PE4.22 Evaluation of influence of edible cryoprotectors on functional-technological properties of meat raw materials 69.00

Andrey Lisitsyn (1) vniimp@inbox.ru, A Semenova(2), L Veretov 2, F Holodov 2
(1)The V.M. Gorbatov VNIIMP, director, Moscow, Russian Federation
(2)The V.M. Gorbatov VNIIMP, laboratory of sausages and half-prepared products technology, Moscow, Russian Federation

Abstract VNIIMP investigated cryoprotecting influence of food additives on quality traits of chilled pork during its freezing, 60 days' storage at-18^{0}C and subsequent defrosting.

Lisitsyn Andrey Borisovitch Arturovna is with the V.M.Gorbatov All-Russian Meat Research Institute of Rosselkhozacademia, director, vniimp@inbox.ru
Semenova Anastasiya Arturovna is with the V.M.Gorbatov All-Russian Meat Research Institute of Rosselkhozacademia, chief of laboratory of sausages and half-prepared products technology, semmm@mail.ru
Veretov Leonid Aleksandrovich, is with the V.M.Gorbatov All-Russian Meat Research Institute, lveretov@mail.ru;
Holodov Fedor Vasilyevich is with the V.M.Gorbatov All-Russian Meat Research Institute, frost3k@mail.ru;

Key words: meat raw materials, freezing, storage, cryoprotectors, functional-technological properties

I. INTRODUCTION

The condition of cellular structure of meat raw materials before refrigeration has large influence on sensory and consumer characteristics of half-prepared and final products. Their high values will have positive effect on growth of economic figures of meat plants. One way to solve this problem is the use of food additives, the cryoprotecting mechanism of which is connected with decrease of water activity, formation of amorphous structure in the product and reduction of a number of crystallization centers which is especially important for deep freezing of meat products and prolonged cold storage at temperatures, lower than -18^{0}C [1].

Though creation and use of cryoprotectors in food industry is only in the beginning, importance and good prospects for this trend are without doubt.

Therefore, at VNIIMP, studies of cryoprotecting effect of food additives on functional-technological properties of chilled pork during its freezing, 60 days' storage at -18^{0}C and defrosting have been conducted.

II. MATERIALS AND METHODS

Materials: chilled pork, brines, edible cryoprotectors. Prior to freezing the meat raw materials were injected with brines, containing cryoprotectors as follows: sodium tripolyphosphates- and diphosphates (E451, E450), sorbitol (E420) and sucrose.

The samples of meat raw materials were prepared as follows: ***Longissimus dorsi*** of pig side was cut into 4-5 parts with the weight not less than 300 g. One part served as a sample, others were injected with brines of two different formulations, containing cryoprotectors. The first one (Brine №1) contained a combination of sodium phosphates E450 and E451, the second (brine №2) sodium phosphate E-451, sorbitol E-420 and sucrose. The content of salt in two formulations was the same.

The samples were injected with brines at 10% to the mass of raw materials. The level of injection of each sample was determined by control weighing. Then the samples were massaged on vibration massager during 90 minutes. Starting values of all samples were determined, then samples 1 and 2 were kept in brine during 12 hours at 2^{0}C- 4^{0}C, then frozen at -18^{0}C, and the control was subjected to freezing just after taking starting values. All samples were stored at -18^{0}C during 60 days.

Methods: prior to freezing and after defrosting of samples, sensory characteristics, water activity criterion and pH change, and also moisture-holding capacity prior to freezing and microstructure characteristics – after freezing, were determined.

III. RESULTS AND DISCUSSION

Table 1 compares sensory characteristics of the samples injected with brines containing cryoprotectors and controls prior to freezing.

Table 1. Sensory characteristics of meat materials samples prior to freezing

Samples prior to freezing	Sensory characteristics		
	Color	Aroma	Consistency
Sample 1 (with brine №1)	Slightly pink	Typical of fresh meat	The cut surface is dense, springy, slightly sticky; the pit, appearing after pressing with finger, is quickly recovered.
Sample 2 (with brine №2)	The same	The same	The same
Control	The same	The same	The same, less sticky

As can be seen from Table 1, adding cryoprotectors to the brines did not lead to changes in sensory characteristics of meat raw materials. All pork samples prior to freezing were slightly pink, had aroma, characteristic of fresh meat, dense and springy consistency. Experimental samples 1 and 2 were slightly sticker compared to the control.

