EFFECTIVENESS OF PHOSPHATES AND PHOSPHATE-CONTAINING ADDITIVES IN PRODUCTION OF SMOKED BEEF PRODUCTS

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Introduction

Meat products quality considerably depends upon the properties of initial raw materials the main of which are moisture-binding and emulsifying capacity of the meat system. Functional-technological properties of the raw materials are mainly determined by the conformation and structure of protein macromolecules, particularly such as actin, myosin and actomyosin. Among all the additives it is phosphates being readily available and the cheapest ones which allow to increase the capacity of proteins to retain moisture. Their effect is based upon the increase in proteins hydration through the removal of calcium from some chains of muscle proteins and the shift of pH of meat medium from the isoelectrical point of proteins. The increasing buffer capacity of the meat system prevents from meat pH change during subsequent thermal treatment, favors increasing of moisture-holding capacity and prevents from the formation of broth-fat pockets in processing of refrigerated and defrosted raw materials, and the meat from exhausted animals.

At the present time in the Russian meat industry the situation is characterized with the deterioration of the quality of supplied raw materials, which decreases the effectiveness of its processing and obtaining meat products of guaranteed high quality. As a result, sensory characteristics of meat products have deteriorated, the cases of rejected products due to broth-fat pockets, considerable losses during thermal treatment became more frequent.

At the present time the market offers a large number of phosphates and various phosphate-containing additives (PCA). However, non-differentiated use of phosphate preparations in the manufacture of meat products from the raw materials of different quality not only is unable to improve functional-technological properties of meat raw materials but in some cases can lead to deterioration of quality of final products.

Purpose

VNIIMP has carried out comparative evaluation of the effectiveness of use of phosphates and phosphates-containing additives (PCA) in order to determine the most promising ones for production of smoked beef products.

Methods

In the experiments were used phosphate-containing additives, as follows : Cooked ham 50, Polyfan A, Polyfan A-extra, Lamefos 940, Carnall 822 . The raw materials - M. Triceps femoris of beef of the first grade of fattening were injected by means of a multi-needle injector at 25-50% of the brine to the weight of the raw materials and massaged in the brine. Massaging was carried out in massagers under the following conditions: rotation - 20 min., rest – 10 min., the cycle is repeated at n = 8 rev./min during 14 hours. After treatment in the massager the raw materials were held in the brine at 2-4° during 12-16 hours, then the product «Govyadina Moskovskaya» (Beef Moskovskaya) was manufactured according to adopted technology. Similar products manufactured according to the same technology, but without PCA served as controls.

Results and discussion

Table presents quality characteristics of beef studied in different treatments. The data suggest that by such values as pH, protein and ash content, the samples of meat were quite similar. Some fluctuations in fat content (1.8-4.3%) and moisture content (71.6-77.9%) were observed.

Histological investigations of the initial raw materials have shown that the microstructure of muscular tissue had characteristics of defrosted meat in the initial stage of aging. Muscle fibers had a straight or coiled shape with well pronounced cross striation. In some areas there were maintained deformed muscle fibers with cavities at the sites of ice crystal localization and widened interfiber and interbundle spaces. Destructive changes of fibers were revealed as separate microcracks or small slot-like spaces, which were the results of development of autolytic processes in the meat.

When the salted raw materials were aged during 12-16 hours complex physico-chemical and biochemical changes developed that were manifested in swelling of muscle fibers and connective tissue, marked weakening or disappearance of cross striation of muscular fibers, going out of salt-soluble proteins from muscle fibers with the formation of fine-grained protein mass between muscle bundles and fibers. It should be mentioned that PCA influenced in different ways on the development and intensity of microstructural changes, which were the basis of formation of quality attributes of final products.

As a result of swelling of muscular tissue the diameter of muscular fibers increased and they became round in form. When Lamefos 940, Polyfan A-extra and Polyfan A were used in the curing brine the increase in the average diameter of muscular fibers of the treated raw materials was 36.9, 34.3 and 34.4, respectively, while in control samples it was only 17.2%. Significant swelling of muscular fibers in the experimental samples was likely associated with high water-binding capacity of muscular proteins. Experiments have shown that in the samples injected with the brine, containing Polyfan A, Polyfan A-extra, Lamefos 940 the degree of destruction of sarcoplasmic matrix and solubility of proteins of actomyiosin complex with the going out of fine-grained protein mass under the sarcolemma and into spaces between fibers were more pronounced as compared to other treatments. The data suggest that these samples and the samples containing Karnall 822 were different in terms of their higher velocity of absorption of salt from the brine, that on one hand, was caused by the increase of permeability of muscular tissue through freezing-thawing and mechanical processing, and on the other hand, due to the influence of sodium chloride and phosphates.

