APPLICATION OF BACTERIAL CONCENTRATES IN THE MANUFACTURE OF SMOKED BEEF PRODUCTS

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ABSTRACT: The advanced techniques of raw animal material mechanical treatment at curing make it possible to obtain (for a short time interval) tender beef products of excellent color and attractive appearance, but their desired aroma and flavor fail, as a rule, to be timely formed. At the same time, the experience gained in application of some species and strains of lactic-acid bacteria has proved that this technique is ambitious for intensifying the processes of flavor and aroma formation in the meat product manufacture. The beef product polatability can be improved by application of the smoked beef product technology with utilization of bacterial concentrates which give the product a specifically pleasant flavor, fine aroma and adequate consistency. Appropriate normative-and-technical documents have been elaborated for the smoked-boiled beef ham manufactured from muscles (prebone, postbone, tricephalous) of the beef bladebone, egg powder, and vivified bacterial concentrate.

INTRODUCTION: The smoked beef product manufacturing process is known to be rather difficult since the beef meat shows a specific flavor, aroma and coarse consistency. The specialists of the Ukrainian Research Institute of Dairy and Meat Industry have developed the bacterial concentrates added to multicomponent brines, which allow to manufacture the high-quality smoked beef products. In the course of degustation procedures, the specialists highly appreciated the organoleptic indices of the products: the surface is dry, uniformly colored in golden-brown color, pink in cutting, the products are succulent with full-bodied aroma of smoke curing and spicery, and delicate consistency.

MATERIALS AND METHODS: With a view to select microorganisms to be used in the manufacture of smoked beef products, the following cultures were studied: Streptococcus diacetilactis, Streptococcus thermophilus, Lact. acidophilus.

The selected strains were checked by basic indices inherent to each bacteria species. The antagonistic properties of Lbc. acidophilus and Str. thermophilus were studied as against the sapro-

genic and sanitary-representative microflora. Selected as components of leavening combinations were the strains showing a high-level antagonistic activity (10^{-1} to 10^{-3}) and an acidification activity of 80 to 110 °T for 5.5 to 8 hours (at the 1-% inoculation). Strains Str. diacetilactis selected for the study showed almost similar indices and represented the diplococci, rarely short chains of cocci; the alkaline-test occurrence of diacetyl and acetoin was observed within 7 to 10 minutes, the leavening time at inoculation of the 10-% culture was from 17 to 20 hours.

The flavor and aroma of milk fermented by all strains are delectable, full-bodied, without foreign flavors and odors. All the strains are resistant to the 0.4 % phenol and 2 % common salt and show the denitrification properties, i.e. they enhance the reduction of nitrates into nitrites. The latter property is especially important because it allows a twofold reduction of sodium nitrite in a brine employed for meat stuffing. The cultures selected following the above-enumerated indices were used as a basis to compose the leavening combinations featuring a set of strains. Some research works were conducted resulting in creation of a bacterial concentrate based on leavening combinations of the following strains: Streptococcus diacetilactis, Streptococcus thermophilus, and Lbc. acidophilus.

Prior to introducing the bacterial concentrate into a brine, it is subjected to vivification. To this end, the nonfat or reconstituted dried milk is used, which is obtained by dissolving 0.5 kg of nonfat dry milk in 91.3 l of tap water preheated to a temperature of 40 ±2 °C. The nonfat and reconstituted dried milk is to be pasteurized at a temperature of 93 ±2 °C for 40 ±5 minutes and cooled down to a temperature of 37 ±1 °C. The bacterial concentrate is introduced into the pasteurized milk in quantity of 1 g per 100 l, having predissolved the concentrate in 10-20 ml of the pasteurized milk or physiological salt solution. The leavening is conducted at 37 ±1 °C until the milk is clotted for 16 ±2 hours, then it is cooled down to a temperature of 7 ±2 °C and stored at this temperature for not more than 24 ±1 hr.

The multicomponent brine formulas and the cured beef product manufacturing procedures were elaborated. In addition to the vivified bacterial concentrate, the brine composition is added with a number of components which intensify the meat curing process, facilitate the aroma formation and increase the biological and nutritive value of the ready-to-eat product. The multicomponent brine is introduced into meat pieces by pumping in quantity from 20 to 35 %. The pumping brine temperature should be 0 to 4 °C. After the pumping, the raw meat material is to be kneaded for 30 to 40 minutes, employing the smooth-wall agitators. When a mixer-tenderizer is used, the raw meat material is cured and kneaded in the automatic mode

for 15 to 25 minutes. No disruption of muscular tissue is allowed during kneading. Then the raw meat material is kept in a brine for 18 hours at a temperature from 2 to 4 °C. The as-cured and as-formed product is transferred to heat treatment in thermal chambers or stationary and cooking chambers. The smoking is conducted in a fume-air atmosphere occurring after burning dry sawdust of leaf-bearing hard wood, the process temperature ranging from 80 to 100 °C during 1.5 to 2 hours. The cooking is conducted by steam in the steam chambers or in water in open digesters at a temperature range from 78 to 82 °C until the in-product temperature reaches 70 to 74 °C. The term of cooking is 50 to 80 minutes for a product mass of 1 kg. The smoking and cooking procedures can be carried out in automatic thermal chambers. The as-cooked product is cooled down in a chamber at 0 to 4 °C until the temperature inside the product does not exceed 8 °C.