After injecting the experimental samples with brines containing cryoprotectors, a reduction in a_w was observed: in sample 1, a_w was reduced by 0.002-0.014, in sample 2 – by 0.002-0.010 (Fig.1).

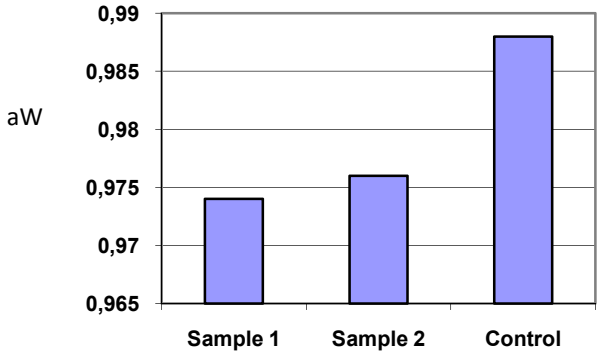


Fig.1. Water activity of meat samples prior to freezing

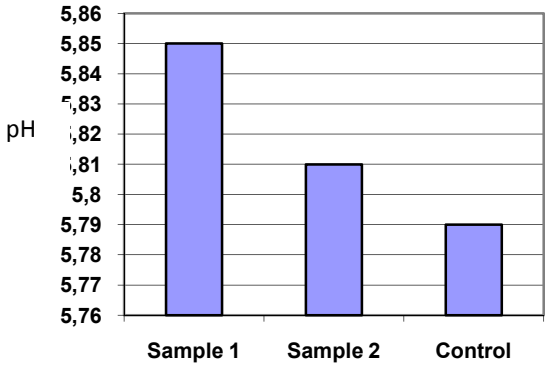


Fig.2. pH value of meat samples prior to freezing

Reduction of a_w in these samples was due to the increase in concentration of solutes in meat juice, which suggested reduction of the temperature moisture crystallization beginning in meat, and chan in the pattern of ice crystals growth in cellular structure of muscle tissue, respectively.

The incorporation of cryoprotecing agents in the raw materials increased pH value insignificantly (0.02-0.6) (Fig.2), and had a slight influence on the increase of moisture-holding capacity up to 7-18% [Fig.3].

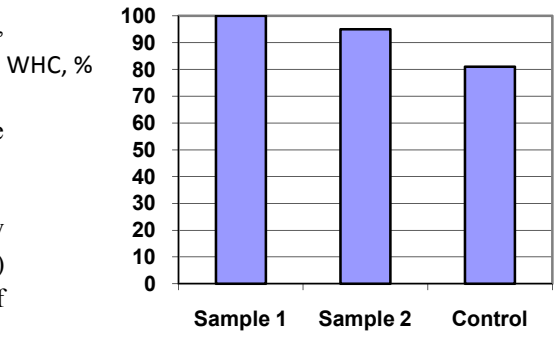


Fig. 3. Water-holding capacity of meat samples prior to freezing

Adding cryoprotectors led to insignificant reduction of meat toughness, increase of pH value, reduction of a_w value, which had a hurdle effect on microorganisms

development. Increase in the values of WHC of the samples first of all was connected with edible phosphates in the brines.

Table 2 shows the results of sensory evaluation of defrosted samples of meat raw materials after storage during 60 days.

Table 2. Sensory characteristics of samples after defrosting on the 60th day of storage

Samples of meat raw materials after defrosting on the 60th day of storage	Sensory indices		
	Color	Aroma	Consistency
Sample 1 (with brine №1)	Red, darker than prior to storage	Specific, intrinsic to meat	The cut surface is dense, springy, sticky; the pit, appearing after pressing with finger, is slowly recovered
Sample 2 (with brine №2)	Pink, slightly darker, than prior to storage	The same	The same
Control	Grayish-pink (discolored)	The same, Slightly sour	The cut surface is loose, the pit, which is formed during pressing with finger did not recover

As can be seen from Table 2, the experimental samples of meat were darker after defrosting compared to the initial sample. The darkest was sample 1, containing diphosphate composition. The control sample, on the contrary, became lighter and was somewhat grayish. Samples 1 and 2 on the 60th day of storage had specific aroma, intrinsic to raw meat. The control had undesirable, slightly sour aroma.

