The degradation of polyphosphate in meat matrix

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SUMMARY

Research has been conducted simulting conditions present in the meat transformation industry to affirm the degradation of tripolyphosphate in the meat matrix. An investigation was also carried out under conditions similar to those found in the industry using a mixture of mortadella and wurstel as a substratum.

For the analysis it was adopted the ion exchange chromatography and the results demonstrated the following:

1 - The cause of the degradation is clearly enzymatic.

2 - All of the tripolyphosphate is degraded to orthophosphate within a shorter period of time than that wich is required for the product to reach the temperature that inactives the tripolyphosphatase.

3 - Pyrophosphate is the intermediate product of degradation.

4 - Any nutritional doubts about the presence of tripolyphosphates or pyrophosphates in cooked meat products are unfounded since only orthophosphates can be found.

INTRODUCTION

Polyphosphates are additives widely used in several food industries and particularly in the meat industry in all countries.

Italy authorized the use of these additives in meat products with the D.M. of March 31, 1965 and it's successive modifications in the following doses:

1) canned meat pies 0,25%

2) cooked shoulders and hams 0,25%

3) cooked salami (mortadella, wurstel, ect.) 0,40%

The chatacteristics of polyphosphates are, by this time, fully known (GHINELLI, 1976; ALLAVENA, et al. 1976; CANTONI, et al. 1976). However, there are differing opinions about how their mechanism restores the "power of water retention" of the muscle.

At first, the "hydration effect" of the polyphosphate was correlated with the increase of the pH-values, (WIEKER, 1956), and then it was attributed to the complexing capabilities of certain cations. Presently, the propensity is to think that the true cause is the introduction into the meat matrix of the phosphoric ions contained in these additives which perform the same function as ATP in the living cell (RUF, 1956).

In addition, it is known that polyphosphates, those with a high condensation degree (i.e. hexapolyphosphates) or those with a low condensation degree (i.e. pyrophosphates), are subject to hydrolysis eitherchemically, with the help of acids, or enzymatically though specific enzymes naturally present in various food matrixes (polyphosphatases) or even characteristic of some bacteria (HAMM et al., 1977).

For this reason, a series of studies were conducted to verify the type of hydrolysis and it's velocity utilizing the most widely used polyphospate (sodium tripolyphosphate) in various meat matrixes and specifically in beef and pork meat, as well as in a pork mixture like that of mortadella and wurstel.

MARERIALS AND METHODS

The following meats were used in the experiments;

1) lean pork shoulder

2) lean beef shoulder

3) choice mortadella mixture (classic italian)

4) choice wurstel mixture (classic italian)

10 ml of tripolyphosphate acqueous solution (3.637%), corresponding the 2,50% of tripolyphosphate ions,

was added to 50 g of finally gound meat matrix. Distilled water was then added until the total weight achieved was 100 g. In this way, the final concentration of product was equal to 0,50%.

At pre-arranged intervals, a 1 g sample was drawn, briefly homogenized with 100 ml of distilled water, and filtered through a 0,45 micron membrane to obtain a 1-2 ml fluid portion.

The filtered sample was then analyzed with HPLC on an ionic exchange column equipped with conductometric revelation.

The experiments were divided into two series: the first was conducted by maintaining the samples at room temperature (22-23°C) and the second by immersing the samples in a water-thermostat (75°C). The temperature at the core of the samples was recorded at the varieus drawing times with thermoeletric sensors.

APPARATUS

Chromatograph	Dionex mod 2.00 I
Suppressor	Dionex mod AMMS I. P:N 038019
Detector	Dionex Conductivity
Column	Ionpac AS5
Pre-column	Ionpac AG5
Mixer	Osterizer
Thermostat and glass	Normal for laboratory

REAGENTS

Mobile phase	Water solution	NaOH	0.07 n
	" "	NaHCO3	6.62 mN
Regenerating phase	" "	H2SO4	70.0 mN

OPERATING CONDITIONS

Mobile phase efflent velocity	1.2 ml per min.
Regenerating phase effluent velocity	5-6 ml per min.

RESULTS AND DISCUSSION

The results are reported in the graphics from 1 to 4.