The above-specified technology with application of bacterial concentrate "ACIDOBACT" is supported with the normative-technical documentation which was elaborated and certified for a wide variety of beef products: top-grade "cured ham", first-class "Desnyanskaya beef neck", first-class beefroll "Slavutich", and first-class "beef ham". The raw meat materials used to manufacture the above products are as follows:
"Cured ham" - back and fore rib (thick end: eye muscle of loin) or sirloin (thin end: backbone muscles), or rump (flesh);
"Desnyanskaya beef neck" - muscular tissue of scrag from 3rd to 7th vertebra inclusive;
Beefroll "Slavutich" - flat flesh (broadest muscle of back) dressed out in one muscular layer from the rib and breast of a half carcass;
"Beef ham" - prebone, postbone and tricephalous muscles of the beef bladebone.

RESULTS AND DISCUSSION: The bacterial concentrate for the smoked beef products is characterized by the following indices: milk clotting due to introduction of 1 g into 100 l of water occurred after 14 to 18 hours, the titratable acidity was within the range of 84 to 115 °T. This concentration corresponded to a lactic acid content of 7.6 to 10.3 g in 1 l of leaven, thus affecting favourably the quality of meat products manufactured with application of bacterial concentrates. The lactic acid produced by microorganisms increases the tissue proteolytic ferment activity thereby facilitating the manufacture of a tender beef product. It should be noted, however, that the meat tissue ferment activity change has been poorly studied so far. An important role of tissue ferments (cathepsins) was found in the mechanism of formation of the meat tender features, flavor and aroma. The curing-associated meat proteolysis, followed by accumulation of non-protein nitrogenous substances to which the free amino acids pertain, occurs under activity of curing ingredients and due to continuous activity of tissue proteolytic ferments whose action is increased with

presence of lactic acid produced by microorganisms. The proteolysis is induced by cathepsins effect. Cathepsin D or acidic proteinase is one of basic lysosome proteinases of muscular tissue, which presents a wide spectrum of effects and is an important contributor to degradation of various proteins and peptides. The maximum activity of this ferment manifests itself in a distinctly acidic zone. In the course of meat curing with application of a brine containing a bacterial concentrate, a complex system of structural changes is developed. These changes consist in swelling of muscular fibers, deterioration or disappearance of their lateral striation, nuclei chromatolysis, outflow of salt-soluble proteins from muscular fibers with formation of fine mass between muscular fascicles and fibers, occurrence of cracksand fissured spaces in muscular fibers with subsequent fragmentation of fibers due to development of autolytic processes, as well as destruction and lysis of fibrillar structures affected by lactic acid microflora. In the microorganism localization sites, the muscular fibers show a disjunction of miofibrilla ends with occurrence of homogeneous mass in expanded spaces (Skalinsky et al., 1978). In the course of curing by the conservative method, the microstructural change development is very slow. Application of the pumping method is known to speed up the meat curing process due to more uniform distribution of a brine in the meat mass and more intensive and uniform distribution and action of lactic acid bacteria on it. The histological examinations of muscular tissue (Plotnikov, 1973) showed that the quantity of microorganisms in samples of meat cured without pumping at all terms of curing was dramatically lower as compared with the pumped samples. However, the pumping process at reduced terms of keeping the beef in curing is essentially insufficient for ensuring the uniform distribution of curing ingredients including bacterial cultures. In view of great contribution of lactic acid microflora to the curing, a special emphasis should be put on its distribution within the muscular tissue, which can be achieved by kneading. The liquid being injected at curing is distributed, first of all, through the sections offering a least resistance (Belousov et al., 1975). For introducing the microbic bodies into a complex structure of muscular tissue, an injectable curing ingredient has to overcome the resistance of interfiber connections and connective-tissue interlayers. When the pumping is used with kneading, the tissue is loosened thus enabling better distribution of curing agents in meat. The results of bacteriological analysis have shown that the kneading affects the intensity of microbic nuclei distribution. As the distance from the brine injection point increases, the microbic nuclei content in the kneaded samples is several times as higher as compared with a check sample. The examinations have allowed to set a kneading process duration of 30 to 40 minutes for the raw meat material pumped with a brine containing the lactic acid bacteria. In order to study

the product nutritive value, the biochemical examinations were conducted over five manufactured products with triple recurrence. The check samples were represented by the products whose curing had been carried out without introducing a bacterial concentrate into the brine. The following indices were analyzed: content of protein, moisture, fat, ash, pH value, and water holding capacity (WHC).

