FORMATION OF ORGANOLEPTIC PROPERTIES OF "BRAUNSCHWEIGSKAYA" SAUSAGE UNDER THE INFLUENCE OF STARTER CULTURES

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Abstract – The paper describes the process of organoleptic properties formation in the Russian uncooked smoked sausage "Braunschweigskaya", which was produced according to the original fermentation technology of the V.M.Gorbatov All-Russian Meat Research Institute, in the presence of the modifying mixtures of starter cultures Lactobacillus plantarum/ Staphylococcus carnosus and Lactobacillus plantarum / Micrococcus varians. The changes in the pool of chemical substances that form taste and aroma of the national product associated with the presence of the bacterial cultures and addition of cardamom and black pepper were revealed.

Key Words – smell, Brunswick sausage

I. INTRODUCTION

The process of aroma formation in uncooked smoked sausages has been studied by national and foreign scientists for decades (1). The interest to this question is generated by a range of objective reasons. First of all, uncooked smoked sausages are a product of the lengthy production process with high consumer cost. Second, their production presents the complex of compound microbiological and biochemical processes including fermentative, proteolytic and oxidative transformations, the end result of which is so far difficult to predict even in the conditions of the well-established technological process. Third, alteration of the concept of safety and quality of uncooked smoked sausages under the influence of new knowledge forces to search for the new directions for a technological process modification and study their impact on formation of the traditional consumer quality of a product.

At present, the scientific research performed abroad has established more than 400 key components determining the taste and aroma of the traditional fermented sausages produced in different countries. This research has been carried out not only in France, Italy, Spain and Belgium, but also in Portugal, Chili, Mongolia and other countries (2).

One of the most popular fermented products in Russia is uncooked smoked sausage "Braunschweigskaya", key aroma compounds of which have not been studied by the contemporary chromatographic methods. During the last decades, this sausage has been produced by industrial enterprises using starter cultures that contain Staphylococcus. *Staphylococcus*, in particular, *Staphylococcus carnosus* facilitates the formation of product specific aroma by amino acids transformation (including branched-chain amino acids, leucine, iso- leucine and valine) and free fatty acids. Aroma formation also depends on the sausage type and technology of their production. In case of fast ageing sausages, application of *Staphylococcus* facilitates the formation of methyl branched aldehydes. In case of slow ageing sausages, application of *Staphylococcus* in large quantities facilitates formation of methyl branched acids and sulfites, and at the low level of their addition, the diacetyl and ethyl esters are formed. Furthermore, addition of nitrite, nitrate or ascorbates, parameters of the preliminary growth of cultures and environmental factors also influence the aromatic compounds formation.

Application of *Staphylococcus*, which generates a large quantity of aromatic compounds, enables improvement of the organoleptic quality of uncooked smoked sausages and acceleration of the fermentation process. *Micrococcus* as starter microorganisms are considered less effective compared to *Staphylococcus*. However, application of *Staphylococcus* in the composition of starter cultures can be accompanied by the risk of development of the enterotoxigenic strains of *Staphylococcus aureus* due to the impossibility of performing an effective microbiological control in the presence of the technological related microflora. In this connection, taking into account the impact of the production technology of a particular sausage, the study on the comparative assessment of the aroma of the traditional uncooked smoked sausage "Braunschweigskaya", when substituting the *Staphylococcus* strain by the *Micrococcus* strain in the composition of the starter culture, was of practical interest.

The aim of the work was the comparative study of organoleptic properties formation in uncooked smoked sausages with use of *Staphylococcus* and *Micrococcus* in the composition of the starter cultures.

II. MATERIALS AND METHODS

The subjects of research were the samples of uncooked smoked sausage of "Braunschweigskaya" type produced industrially without starter culture addition (control sample "C"), with addition of the starter culture, contained Lactobacillus plantarum + Staphylococcus carnosus (experimental sample «A»), and with addition of the starter culture, contained Lactobacillus plantarum + Micrococcus varians (experimental sample "B"). Control and experimental samples were made from sausage meat contained 45% of lean beef, 25% of lean pork and 30 % of back fat. Nitrite salt was added in the quantity of 3%, glucose 0.3%, cognac 0.25%, black pepper 0.1%, cardamom 0.05%, ascorbic acid 0.05% to the mass of sausage meat.