Sodium chloride levels in them were from 1.84 to 2.90%, while in the control one – 1.58%, and in the sample, injected with the brine, containing Cooked ham 50 - as little as 0.89% (Table).

As the experiments have shown keeping of raw materials in the brine led to a decrease of the concentration of ions of hydrogen in the samples containing Lamefos 940 and Carnall 822, and in the rest cases there was an increase in the concentration of hydrogen ions. The moisture content increased in all samples. Concurrently with physico-chemical and histological investigations, analysis of structural-mechanical characteristics of raw materials and final products was carried out. Results showed that after keeping in brine not depending upon the used PCA there was practically a similar decrease in the shear stress in all the samples.

As one can see from the obtained data (Table), after thermal treatment shear stress of all the samples increased because of denaturation-coagulation changes of muscular proteins and increase of their density due to partial loss of moisture. And the experimental samples of "Govyadina Moscovskaya" injected with PCA: Polyfan A, Polyfan A-extra and Cooked ham 50 had their lower values of shear stress by 5.7-8.1% higher than the experimental ones. Analysis of yields of final products shows that the highest yield was obtained for samples manufactured with the use of PCA-Polyfan A (123%), and the lowest – for the control sample (98.6%). Rather high yields are obtained with the use of Polyfan A-extra - 119.5%, Karnall 822 – 119% and Lamefos 940 - 115%.

High efficiency of PCA: Polyfan A-extra., Polyfan A and Karnall 822 , is likely a result of great dispersion effect on the main muscular proteins, that favoured better retaining of water by them. Histological investigations have shown that after thermal treatment muscle fibers in all the experimental samples became denser, lay separately with regards to each other. The diameter of fibers decreased due to moisture loss, the amount of destructive violations of fibers increased as compared to cured samples.

The lowest change in diameter of fibers was found when for curing the following PCA were used: Polyfan A (0.81%), Polyfan-A-extra (6.8%) and Karnall 822 (2.8%) that is likely associated with less moisture losses. In the experimental samples connective tissue interlayers were more swollen, which imparted to the product a monolith view. These data are in good agreement with the higher yield of the product. According to the opinion of a sensory panel, the samples made with PCA, particularly Lamefos 940 and Karnall 822, had the best taste and consistency.

Conclusions

Thus , it is found that pumping the beef with the brine containing PCA and subsequent massaging increases the degree of swelling of muscle fibers and enhances destructive changes as compared to the use of traditional brines, and a greater tenderness and juiciness of experimental samples is noted. Use of PCA and mechanical massaging of the raw materials reduces moisture losses during thermal treatment which leads to increase in the yield of the products. Taking into account the obtained results one can state that the highest yield of the products results from the use of Russian PCAs, such as Polyfan A-extra, Polyfan A and a German preparation Karnall 822 in the brines.

Table

Indices	Indices of unsalted raw materials with different PCA						Indices of salted materials with different PCA						Characteristics of final products with different PCA					
	Control (without phosphates)	Cooked Ham 50	Polyfan A	Polyfan A-extra	Lamefos 940	Karnall 822	Control (without phosphates)	Cooked Ham 50	Polyfan A	Polyfan A-extra	Lamefos 940	Karnall 822	Control (without phosphates)	Cooked Ham 50	Polyfan A	Polyfan A-extra	Lamefos 940	Karnall 822
pH	5.9	5.8	5.75	5.65	5.85	5.93	5.3	5.5	5.4	5.45	6.03	6.22	6.12	6.46	6.56	6.32	6.67	6.63
Moisture, %	77..9	76.9	71.6	71.6	75.68	74.6	79.7	79.32	75.0	76.4	78.67	76.52	75.5	76.5	74.6	74.2	73.2	73.5
Fat, %	2.1	1.8	4.3	4.3	2.0	3.8	1.69	1.44	3.25	2.87	1.33	2.66	1.5	1.2	3.1	3.0	1.6	3.1
Protein, %	18.4	19.4	21.9	21.9	21.3	20.5	14.7	15.52	16.6	14.57	14.22	15.37	18.2	17.5	17.6	18.0	18.4	17.5
Ash,%	1.1	1.05	1.40	1.45	1.0	1.08	1.81	1.88	2.42	2.82.	3.44	2.53	2.35	2.3	2.4	2.4	4.4	3.45
Salt,%	0.5	0.95	0.8	0.8	0.02	0.02	2.08	1.84	2.64	3.33	2.34	2.92	2.45	2.5	2.3	2.4	2.4	2.45
Shear stress, kPa	57.2	54.2	55.52	53.52	55.7	56.1	52.06	44.72	46.21	44.17	47.14	45.95	53.42	49.40	48.75	47.67	51.02	48.88
Yield	--	--	--	--	--	--	--	--	--	--	--	--	98.6	110.5	123.0	119.5	115.0	119.0