The largest changes in sensory characteristics after freezing, storage during 60 days and defrosting were observed in the controls, which were characterized with discoloration, appearance of grayish hue, slightly "sour" aroma, loosening of muscle structure tissue.

Fig.4 shows results of study of the influence of food additives with cryoprotecting effect on changes in a_w of meat raw materials after storage during 60 days and defrosting.

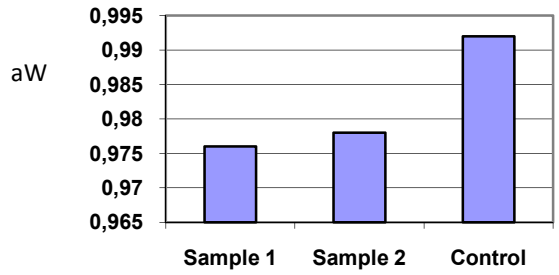


Fig.4. Water activity of meat samples after defrosting on the 60th day of storage

After freezing, storage and defrosting of meat, an increase in a_w was observed: in experimental samples – by 0,002, and the control – by 0.005 compared to the values before freezing. This could be explained by partial destruction of cell walls and meat juice drip, more evident in the control, not treated with brine with cryoprotecting agent.

The influence of cryoprotectors on pH value of meat samples after storage and defrosting is shown in Fig.5.

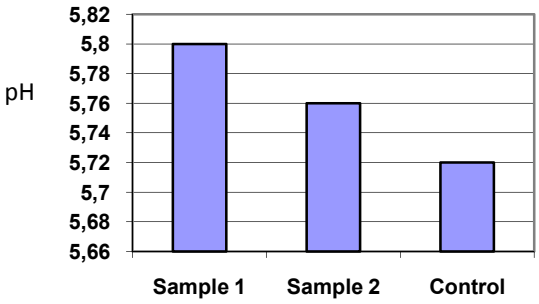
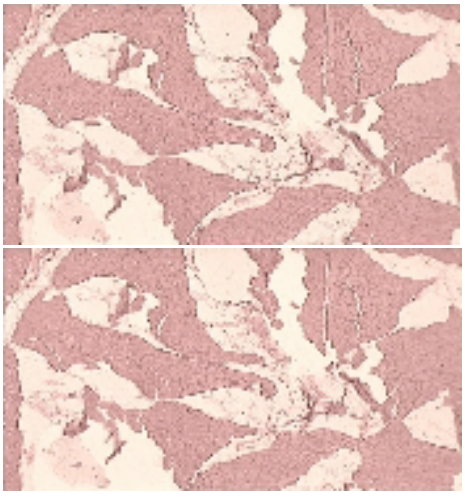


Fig. 5. pH value of meat samples after defrosting on the 60th day of storage

After freezing, storage and defrosting there was an insignificant decline of pH value by 0.05-0.07in the samples, compared to initial level, due to decomposition of glycogen in meat prior to freezing, and formation of lactic acid [2].

Results of microstructure study of control samples after frozen storage during 60 days (Fig.6) suggested a deformation and thinning of muscle fibers, small and weakened cross striation, homogeneity of fibers nuclei.

Multiple micro-cavities of different form and size - sites of ice crystal localization - could be found between bundles of fibers.



a) b)

Fig.6. Longitudinal, (a) and cross (b), section of frozen muscle tissue of control sample

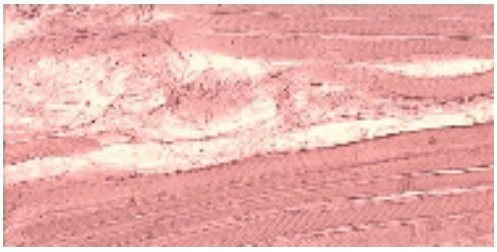
of meat raw materials

As is seen in microstructure photos of muscle tissue of the control, the connective tissue interlayers were loose, there were small numbers of fine-grain protein mass in microcavities.

