Specifics of lipid composition of animal raw materials

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Abstract – Fatty acid composition of lipid components being a part of recipes of meat products has been studied. The factors influencing the results of analytical determination of individual fatty acids are shown. The main ratios of fatty acids content, mostly characteristic of particular kinds of the used fats are presented, allowing their use in production of modern meat products with variable nutrition value.

Index terms – fatty acids, functional products, lipid components of animal raw materials

I. INTRODUCTION

The role of fats in human's nutrition is known. The recent trends in production of new meat products, being complex food compositions and containing a large number of special ingredients, show evidences of transition from traditional meat products manufactured from one component and salt, to food mixtures, containing plant and animal ingredients with different degree of processing. Many diseases, especially those associated with age, are directly connected with nutrition, with significant role of fats. Chemical composition of fats is also very important for characterization of food value of specific product.
Our investigations show that by the composition of main fatty acids, being in bound state (fats, oils) and also in free state as the products of biochemical decomposition of fats and oils due to technological processing or changes in storage conditions, one can obtain important information about species of raw materials, presence of admixtures of other kinds of raw materials, storage time, etc (Ivankin, Chernukha, Kuznetsova, 2007, Nekluov, Ivankin. 2002).

II. MATERIALS AND METHODS

Raw materials of different origin containing lipids were used as the objects of investigations. Gas-chromatographic analysis of fatty acid composition was used. For this purpose a sample was subjected to 3 hour extraction by ether in Soxhlet apparatus for isolation of fat fraction. This fraction was subjected to treatment with the mixture 1 : 1 of chloroform with methanol according to Folch in the presence of 1% of KC1 solution for a full dilution of lipid components; then the mixture was filtered through paper and after removal of the excess solvents by evaporation, the extract was subjected to alkaline or acid hydrolysis to obtain the mixtures of methyl ether of acids, which were further analyzed on gas chromatograph HP6890 Hewlett-Packard (USA) – using PID detector and column HP-Innowax 30 m x 0.32 mm x 0.5 μm. The optimum conditions of methylation – two-hour treatment of 0.01 g of lipids with 3 ml of 15% solution of acetylchloride in methanol at 100^0C with subsequent neutralization of the mixture adding 1.25 ml of saturated KOH in CH_3OH to pH 5.0-6.0. The mixture was extracted with 3 ml of saturated aqueous solution NaC1 and 3 ml of hexane, sampling 0.2 μl from transparent hexane layer, containing methyl ethers of fatty acids (Lisitsyn, Ivankin, Nekludov, 2002).

III. RESULTS ANS DISCUSSION

Typical fatty acid composition of pork fat from *Longissimus Dorsi* muscle can be presented as follows (%): ∑ of fatty acids (∑FA) – 96,3; saturated (SFA) – 42,8, including.: C4:0 (butiric) <0.2 (0.1…1), C6:0 (caproic) <0.1 (0.1…1), C8:0 (caprylic) <0,2 (0.1…1), C10:0 (capric) – 0.14 (0.1…1), C12:0 (lauric) – 0.2 (0.2…2.0), C14:0 (myristic) – 1.5 (0.8…1.4), C15:0 (pentadecanoic) – 0.06 (0.1…1), C16:0 (palmitic) – 25.1 (27…30), C17:0 (heptadecanoic) – 0.25 (0.1…1), C18:0 (stearic) – 13.3 (13…18), C19:0 (nondecanoic) – 1.0 (0.1…2), C20:0 (eicosanoic) – 0.3 (0.1…0.4), C22:0 (behenic) – 0.55; monounsaturated (MUFA) – 41,9, including: C14:1 (myristoleic) – 0.08 (0.01…0.5), C15 : 1 (*cis*-10-pentadecenoic) – 0.3 (0,1…2), C16 : 1 (palmitoleic) – 2.32 (1.7…2.5), C17:1 (cis-10-heptadecenoic) – 1,2 (0,5…3), C18:1 n9c (*cis*-9-oleic) – 34 (30…44), C18:1n9t (*trans*-9-elaidic) – 2.7 (1.1…4), C20:1 (*cis*-11-eicosenoic) – 0.5 (0.5…1.5), C22:1n9 (erucic) – 0,8 (0,1…1,5); polyunsaturated (PUFA) 11.6, including: C18:2n6c (linoleic) – 7,8 (7…9), C18:3n6 (γ-linolenic) – 0.8 (0.5…2.0), C18:3n3 (α-linolenic) – 0.6 (0.5…1.5), C20:2 (*cis*-11.14-eicosadienoic) – 0.2 (0.1…1), C20:3n6 (*cis*-8,11,14-eicosatrienoic) – 0.4 (0.1…2), C20:4 (arachidonic) – 1.2 (0.5…2.0), C22:2 (*cis*-13,16,17-docosadienoic) – 0.4 (0.1…2), C22:6 (*cis*-4,7,10,13,16,19-docosahexaenoic) – 0.2 (0.1…1). The range of values of individual acids levels most frequently occurring is indicated in parentheses.

