA/S ratio is 1.96 and for spinal cords, it is 4.20 (Table 3), for muscle tissue, it is 0.44, livers 0.24 and for fatty tissue phospholipids the ratio 0.20.

In the phospholipid fraction of all tested tissues, the linolenic acid is present in the highest quantities especially in brains (34.54%) and spinal cords (31.10%) whereas in muscle tissue, it is 6.28%, in the liver - 3.07% and in fatty tissues 0.67%. In monounsaturated acids, there is also a high participation of oleic acid being 22.0%

in brains, 18.38% in spinal cords, 17.49% in muscle tissue, 4.0% in livers and 0.89% in fatty tissue. Stearic acid is in high quantities in this fraction : 43.66% in livers and 13.94% in fatty tissue whereas in other tissues, it is considerably lower. Phospholipid fraction is particularly characterised by high quantities of long-chain polyunsaturated fatty acids as well as monounsaturated ones especially in spinal cord phospholipids and in brain ones.

Regarding relative proportions of saturated, monounsaturated and polyunsaturated fatty acids in glucolipids from muscle tissues, livers, fatty tissues, brains and spinal cords (Table 4), it is remarkàble that livers are the richest tissue in saturated fatty acids in glucolipids while unsaturated fatty acids are not concentrated in brains.

Fatty acid composition of glucolipids is much less complex, slightly more complex are brain glucolipids and still more are spinal cordones. In glucolipids of spinal cord and brain there are long-chain polyunsaturated and monounsaturated acids; in lower quantities, there are saturated fatty acids. Experimental results show that glucolipids of fatty tissues and livers are free from long-chain fatty acids whereas glucolipids of muscle tissues only contain fatty acids with 20C.

Presented data in the work point out that differences in lipid composition and fatty acid one are significant. A comprehensive study of obtained results is useful not only from the viewpoint of lipid quality appraisal of tested tissues but also for the prevention of undesirable tissue changes during processing and frozen storage.

REFERENCES

De Boer, Th.J. and Backer, H.J. (1956). *Org. Syntheses* **36**:16.

Folch, J.M., Lees, M. and Stanley, G.H.S. (1957). *J. Biol. Chem.* **226**:497.

Johnston, J.J., Chanbari, H.A., Wheeler, W.B. and Kirk, J.R. (1983). *J. Fd. Science* **48**:33.