Changes in the lipid content during the refrigerated storage of animal raw material

A.A. Semenova[1], A.N. Ivankin[1*], T.G. Kuznetsova[1], A.V. Bogdanova[1]

[1]The V.M. Gorbatov All-Russian Meat Research Institute, Russian Agricultural Academy, 109316, Russia, Moscow, Talalikhina Street, 26
*Corresponding author (e-mail: aivankin@inbox.ru)

Abstract – **The aim of this study was to evaluate the quantitative changes in fatty acid content of meat, and to predict its shelf life. Pork and beef were stored at -4^{0}C to -25^{0}C for 1 month. Lipids were isolated using Folch method or by steam stripping. Fatty acid composition was analyzed on the Hewlett-Packard HP 7890 Chromatograph. The results showed that the proportion of saturated fatty acids (C10:0, C14:0, C18:0, C22:0, C24:0 and others) generally increased, although the mass fraction of the principal fatty acid, palmitic acid (C16:0), decreased almost by one forth during the pork storage. The overall trend towards the decrease in the proportion of unsaturated fatty acids (the principal fatty acids C18:1, C17:1, C15:1, C16:1, C20:5) holds true. During the short-term storage the tendency can be reversed. For example, the proportion of large fatty acids with one, two and more unsaturated bonds (C14:1, C18:3w6, C18:3w3, C20:1w9, C20:2w6, C20:4w6, C22:1n9t, C22:2w6, C22:6w3) increased. The trend towards fatty acid isomerization was found, specifically, the proportion of trans-isomer C18:n9t of elaidic acid increased. Thus, the change in free fatty acid composition is clearly associated with food storage duration and conditions, which can be used for the assessment of meat product shelf-life.**

Keywords – **fatty acids, lipids, meat raw material**

I. INTRODUCTION

During the long term storage of meat and meat based food products including the storage under the temperatures below zero clearly apparent changes in lipid components, particularly in lipids are observed. It is known that animal fats are basically triglycerides, in which mainly saturated, unsaturated and polyunsaturated C8-C24 fatty acids act as substituting fatty acids. These acids can undergo a variety of chemical changes under the influence of residual fermentative activity. The result of these changes affects the product sensory characteristics. At the same time, we can estimate the storage time of this product type according to the degree of changes in fatty acid composition. The aim of this study was to evaluate the qualitative changes in fatty acid composition in meat, stored under the temperatures below zero and to predict its shelf life on the basis on the obtained results.

II. MATERIALS AND METHODS

Pork and beef stored at -4^{0}C to -25^{0}C for 1 month were the subjects of research. Lipids were isolated by extraction with chloroform/methanol using Folch method or by steam stripping. Fatty acid composition was analyzed on the Hewlett-Packard HP 6890 Chromatograph according to the described method [1].

III. RESULTS AND DISCUSSION

Our study shows that valuable information on species origin of raw material, the addition of the different kind of raw material, storage duration of product, etc. can be obtained from the analysis of composition of main fatty acids that occur in the bound state (fats, oils), and in the free state as products of biochemical disintegration of fats and oils due to the technological processing and changes in storage conditions. Thus, the typical fatty acid composition (in brackets) of pork fat from *Longissimus Dorsi* muscle can be presented as (%): ∑ 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 analysis of lipid fraction (so called volatile fatty acids) of pork samples stored at -18^0C and -25^0C demonstrates somewhat different picture. The overall well-known tendency of biochemical changes regarding saturated fatty acids, which are constituents of animal fats, shows that their proportion generally increases. For example, it clearly reveals itself for capric (C10:0), myristic (C14:0), stearic (C18:0), behenic (C22:0), lignoceric (C24:0) and other acids, although the mass fraction of the principal fatty acid, palmitic acid (C16:0), decreases by almost one-fourth during pork storage. The overall trend towards the decrease in the proportion of unsaturated fatty acids (the principal fatty acids C18:1, C17:1, C15:1, C16:1, C20:5) holds true. However, during short-term storage the reverse tendency takes place. For example, the mass fraction of virtually all large fatty acids with one, two and more unsaturated bonds (C14:1, C18:3w6, C18:3w3, C20:1w9, C20:2w6, C20:4w6, C22:1n9t, C22:2w6, C22:6w3) increased. This fact can indicate that at the first steps the inner fermentative activity during storage develops as lipase activity (fat disintegration) and dehydrolyzing activity (hydrogen abstraction with the increase in the amount of the double bond quantity). Simultaneously, the trend towards fatty acid isomerization manifests itself, specifically, the proportion of trans-isomer C18:n9t of elaidic acid (the chemical analogue of oleic acid) increases, which is an additional argument against storage of meat in frozen condition.

IV. CONCLUSION

Therefore, the change in free fatty acid content is clearly associated with food storage duration and conditions, which can be used for the shelf-life assessment for meat based food products.

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