The experiments conducted on the beef and pork revealed a rapid disappearance of tripolyphosphates from the time they were added to the meat: 100 minutes for the beef and 120 minutes for the pork. Simultaneously, pyrophosphates appear and reach their maximum value in 90 minutes from the time they were added to both meats. At this point the pyrophosphates begin a gradual disappearance that is completed in approximately 6 hours.

In the thermostatically conducted experiments it is evidenced that when the temperature of the meat samples reachs 50°C the hydrolysis of the tripolyphosphate is arrested. The residual values compared to the initial values are 28% for the beef meat and 36% for the pork.

The results of the experiments performed on the mortadella and wurstel proved to be quite similar, with the only difference being the length of time required to complete the same developments. For example the disappearance of tripolyphosphates required 7 hours in the mortadella and 10 hours in the wurstel. The behavior of the pyrophosphates was comparable, achieving maximum content in approximately 6 hours in the mortadella and 10 hours in the wurstel. The disappearance of the pyrophosphates required 26 hours and 28 hours respectively.

The behavior of the same thermostatically samples confirmes what was pointed out in the previous experiments on the meats. Namely that the hydrolysis of the two examined polyphosphates stopped when the temperature of the matrixes reached approximately 55 °C.

CONCLUSIONS

The results of the research show that:

- the tripolyphosphates begin their enzymatic hydrolysis immediately after the addition to the meat matrix and stop when the temperature reachs approximately 60°C in the meat samples and 55°C in the meat mixtures;
- the hydrolysis velocity is the same for the two meats examined;
- simultaneous with the disappearance of the polyphosphate there occurs the appearance of the pyrophosphate which reachs it's maximum content value at the time of the complete disappearance of the tripolyphosphate. Successively, also the pyrophosphate hydrolyzes until it's complete disappearance requiring the same time for the two species examined;
- the relatively short times necessary for the hydrolysis of the tripolyphosphates warrant the hypothesis that the effects presently attributed to the polyphosphoric ion should be accredited merely to the phosphoric ions originated from the hydrolysis of the tripolyphosphate and pyrophosphate used;
- the required times of hydrolysis, both in simple and complex meat matrixes, are fully within the technological times necessary for meat products (mortadella and wurtsel) before the temperature reachs the inactivation value of the enzyme. Consequently, the final product will not contain any significant quantity of the polyphosphate and in any case, only 10-15% of the employed quantity;
- any doubt about the danger of ingetion of the polyphosphate is eliminated because the hydrolysis of the polyphopshate transforms it into orthophosphate, currently present in many foods and beverages and generally in higher quantities.

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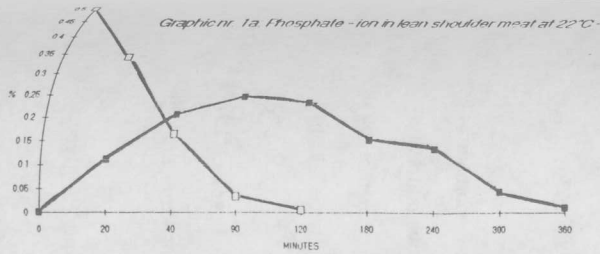
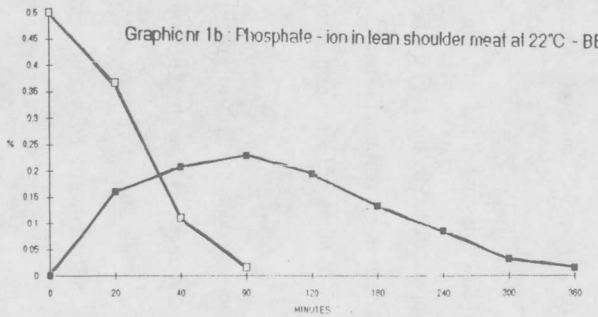
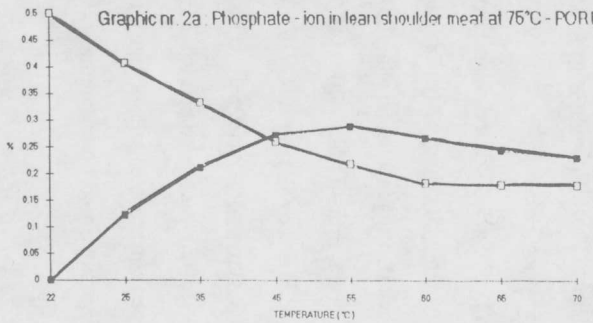
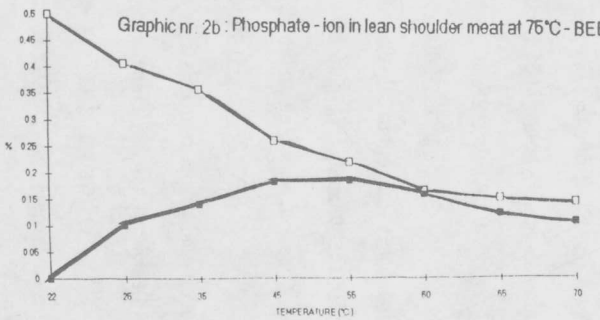
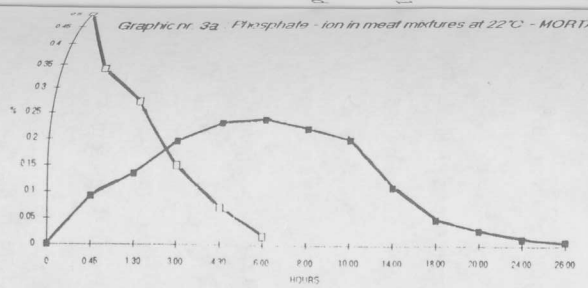