When preparing the experimental sausage samples, one Lactobacillus plantarum strain and Staphylococcus carnosus and Micrococcus varians strains were added on the basis of their addition to the sausage meat at the level of 10^7 CFU/g. Prepared sausage meat was stuffed into the artificial sausage casing "fibrouse" with 48 mm diameter forming links with weight of 300 g. All samples were setted at the temperature of +2…+4°C for 24 hours. After setting, sausage links were placed to a climatic chamber and hold at the temperature of +24….+25.5°C and relative humidity not higher than 95% until the drop of the product pH value not higher than 5.2. After this, the humidity in the chamber was reduced to the values not higher than 92% and began to perform smoking by steps, with 90 min duration of each step. With that, the temperature and humidity in the chamber were gradually reduced during 8 days to 14°C и 74%, respectively. Then the uncooked smoked sausage samples were dried at the temperature of 12–14°C until achieving the ultimate product moisture not higher than 32% (Fig. 1).

Analysis of the aroma volatile components composition was performed on the gas chromatograph 7890A with the Mass Selective Detector 5975C VL MSD Agilent Technologies (USA). Extracts (1:1) by 40% aqueous ethanol and extracts by chloroform/methanol using Folch method with subsequent methylation by the solution of acetyl chloride in methanol were used. The calculation of the component content (the names are presented according to IUPAC) with mass content in the aromatic mixture of substances more than 0.01% was performed with use of automatic search base and data identification NIST08 MS Library with the probability of peak correspondence more than 65%.

III. RESULTS AND DISCUSSION

It is seen from the obtained results that the sausages with the added cultures have the distinctive substance composition determinating the aroma of sausage "Braunschweigskaya". Substance pool, which is eventually formed under the influence of the starter cultures and technological operations, is practically unique.

It is known that many organic substances have a characteristic taste; for example: indolisin - cucumber, 2- nonenal - watermelon, tetradecanic acid - balsam, frankincense, 1-octen-3-ol - mushrooms; n-decan and quaiacol – tobacco, indole - fruit; pentadecanal - burnt wood and so forth (3).

The composition of the aromatic components in the defatted sample of sausage "Braunschweigskaya" with Lactobacillus plantarum + Staphylococcus carnosus, includes (μg/kg): 2-methoxy-phenol 5.29; methoxy-phenyl-oxime 0.37; malic acid 0.20; 2-methoxy-4-methyl-phenol 1.02; hexadecane 0.60; 1-bromodocosane 0.10; tetradecane 0.54; 1-methyl-4-(1-methylethyl)-1,3-cyclohexadiene 0.62; 2,6-dimethoxy-phenol 1.03; 4-methoxy-3-(methoxymethyl)-phenol 0.78; heneicosane 0.95; 7-hexyl-tridecane 1.63; 6-methyl-tridecane 0.93; 5-methoxy-4-methyl-1-heptene 0.20; hentriacontane 1.19; hexadecane 0.88; 3,6-dimethyl-undecane 0.32; ethyl tridecanoate 1.99; 5-hydroxy-2-methyl-3-hexenoic acid 0.07; propyl-2-ethylhexanoate 0.57; 9-hydroxy-2-nonanone 0.21; n-propyl-9-tetradecenoate 1.82; hexadecanoic acid, methyl ester 0.92; hexadecanoic acid, ethyl ester 21.41; 3,5-

dinitro-benzonitrile 0.05; decanoic acid, methyl ester 0.23; 1-hexadecanol 2.21; eicosane 0.21; ethyl oleate 28.25; heptadecanoic acid, ethyl ester 2.14; octadecanoic acid, ethyl ester 8.96; octahydro-2-methylene-4,7-methano-1H-indene 0.20; nonadecane 0.83; octahydro-4a,5-dimethyl-3-(1-methylethyl)-2(1H)-naphthalenone 1.04.

The aromatic components in the defatted sample of sausage “Braunschweigskaya” with Lactobacillus plantarum + Micrococcus varians, include (μg/kg): 2-methoxy-phenol 6.41; 6-ethoxy-pyridin-2-amine 0.33; 2-methoxy-4-methyl-phenol 3.33; D,L-arabinose 0.27; 1-iodo-tridecane 0.57; 4-ethyl-2-methoxy-phenol 1.42; 3-methyl-5-propyl-nonane 0.28; (+)-4-carene 0.54; 2,6-dimethoxy-phenol 0.98; 4-aminobutanoic acid 0.21; 4-methoxy-2-methyl-1-(methylthio)benzene 0.65; heptadecane 1.07; octadecane 8.18; 5,5-dimethyl-3-(3-methyl-oxiran-2-yl)-cyclohex-2-enone 0.19; N-cyclohexyl-3-nitro-4-pyridinamine 0.60; 3,5-dichloro-2,6-dimethyl-4-pyridyl ester 0.12; 2-bromo dodecane 1.08; docosane 0.71; nonanoic acid, ethyl ester 1.95; 2-methyl-propanamide 0.4; 2,4,6,8-tetramethyl-13-tetradecenoic acid 0.5; 2-dodecanone 0.4; heneicosane 0.89; methyl hexadec-9-enoate 2.02; hexadecanoic acid, ethyl ester 19.26; 2-(p-tolyl)ethylamine 0.08; 9-eicosene 2.62; 2-methyl-decane 0.27; ethyl oleate 28.53; octadecanoic acid, ethyl ester 16.08; 5-acetoxypentadecane 2.10; 2,2-dimethyl-5-methylene-bicyclo[2.2.1]heptane 0.23; Z-7-hexadecenoic acid 1.12; eicosane 1.00; 3,3-dimethyl-2-(phenylselenyl)butanoic acid, 2-methylbutyl ester 0.88.

