The Influence of Polyphosphates Having Different Chemical Nature on the State of Structure of Myofibrillar Proteins and Collagen of Intramuscular Connective Tissue of PSE Pork

Part 2. The Influence of Different Polyphosphates on Collagen on Intramuscular Connective Tissue of PSE Pork

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SUMMARY: This work was aimed at the study of influence of three chemically different polyphosphates (Curafos 700, Curafos II-2, $Na_3HP_2O_7$) on the process of heat-induced denaturation of intramuscular connective tissue collagen of PSE pork. It was shown, that polyphosphates deeply influence temperature and enthalpy of collagen denaturation. In this process chemical nature of phosphate plays an important role.

INTRODUCTION: It is already known, that intramuscular connective tissue plays a very important role in meat and meat products quality. Being very closely studied, this tissue still causes a lot of unsolved problems, namely: changes in the process of meat ageing, influence on water-binding ability of meat, changes under influence of brine ingredients, peculiarities of connective tissue state in meat of low technological quality (PSE and DFD). Scientific data, dealing with these problems, are scarce and bear contradictory character "Mills E.W. et al. (1989)"; Mills E.W., Smith S.H. et al. (1989); Stanton C. et al. (1990); Stanton C. et al. (1988)". Thus, the problem of collagenic change still rests without solution, though majority of authors express common opinion that all possible changes take place during the first 10-12 hours post mortem, and that during further ageing collagen doesn't change any more. In the aspect of connective tissue influence on water-binding ability of meat, a very modest role is attributed to this tissue, that is decreasing of muscle protein share in total meat volume or mechanic action through compression under heat denaturation. In both cases connective tissue negatively influences water-binding ability of meat. We consider the problem of connective tissue state in PSE meat a very interesting and important one. It is most probable that intensive formation of lactic acid already in the first hours post mortem is sure to influence destructively collagen of PSE meat connective tissue "Stanton C. et al. (1990)".

For those reasons we investigated the process of heat denaturation of intramuscular collagen of connective tissue during ageing of PSE meat and we also conducted research devoted to influence of polyphosphates as brine ingredients, on two most important components of meat: myofibrillar proteins (Part 1) and connective tissue collagen (Part 2).

MATERIAL AND METHODS: Object and experimental conditions of research were similar to those depicted in Part 1. Samples of intramuscular connective tissue were taken from PSE pork, representing each time of ageing. The process of heat denaturation in temperature range of 20-90°C was studied by method of differential scanning calorimetry using calorimeter DSM 2M

SSR/. "Koteljnikov G.V. (1983)".

RESULTS AND DISCUSSION: The main parameters of heat-induced denaturation of intramuscular connective tissue collagen on different stages of PSE pork ageing are given in Table 1.

Table 1. Thermodynamic parameters of denaturation of intramuscular connective tissue collagen of PSE pork under influence of polyphosphates with different chemical composition

Heat Ageing Time hours	T_d° C	Δ H arbitrary units	Δ G arbitrary units	Type of Polyphosphate Manufacturing Country
3	67,0	1100	160	
24	62,5	2100	210	$Na_3HP_2O_7$ /USSR/
48	64,0	2600	340	
3	66,0	1750	270	Curafos 700 /Germany/
24	68,5	3400	450	(Sodium diphosphate + sodium
48	64,0	3200	380	tripolyphosphate + sodium hexametaphosphate)
3	64,0	2400	230	Curafos II-2 /USA/
24	66,0	3300	340	(Sodium tripolyphosphate +
48	55,0	5560	490	sodium polyphosphate "glassy")

Data of Table 1 may be interpreted as follows:

1) During first hours post mortem the use of $Na_3HP_2O_7$ (Sample 1) and Curafos 700 (Sample 2) gives practically equal temperatures of maximum of collagen denaturation (66-67°C).

In the process of ageing till 24 hours temperature of denaturation maximum lowered to 62,5°C, however, Δ H rose nearly 2 times as compared to 3 hrs post mortem. Temperatures of collagen denaturation maximum of samples 2 and 3 rose to 68,5°C and 66,0°C, accordingly. Enthalpy in case of Curafos 700 increased by 2 times and Curafos II-2 by 1,3 times compared with first hours post mortem.

3) After 48 hours of ageing, temperature of collagen denaturation maximum and denaturation enthalpy of sample 1 rose, t_g being 64°C, and Δ H - 2,5 times higher than value, corresponding to 3 hrs post mortem. Temperature of denaturation maximum of sample 2 lowered to 64°C, Δ H slightly decreased, resting 1,8 times bigger than during first hours post mortem. Denaturation maximum temperature of sample 3 lowered to 55°C, Δ H grew, 2,5 times exceeding its value in meat during first three hours post mortem.

Comparing influence of Curafos 700 and Curafos II-2 on state of collagen structure at heating, we saw that Δ H values of connective tissue denaturation in PSE pork in both cases after 3 and 24 hours of ageing differed quite insignificantly. This could also be related to temperature. However, after 48 hours of ageing significant difference in action of those phosphates was observed.

In both cases temperature of denaturation maximum lowered, but if for sample 2 this value made only 2°C, for sample 3 - already 11°C, however Δ H of sample 2 was 2 times smaller than that of sample 3. Thus, a higher temperature of denaturation maximum of PSE pork collagen under action of Curafos 700 seemed to evidence about better stability of this

protein compared to action of Curafos II-2. However, fall of denaturation enthalpy evidence about the opposite.

First experience failed to discover some regularity in action of chemically different phosphates towards thermostability of intramuscular connective tissue collagen of PSE pork in process of its ageing.

Nevertheless, we should bear in mind, that in the present study we tried to evaluate state of connective tissue collagen by mere analysis of thermodynamic characteristics. Besides, it is known, that a true measure of structural stability of system is difference between functions of free Gibbs energy (Δ G) in denaturated and native states. Analysis of ΔG change in our research showed that when PSE pork was cured with $Na_3HP_2O_7$ (USSR) and Curafos II-2 (USA), monotonous increase of this value took place during meat ageing from 3 to 48 hours ($\sim$ by 2 times). This allowed to suppose that collagen of connective tissue under influence of these phosphates becomes more rigid (structured) in process of ageing. In case of Curafos 700 the picture was different. At absolute Δ G values which were smaller than in Curafos II-2 case and bigger than under $Na_3HP_2O_7$ influence, Δ G, passing through maximum after 24 hours of ageing, fell towards 48 hours.

In other words, Curafos 700 acted as stabilizer of collagen structure during first hours and after 24 hours post mortem; however, by 48 hours its action became opposite.

It is worth noting that degree of collagen structure stabilization was practically equal to that when $Na_3HP_2O_7$ had been added, but significantly lower, than in case of Curafos II-2.

CONCLUSION: Upon evaluation of data on polyphosphatic influence on the process of heat denaturation of intramuscular connective tissue collagen, first of all we must note that this influence does exist and is different for different polyphosphates. To solve this problem completely still seems impossible for us. However, even now we can state that chemical composition of the used polyphosphate plays important role in the influence on collagen structure of PSE pork and its change in process of heating. In doing so, Curafos II-2 and $Na_3HP_2O_7$ monotonously increase structural stability of collagen in process of PSE meat ageing till 48 hours; however, Curafos 700 under similar conditions acts quite differently. Till 24 hours of ageing it functions in a way, similar to the other two phosphates, but after 48 hours it causes significant structural destabilization of intramuscular connective tissue collagen of PSE pork.

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