BEHAVIOUR OF POLYPHOSPHATES DURING THE STORAGE OF MEAT PRODUCTS

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Polyphosphates are widely used in the meat industry of several countries. As generally known, they improve the water binding capacity of meat products. According to Fukazawa /1/ diphosphate /pyrophosphate/ causes the dissociation of actomyosin to actin and myosin. Yasui et al. /2/ established that only diphosphate molecules were effective on actomyosin. Triphosphate (tripolyphosphate/ had an effect only after its hydrolysis to diphosphate. There are very few data on the behaviour of polyphosphates during the ripening of meat emulsions and cured meat. Recently Nakamura et al. /3/ found two pyrophosphatases in rabbit skeletal muscle . Acid pyrophosphatase was found to be associated with muscle particulate components, a neutral one was present in the soluble fraction.

Materials and Methods.

Semimembtanosus muscle was obtained from post rigor pork carcasses. The separable fat and connective tissue were removed and the muscle was ground in a meat grinder. 2,0% /^{W}/w/ NaCl, and 0.5% ^{W}/w/ polyphosphate /$Na_4P_2O_7$ or. $Na_5P_3O_{10}$/ were added to the ground tissue and thoroughly mixed. The samples were kept in refrigerator at 4 C°.

To investigate the behaviour of polyphosphates in cured meat, the semimembranosus muscles were pumped to 110% weight with curing brine containing 20% /^{W}/w/NaCl, 0.1% ^{W}/w/ $NaNO_2$ and 5% /^{W}/w/polyphosphate /$Na_4P_2O_7$ or. $Na_5P_3O_{10}$/ and stared in refrigerator at 4 C°. Extraction of samples was carried out with cold trichloracetic acid at 4 C° according to the method of Pohja et al. (4).

Separation of phosphates was made by thin-layer chromatography on carboxymethyl cellulose MN 300 with the solvent isopropanol: 20%/^{W}/w/ trichloracetic acid: water: concentrated ammonia /70:20:10:0.3/ at 10°C. The phosphate content of the eluted spots was measured according to the method of Editha Karl-Kroupa (5).

To avoid bacterial growth generally toluene was added to the meat samples.

Results and Discussion.

Table 1. Shows the break-down of diphosphate and triphosphate in function of the storage time at 4 C°. As shown total hydrolysis of diphosphate occured in 3 days. The hydrolysis of triphosphate is a consecutive reaction. It is interesting to note, that a considerable amount of triphosphate /40-50%/ hydrolyses immediately after addition to the minced meat. It was established that this phenomenon is not due to the hydrolysing effect of trichloroacetic acid during extraction of the sample. Trichloroacetic acid hydrolysis only about 10% of the total amount which was added to the meat. The rapid hydrolysis of TP is in some special cases somewhat similar to the ATP breakdown in muscular tissue. It is also interesting to note that toluene, which reduced total bacterial count with about two logaritmic units, seems to have a significant accelerating effect on the hydrolysis of diphosphate. The reason may be explained by plasmolysis i.e. by releasing pyrophosphatase isosyme which was associated

with particulate components of the tissue.

Table 2. shows the effect of NaCl /2% /^{w}/w/ on the rate of hydrolysis of the two polyphosphates. As shown NaCl had a considerable inhibiting effect on the rate of hydrolysis of diphosphate. On the contrary, NaCl seemed to have an activating effect on tripolyphosphatase.

Table 3. shows the results obtained with cured semimembranosus muscle. It is obvious that the rate of hydrolysis of polyphosphates is lower in non communited meat.

Experiments on the subcellular distribution of di- and triphosphatase are not yet finished. It has been proved that sarcoplasmic tri- and diphosphatase isosymes do exist in pork meat. Yasui et al /2/ found only myosin B tripolyphosphatase in muscular tissue. It should be noted that the breakdown of pyrophosphate apart from hydrolysis could follow other reaction schemes too:

$$PP_i + ADP \qquad P_i + ATP \text{ or}$$

$$ROH + PP_i \qquad ROP + P_i$$

(Where ROH = hydroxy group of a monosaccharide). This makes experimentations on reaction kinetics more difficult.

Summary.

Hydrolysis of dephosphate (pyrophosphate) and triphosphate (tripolyphosphate) was followed during the storage of comminuted or cured, non comminuted post rigor semimembranosus pork muscle at 4 C°. A considerable hydrolysis of both polyphosphates took place under these conditions. Toluene, which was added to avoid bacterial growth, had an accelerating effect on hydrolysis of polyphosphates due persumably to plasmolysis. NaCl seemed to activate pyrophosphatase and inhibit trypolyphosphatase. The rate of hydrolysis of both polyphosphates was lowe in cured, non comminuted meat.

Literature.

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TABLE 1. Break-down of diphosphate and triphosphate in minced post rigo r semimembranosus of pork muscle at 4Co. /pH=5.8 - 6.2/ Mean of 4 determinations.

Storage time /days/	2% NaCl and 0.5% $Na_4P_2O_7$ added		2% NaCl and O.5% $Na_4P_20_7$ added			
	without toluene	with toluene	without toluene		with toluene	
	PP	PP	TP	PP	TP	PP
O	100%	100%	40.6%	39.6%	31%	46%
1	70%	50.5%	12.7%	28-7%	5.8%	42.2%
2	3%	6%	4.9%	23.3%	4.2%	31%
3	0	0	4.2%	12.4%	3%	15.7%
4			0	0	0	0

TP - triphosphate, PP - diphosphate

TABLE 2. Effect of 2% /w/w/ NaCl on the rate of hydrolysis of polyphosphates in minced post rigor semimembranosus po rk muscle at 4C° /pH= 5.9/

Storage time /days/	0.5% $Na_4P_2O_7$ added		0.5% $Na_5P_3O_{10}$ added			
	without NaCl	with NaCl	without NaCl		with NaCl	
	PP	PP	TP	PP	TP	PP
O	100%	100%	56,2%	29,2%	39%	40.3%
1	0	44%	4,7%	11,8%	9,2%	9.6%
2		0	0	0	0	0

TP= triphosphate, PP= diphosphate

TABLE 3. Rate of hydrolysis of $Na_4P_2O_7$ and $Na_5P_3O_{10}$ in cured, non comminuted post rigor semimembranosus muscle /pH= 6.1/ stored at 4C°.

Storage time /days/	Meat pumped with NaCl, $NaNO_2$ and $Na_4P_2O_7$	Meat pumped with NaCl $NaNO_2$ and $Na_5P_3O_{10}$	
	PP	TP	PP
0	100%	21,2%	52,5%
1	69,6%	9,4%	41,0%
2	50,4%	8,0%	35,5%
3	24,0%	7,3%	13,1%
4	0	0	0

TP = triphosphate PP = diphosphate