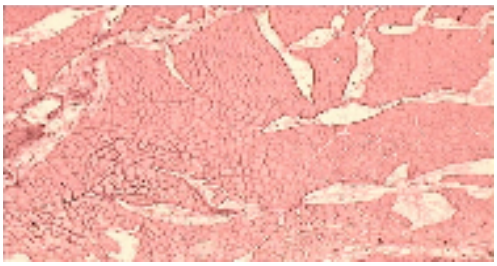
On cross sections, muscular fibers have polygonal form and were positioned freely in relation to each other. The bundles of fibers were sharply deformed, their integrity was broken by multiple microcavities with the size 350-450 μm. During subsequent storage changes in the structure of samples were characterized with the increase of the size of microcavities up to 450-500 μm. Figs 7 and 8 show the results of microstructure investigation of muscle tissue of experimental samples with cryoprotectors.

The investigation of microstructure of sample 1, (Fig.7) shows that muscle fibers are deformed to less extent, as compared to the control, cross striation of fibers is wide, the nuclei are homogenous. Destructive changes were revealed as single cross cracks. On the cross section, the muscle fibers are slightly swollen, with rounded angles. The bundles of fibers are less deformed as compared to the control, however, between bundles there were the sites of localization of ice crystals with the size 250-350 μm. During subsequent storage the increase in the size of microcavities was insignificant, constituting 30-50 μm.

Study of microstructure of sample 2 (Fig.8) has shown that muscle fibers were swollen, closely adhered to each other, cross striation was wide, nuclei of fibers – homogenous, connective tissue interlayers – dense. On the cross section muscle fibers have rounded form, closely adhered to each other, a significant amount of small-grain protein mass was found between them. The bundles of fibers were deformed insignificantly. The size of microcavities was 50-70 μm.

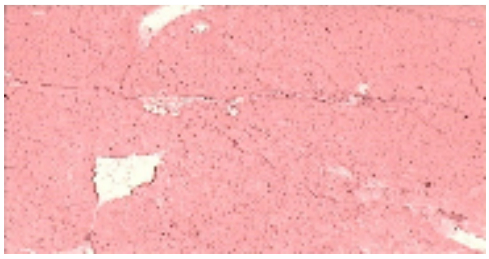


a)

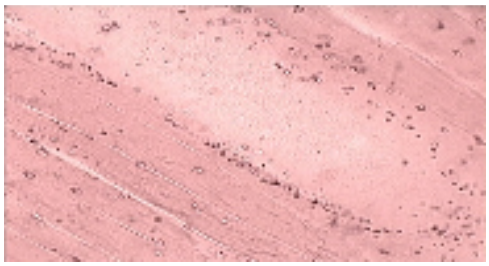


b)

Fig.7. Longitudinal (a) and cross (b) section of frozen muscle tissue of meat sample 1



a)



b)

Fig.8. Longitudinal (a) and cross (b) section of frozen muscle tissue of meat sample 2

These results suggested a positive influence of cryoprotectors on preservation of cellular structure preservation of muscle tissue of the samples. Also it was found that the period between injection and freezing of the raw materials had the influence on the quality of defrosted meat.

IV. CONCLUSIONS

The obtained results led to the conclusion that new compositions of food additives possessed high cryoprotecting effect. However, to increase their efficiency, the technology of their addition and meat treatment prior to freezing should be improved.

Thus, the investigations of the influence of cryoprotecting additives on sensory, physico-chemical indicators and microstructure of meat samples have shown, that:

- addition of cryoprotecting components to chilled meat actually did not change its quality traits prior to freezing;
- introduction of cryoprotectors as a part of brines allowed preservation of dense structure of meat after its long frozen storage, characteristic of chilled raw materials and prevented from appearance of undesired sour flavor
- injecting of meat raw materials with brines, containing cryoprotecting complexes, decreased a_W, which during freezing and 60-days storage of meat increased insignificantly.
- Use of cryoprotectors allowed preservation of integrity of muscle fibers of meat due to reduction of ice crystal size during freezing;
-

In future we plan to continue the search and study of food additives and ingredients,and their effective compositions, possessing cryoprotecting effect including protein components and polysaccharides.

REFERENCES

[1] A.A Semenova. M.V.,Trifonov , F.V Kholodov, “New look at the production of frozen half-prepared products”, All about meat, №1, 2008

[2] P.E.Pavlovsky, Palmin V.V, “Biochemistry of meat”, Book style, M. “Pischevaya promyshlennost”, - 1975.