The composition of the aromatic components in the defatted sample of sausage “Braunschweigskaya” produced without cultures (control) include (μg/kg): 2-methoxy-phenol 3.61; 2-methoxy-4-methyl-phenol 0.91; tetradecane 0.41; 4-ethyl-2-methoxy-phenol 0.72; 4-amino-5-imidazole carboxamide 0.20; hentriacontane 0.35; (+)-4-carene 0.53; 2,6-dimethoxy-phenol 1.00; 2-methoxy-5-nitro-benzenamine 1.15; hexadecane 0.3; octadecane 1.12; N-acetyl-dl-serine, methyl ester 0.44; 3-chloro-1,2-propanediol 0.07; 4-phenyl-pyrimidine 0.01; eicosane 0.67; octacosane 0.56; 3,6-dimethyl-undecane 0.18; tetradecanoic acid, ethyl ester 1.45; N-allyl-oxalic acid, monoamide 0.39; 2-pentadecanone 0.36; octacosane 0.62; E-11-hexadecenoic acid 1.79; hexadecanoic acid 0.12; cyclohexadecane 2.35; 2-methyl-decanoic acid 0.19; eicosane 0.12; 9-octadecenoic acid 30.69; octadecanoic acid 17.85; 15-hydroxypentadecanoic acid 2.84; Z,Z,Z-1,4,6,9-nonadecatetraene 0.22; 1-cyclohexylnonene 0.81; octadecane 0.70; N-ethyl-ethanamine 0.21; 13-octadecenal 1.56; 3-(dimethylamino)-2-propenoic acid, methyl ester 0.74; 3,7-dimethyl-2-octen-1-ol 0.15; benzo(a)pyrene-6-methanol 0.07; 17-hydroxy-pregna-1,4-diene-3,20-dione 0.07; 4-methoxy-6-morpholin-4-yl-[1,3,5]triazine-2-carboxylic acid amide 0.10; methyl 3-diethylphosphonoacrylate 0.10; 6-(2-formylhydrazino)-N,N'-bis(isopropyl)-1,3,5-triazine-2,4-diamine 0.13; benzothiophene-3-carboxylic acid 0.10; 3-hydroxy-4-methoxybenzyl alcohol 0.03; 1,1'-binaphthalene 0.05; 2-hydroxy-1H-isoindole-1,3(2H)-dione 0.06; 1-azido-2-nitro-benzene 0.08; 1-adamantanecarboxanilide 0.10; 11,12-dihydroxyseychellane 0.07; 1',2'-epoxyhexobarbital 0.04; 2-methylaminomethyl-1,3-dioxolane 0.12; 2-acetylamino-3-(4-ethoxy-phenyl)-acrylic acid 0.10; 4-phenyl-3,4-dihydroisoquinoline 0.08; N-methyl-1-adamantaneacetamide 0.12; 1-acetyl-4-[1-piperidyl]-2-butynone 0.05; 2-(benzylideneamino)fluorene 0.04; 2-nitro-benzaldehyde 0.11; N-(2'-acetyl-4',5'-dimethoxyphenyl)-4-methoxy-benzamide 0.05; 3,4-dimethyl-N-(4-methylthiobenzylidene)-benzenamine 0.09; hexahydropyridine 0.06; 1H-pyrazolobisthiolium 0.13; 2-hexadecyl-2,3-dihydro-1H-indene 0.09; 4-[N-methylpiperazino]-5-nitro veratrole 0.05; 7-chloroquinoline-2,4-dicarboxylic acid 0.08; 2-acetylamino-3-(4-ethoxy-phenyl)-acrylic acid 0.08; 3,5-dibromo-4-pyridinol 0.12; 3-O-methyl-D-glucose 0.07; 8-hydro-thiazolo[3,2-a]pyridinium 0.05; p,p'-dibromodiphenyl trichloroethane 0.09; 6-chloro-2-phenethyl-4-phenylquinoline 0.08; 1-amino-2-(hydroxymethyl)anthraquinone 0.2; 3-(4-aminophenyl)-2-phenyl-acrylic acid, methyl ester 0.03; benzo[b]thiophene-4-acetic acid 0.08; 2-isopropylidenehydrazono-3-methyl-4-chloro-2,3-dihydrobenzothiazole 0.10; N-(diphenylethenylidene)-methanamine 0.05; 1,2,4-Oxadiazole-5-carboxamide 0.05; pentachloro-pyridine 0.07; propanamide 0.03; N-methyl-4-pyridinecarboxamide 0.13; 4-acetamido-2-methallylphenol 0.07; 6-chloro-3-ethoxycarbonyl-2-methyl-4-phenylquinoline 0.07; 4-methylthiophene-3-sulfonamide 0.04; 2,2-diphenylpropionitrile 0.08; 1-(5-bromo-4-nitro-2-thienyl)ethan-1-one 0.08.