Analysis of fatty acid composition shows significant differences in fatty acids level for lipids of animal and plant origin. So, for animal fats (beef, pork, mutton) high level of C16:0 palmitic (25-30%) and C18:0 (15-30%) stearic acids is characteristic. For plant oils this index is 1-10%. For animal fats the presence of the most important pre-cursor of prostaglandins – C20:4ω6 arachidonic acid (1-4), while for plant products this index is 5-10 times less. All the fats have a high level of oleic acid.

Fatty acid composition of lipids from muscles of wild boar *Longissimus Dorsi* (%) is as follows: ∑ FA – 94.3, SFA – 48.0, including: C4:0 <0.1, C6:0 – 0.04, C8:0 – 0.1, C10:0 – 0.27, C12:0 – 0.4, C14:0 – 5.6, C15:0 – 0.3, C16:0 – 18.5, C17:0 – 1.0, C18:0 – 20.9, C19:0 – 0.2, C20:0 – 0.3, C22:0 – 0.4, MUFA – 35.6, including: C14:1 – 0.08, C15:1 – 0.3, C16:1 – 0.4, C17:1 – 0.05, C18:1n9c – 33.3, C18:1n9t – 0.4, C20:1 – 0,8, C22:1n9 – 0.3, PUFA – 10.7, including: C18:2n6c – 6.3, C18:3n6 – 1.1, C18:3n3 – 1.4, C20:2 – 0.55, C20:3n6 – 0.3, C20:4 – 0.1, C22:2 – 0.6, C22:6 – 0.4.

The level of the main fatty acids in chicken fat is to some extent different from fat of ostrich fat. The breast fat of laying hens (%) is as follows: ∑ FA – 95.8, SAF – 36.9, including.: C4:0 <0.1, C6:0 <0.1, C8:0 <0.02, C10:0 – 0.1, C12:0 – 0.3, C14:0 – 1.3 (0.8…1.7), C15:0 –0.3, C16:0 – 22.1 (20…26), C17:0 <0.5, C18:0 – 8.5 (4…9), C19:0 – 0.1, C20:0 –3.2, C22:0 – 0.3, MUFA – 46.4, including: C14:1 – 0.7, C15:1 – 0.7, C16:1 – 5.1 (3…9), C17:1 – 1.2, C18:1n9c – 36.9 (30…45), C18:1n9t – 1.4, C20:1 – 0.3, C22:1n9 – 0.1, PUFA – 12,5, including: C18:2n6c – 9.3 (9…20), C18:3n6 – 0.6, C18:3n3 – 0.5, C20:2 – 0.1, C20:3n6 – 0.1, C20:4 – 0,4, C22:2 – 0.3, C22:6 – 1.2. The breast fat of pheasant hen (%): C 8:0 – 0.1…0.2, C 10:0 – 0.1…0.5, C12:0 – 0.1…0.2, C 14:0 – 1.8…3.0, C 14:1 – 0.2…0.3, C15:0 – 0.4…0.5 , C15:1 – 0.3…0.5, C16:0 – 23.5…25.6, C16:1 – 1.7… 3.0, C17:0 – 0.4 …0.5, C 18:0 – 11.9…14.5, C18:1 – 39.3…42.4, C18:2 ω6 – 1.3…2.7, C18:3ω3 – 0.1…0.2, C 19:0 – 0.3…0.5, C20:0 – 0.4…0.7.

Comparison of fats' compositions of farm and wild animals, for example, pig-wild boar, hen-pheasant (or ostrich) shows that for wild animals relatively higher content of saturated fatty acids is more characteristic, which evidently is connected with high moveability of animals in nature. The same trend is observed when comparing compositions of muscle lipids over the carcass of the animal: in the lipid composition of "tough" muscles, connected with tendons, ensuring movement a similar picture is observed.