Graphic nr. 1a: Phosphate - ion in lean shoulder meat at 22°C - PORK
%
MINUTES

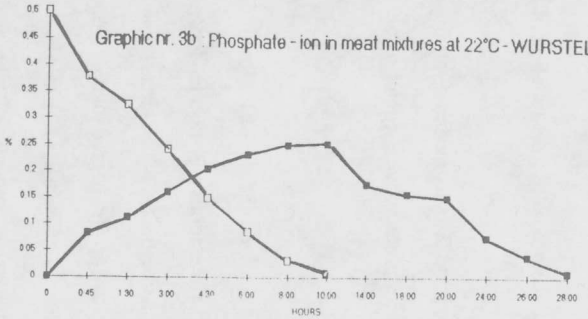

Graphic nr 1b : Phosphate - ion in lean shoulder meat at 22°C - BEEF
%
MINUTES

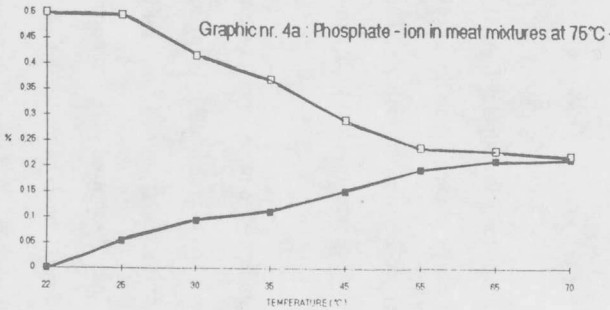

Graphic nr. 2a : Phosphate - ion in lean shoulder meat at 75°C - PORK
%
TEMPERATURE (°C)

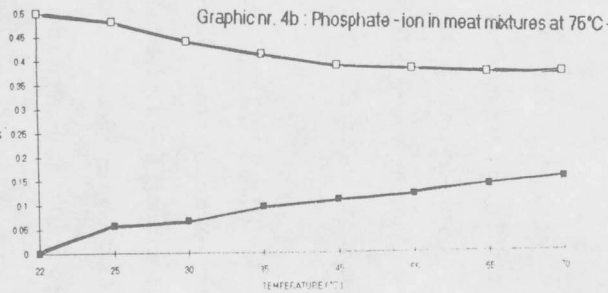

Graphic nr. 2b : Phosphate - ion in lean shoulder meat at 75°C - BEEF
%
TEMPERATURE (°C)

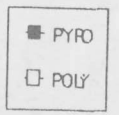

PYRO
POLY


Graphic nr. 3a : Phosphate - ion in meat mixtures at 22°C - MORTADELLA
%
HOURS


Graphic nr. 3b : Phosphate - ion in meat mixtures at 22°C - WURSTEL
%
HOURS


Graphic nr. 4a : Phosphate - ion in meat mixtures at 75°C - MORTADELLA
%
TEMPERATURE (°C)


Graphic nr. 4b : Phosphate - ion in meat mixtures at 75°C - WURSTEL
%
TEMPERATURE (°C)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