Table 1 The main aromatic substances of "Braunschweigskaya" sausages, mg/kg: A – sausage product with Lactobacillus plantarum + Staphylococcus carnosus; B - sausage product with Lactobacillus plantarum + Micrococcus varians cultures; C - control sample without cultures

Name	A	B	C
3-Phenyl-1H-quinolin-2-one	–	–	0.12
1-Ethyl-2-phenyl-1H-indole	–	0.51	–
Decanoic acid, methyl ester	0.06	0.32	0.26
Nonanoic acid, methyl ester	0.41	1.33	1.53
Methyl dodecanoate	0.57	1.64	1.89
Methyl tetradecanoate	7.78	6.57	7.89
Methyl pentadecanoate	0.48	–	–
9-Hexadecenoic acid	–	–	3.21
Methyl hexadec-9-enoate	9.42	5.49	–
Hexadecanoic acid, methyl ester	13.47	19.53	12.19
Methyl cis-10-heptadecenoate	2.32	–	–
Heptadecanoic acid, methyl ester	3.35	–	–
Methyl (Z)-9-octadecenoate	26.0	18.96	14.8
Methyl cis-10-nonadecenoate	1.13	4.69	0.41
5,8,11,14-Eicosatetraenoic acid	2.81	–	–
cis-5,8,11-Eicosatrienoic acid	1.65	–	–
Methyl octadecanoate	–	–	0.36
Octadec-9-en-1-al dimethyl acetal	–	–	2.71
Z-6,17-octadecadien-1-ol acetate	–	2.48	–
2-Octyl-cyclopropaneoctanoic acid	–	–	4.81
Methyl cis-13-eicosenoate	12.04	–	–
Eicosanoic acid	1.85	–	5.78
3,7,11-Trimethyl-2,6,10-dodecatrien-1-ol	–	–	0.46
2,4-Dinitro-5-fluoroaniline	–	0.72	–
Arachidonic acid	–	6.65	–
Methyl 7,10,13-eicosatrienoate	–	3.89	–
1,9-cyclohexadecadiene	–	3.17	–
5-Nonadecen-1-ol	–	–	10.46
11-Hexadecen-1-ol, acetate	–	6.66	–
Methyl 6-octadecenoate	–	–	1.16
Methyl 18-methyl nonadecanoate	–	3.35	–
Methyl 8,11,14,17-eicosatetraenoat	0.61	0.42	3.73
9-Octadecenal	4.46	–	–
Ethyl 5,8,11,14,17-icosapentaenoat	–	4.11	7.23
Palmitoyl chloride	1.87	0.15	0.19
2,3-Dihydroxypropyl elaidate	–	–	8.27
1-Cyclohexylnonene	–	6.67	–
Docosanoic acid	0.27	0.56	0.82
d-Gulopyranoside	–	2.59	2.99
Methyl 10-nonadecenoate	–	–	0.32
Methyl tetracosanoate	–	–	0.17
Cholesterol	0.11	0.41	0.63
1-Docosene	0.12	–	–
Octacosyl acetate	–	0.21	–
13-Tetradecen-1-ol acetate	–	–	0.24

The quantity of the aromatic components was much more here compared to the quantity of the other substances from the same but defatted samples.

Figure 1 Sausage samples during fermentation

It appears that the data obtained suggest that the taste of the national Russian product, sausage "Braunschweigskaya", is mostly determined by the combination of the basic substances repeated in all samples (Table 2); first of all the derivatives of fatty acids – decanoic, hexadecanoic, 9-octadecenoic, palmitic, docosanoic, 8,11,14,17-eicosatetraenoic, cis-10-nonadecenoic, nonanoic, dodecanoic, tetradecanic, cholesterol derivatives and impurities of all other components of aromatic substances presented in tables 1 and 2 and participating in taste and aroma formation in sausage "Braunschweigskaya". Formation of taste gamut occurs due to the used spices and the enzymatic activity of the microbial cultures that break up meat raw material components into organic substances with a characteristic taste.

IV. CONCLUSION

Thus, the target addition of some microbial cultures enables correction of taste gamut of the national meat produce conditioned by the presence of the traditional spices.

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