Comparison of fats composition with fatty acid composition of milk fat of cows analyzed in comparable condition is interesting:

∑FA – 97.2, SFA – 61.0 (50…70), including: C4:0 – 2.9 (2.0…4.3), C6:0 – 2.3 (1.5…3.5), C8:0 – 1.1(1.0…2.5), C10:0 – 2.4 (2.0…3.8), C12:0 –2.7 (2.0…4.0), C14:0 – 12.4

(8.0…1.0), C15:0 – 4.7 (4.0…6.5), C16:0 – 15.3 (15.0…31.0), C17:0 – 4.4 (3.5…6.5), C18:0 – 6.0 (6.0…13.0), C19:0 – 4.0 (2.0…6.0), C20:0 –1.1(0.3…1.5), C22:0 – 1.7 (0.1…2.0), MUFA – 26.9 (25…45), в т.ч.: C14:1 – 1.5 (0.5…1.5), C15:1 – 0.7 (0.1…1.0), C16:1 – 2.6 (0.5…3.5), C17:1 – 0,5 (0.1…1.5), C18:1n9c – 21.1 (20.0…32.5), C18:1n9t – 0.2, C20:1 – 0.2, C22:1n9 – 0.1, PUFA – 9.3, including.: C18:2n6c – 3.4 (3.0…5.5), C18:3n6 – 1.4 (0.1…2.0), C18:3n3 – 0.8 (0.1…1.5), C20:2 – 0.3, C20:3n6 – 0.2, C20:4n6 – 2.5 (0.1…4.0), C22:2 – 0.5, C22:6n3 – 0.2 (0.1…1.5).

After adipolysis, in milk fat one can identify a large part of lower and medium C_{4-8} fatty acids (up to 5-7% from the sum of acids), while for animal and plant fats it is usually less and doesn't exceed 1-2%. Milk fat as the most balanced by nature product, suitable for a human being, can be used as a product for comparison. New food compositions including fats of different origin by their lipid compositions should be similar to it.

The ratios of separate groups of unsaturated fatty acids are important. In connection with large works connected with special significance of individual polyunsaturated fatty acids for long and healthy life of a human being, many scientists conduct investigations on evaluation of the ratio ω6:ω3 of fatty acids. The group of family ω6 includes linoleic C18:2, γ-linolenic (*cis*-6,9,12-octadecatrienic) C18:3, arachidonic (*cis*-5,8,14-eicosatrienoic) C20:4. To ω3 family are attributed: alfa-linolenic (*cis*-9,12,15-octadecatrienic) C18:3, *cis*-5,8,11,14,17-eicosapentaenoic C20:5, and also *cis*-4,8,12,15,21-docosapentaenic C22:5 and *cis*-4,7,10,13,16,19-docosahexaenoic acids C22:6 which are sufficiently difficult to be analyzed chemically. Growth of the share of ω3 fatty acids in food products and special biologically active compositions can be considered as a favorable and even curative factor.

The ω6/ω6 ratio is rather an important index. This is considered to be equal to 4:1 and even better – 2.5:1, though really for animal fats ω6/ω3 exceeds the ratio (6…14) : 1. In other words, high share of "useful for prevention of age diseases fatty acids of group ω3" on the background of other unsaturated fatty acids should be as large as possible. The differences in the ratio ω6/ω3 allow develop various diets with the use of fats of animal, plant or even sea origin.

Our investigations show that differences in fatty acid composition are determined by breeds of animals, and significantly depend on composition and nature of feeds, and also vary depending on the method of chromatographic identification (Table).

Table. Most important ratios of fatty acids in fats of animal origin

Title	Beef	Pork	Lamb	Chicken
Ratio C16:0 / C12:0	25–30	15–150	50–150	60–120
Ratio C18:0 / C12:0	20–30	10–65	15–150	13–30
Ratio C18:1 / C14:0	8–15	20–55	10–18	15–38
Ratio C18:2 / C14:0	0.5–1,6	5.0–11,5	0.9–3,1	5–25

IV. Conclusions

Thus, it can be stated that the main index of biological and therefore food value of fats is the level of fatty acids, and especially unsaturated acids of ω3 family. Their ratio, depending on food intake, influences the state of human beings in future. The use of various types of animal and plant raw materials for production of modern meat products enables not only vary nutritive value, but also control fatty acid balance, imparting functional properties to usual products.

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