The results of the study are presented in Table 1

Table 1

Name of product	Indices (in %)					
	Moisture	Protein	Fat	Ash	WHC	pH
Beefroll "Slavutich"	69.83	20.02	5.05	2.51	32.3	6.29
"Desnyanskaya" neck	71.29	21.00	2.76	2.92	32.8	6.45
Beef ham	69.67	21.15	3.99	4.40	33.0	6.20
Check sample	66.38	19.23	7.76	3.04	25.0	6.65

The data obtained are indicative of positive influence of a multicomponent brine with application of a bacterial concentrate upon the quality of a ready-to-eat product. As compared with the check samples, the assay samples showed the protein content being higher by 0.8 to 1.9 %. The hydrogen ion concentration in the assay samples is lower than that in the check samples, this fact being prominent in formation of a cured product color. The water holding capacity in the assay samples is considerably higher than in the check samples, thus, ensuring the succulent property and tender consistency, and rising the output of the ready-to-eat products. The biological value of the ready--to-eat cured meat products has been studied by determining the amino acid composition and comparable coefficients of protein. The amino acid composition was studied utilising the amino acid analyzer, while the protein efficiency coefficients by the microanalysis method with application of a tetrahymen pyriformis infusorian as a test-object, and by the rat tests. The amino acid composition analysis results presented in Table 2 show that the curing with application of bacterial cultures enhances the increase of amino acids in the product. So, the total quantity of amino acids of assay samples of the product is higher by 700 to 2000 mg as compared with the check samples. Besides, another specifically important feature is that a content of indispensable amino acids is increased from 100 mg to 1100 mg in 100 g of product mass. The high biological value of products under the study is proved by the results of a comparative ana-

lyses of the protein efficiency coefficients determined in the course of rat tests. In the assay samples, they were 14 to 15 % as high as in the check samples cured without application of a bacterial concentrate. The similar data were obtained in tests with a tetrahymen pyriformis used as a test-object, wherein the protein efficiency coefficient of the assay products was 23 to 27 % as high as of the check samples.

Table 2

Amino acids	Check samples	Beefroll "Slavutich"	"Desnyans-kaya" neck	Beef ham
Indispensable amino acids, mg, in 100 g of product, including:	6586	6685	7442	7689
Valine	1010	933	1025	1085
Isoleucine	600	681	794	842
Leucine	1491	1507	1621	1640
Lysin	1362	1396	1614	1682
Methionine	403	412	464	477
Threonine	747	775	844	859
Tryptophan	228	245	275	278
Phenylalanine	745	736	805	826
Nonessential amino acids, including:	12,512	13,137	13,321	13,392
Alanine	1142	1204	1248	1261
Arginine	1041	1234	1338	1349
Aspartic acid	2131	2238	2257	2294
Histidine	659	737	765	774
Glycine	1097	1095	982	891
Glutamic acid	3794	3881	3984	3997
Oxyproline	352	203	160	133
Proline	852	832	771	692
Serine	829	896	965	971
Tyrosine	515	649	681	762
Cystine	100	168	230	294
Total of amino acids	19,098	19,822	20,823	21,101

The bacteriological study data testify to the fact that introduction of the vivified bacterial concentrate "ACIDOBACT" into a brine for meat curing exerts a positive influence upon the storable properties and ensures the manufacture of ready-to-eat products which meet the food sanitation requirements.

CONCLUSIONS: The above-presented results can be summarized as follows:

* Bacterial concentrate "ACIDOBACT" for application in the manufacture of the cured beef products has been developed. The concentrate contains microorganisms which show their antagonistic properties as against sanitary-representative microflora, thereby enhancing the storable properties of the ready-to-eat product. Besides, these microorganisms are famous for their denitrification properties which allow a double decrease of the sodium nitrite quantity in a brine for meat curing. The microorganism vital activity products, i.e. volatile compounds, are aroma carriers of the ready-to-eat product. The lactic acid produced by the microorganisms enhances the effect of tissue proteolytic ferments, thereby facilitating the manufacture of tender products.
* The cured beef product manufacture technology has been developed on the basis of application of bacterial concentrate "ACIDOBACT" in a multicomponent brine.
* The normative-and-technical documentation has been elaborated and certified for new kinds of the cured beef products.
* The products manufactured with application of the bacterial concentrate may be ranked among the high-protein ones. They show delicate flavor, fine aroma and tender consistency. The products display excellent storable properties and conform with the medico-biologic standards of the nutrition science.

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