# PHOSPHATE TREATMENT OF FROZEN PRAWNS

## II. FROZEN STORAGE CHARACTERISTICS OF PRAWN MEAT TREATED WITH POLYPHOSPHATES

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This communication reports the changes in physical, organoleptic and biochemical characteristics of prawn meat dip-treated with alkaline and neutral solutions of polyphosphates during frozen storage. Results are presented on changes in thawed and cooked yields, Water extractable nitrogen, non-protein nitrogen, free $\alpha$-amino nitrogen, salt solubility, myosin and moisture in the muscle and loss of soluble nitrogenous constituents in thaw drip during frozen storage upto seven months. The salt solubility remained unchanged during storage in samples treated with neutral polyphosphate solutions and the organoleptic quality was superior to control sample. It is concluded that dip treatment with neutralised solutions of tripolyphosphate not only maintains correct drained weight and improves cooked yield during prolonged frozen storage but also protects the frozen product from denaturation as measured by the salt solubility of the proteins.

INTRODUCTION

A neutral solution of sodium tripolyphosphate has been shown to be useful in preventing drip loss and improving organoleptic quality of fresh frozen prawns without adversely affecting the biochemical characteristics (Mathen, 1968). To establish the advantages of the method fully it was however essential to determine the relative changes in the physical, biochemical and organoleptic quality of the material during frozen storage for long periods.

Storage characteristics of phosphate treated frozen cod, halibut, redsnapper, Dover sole etc. were studied by various authors (Boyd & South Cott, 1964, Mac Callum *et al* 1964, Dyer *et al,* 1964, Tanikawa *et. al,* 1963). However, literature lacks in the report of such studies carried out with prawn meat. A proper understanding of the storage characteristics of phosphate treated prawns was felt necessary as in the procedure suggested, the polyphosphate used is neutralised with sodium dihydrogen phosphate and thus there is a possibility of the characteristics being different from those treated with sodium tripolyphosphate alone.

In the present study the effect of frozen storage period on physical, organoleptic and biochemical quality of prawn meat treated with alkaline and neutral solutions of sodium tripolyphosphate during storage period upto seven months was determined.

## Materials and methods

Peeled and deveined prawns of the species *P. stylifera* (nearly 250 pieces per Kg) were quick frozen in 450 g (weight of untreated prawns) after treating with the following.

1. Water (100 ml/450 g.)
2. Sodium tripolyphosphate (12%, 100ml/450 g).
3. Mixture of sodium tripolyphoshate (12%) and sodium dihydrogen phosphate (8.6%) (100ml/450 g.)
4. Mixture of sodium tripolyphosphate (12%) and critic acid (2%) (100 ml/450 g).
5. 'Freeze gard' (A patented product made by M/s Calgon Corporation, U.S.A.) (8%, 40 ml/450 g). Dipping time was two minutes. All samples except the fourth were quick frozen at–40°C with 50 ml of water added as glaze. The frozen blocks were stored at-23°C covered with polythene paper. Samples were drawn at intervals and examined for thawed and cooked yields, moisture, total nitrogen (TN), salt solubility (SS), myosin nitrogen (MN), water extractable nitrogen (WEN), non-protein nitrogen (NPN) and free $\alpha$-amino nitrogen ($\alpha$-$NH_2$-N) in muscle and total nitrogen, non-protein nitrogen and free $\alpha$-amino nitrogen in thaw drip. The methods used were the same as those described earlier (Mathen *loc. cit*).

## Results and discussion

Results on thawed and cooked yields expressed as percentage of untreated material are shown in figures 1 and 2. The curves 1 to 5 in all figures correspond to the five treatments described above. These show that the thawed and cooked yields in all cases decrease slowly upto three months of frozen storage and afterwards remain more or less unchanged except in the case of the water dipped sample which shows increase during the initial stages of storge. The percentage of thawed yield decreased in the following order. 2, (3, 4) 5, 1, treatment 2 being the

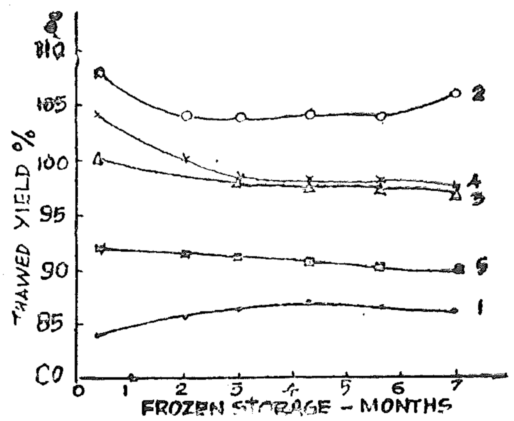


Fig 1. Changes in thawed yield of phosphate treated and untreated frozen prawn meat during frozen storage.

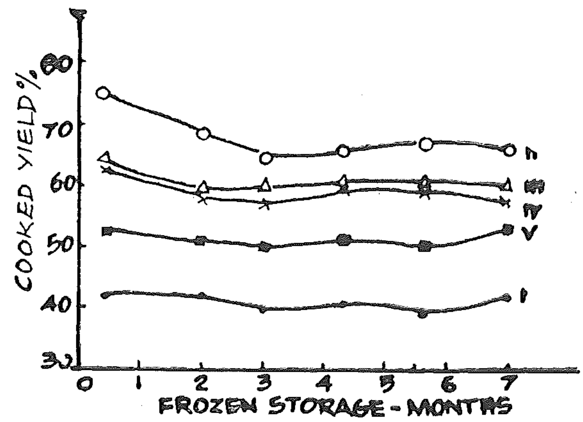


Fig 2. Changes in cooked yield of phosphate treated and untreated prawn meat during frozen storage.

most effective. Also it is noticed that the thawed yields are between 98 to 100% in treatments 3 and 4 and cooked yields 58 to 64% even after 7 months of frozen storage. Treatment 5 did not give the expected yields as observed in earlier studies probably because the concentration used was less. Though treatment 2 is the most effective with respect to thawed and cooked yields, this is unsatisfactory as the treated prawns tend to lose colour on cooking and develop ammoniacal odours during frozen storage resulting in poor organoleptic quality. Since the solution used in treatment 2 is alkaline (pH about 8.5) the muscle pH increases in excess of 7 and this is found to liberate ammonia on cooking (Tayler, 1933). The improved cooked yields might have resulted from the influence of the polyphosphates on tropomyosin which is the only protein remaining undenatured above 100°C and which influences the water holding capacity (Bailey, 1954, Hamoir, 1955). One of the objections to the use of water binding agents is the rise in pH which favour bacterial growth. However, this is not the case with treatments 3 and 4 which have pH between 6.4 to 7.0. The chances of added bacterial contamination from the solution has not been examined. From the results on thawed and cooked yields it is inferred that prawn meat dipped in neutral solution of tripolyphosphate keeps drained weight and cooked yield upto 7 months of storage at -23°C.

*Figure 3* shows the changes in moisture content of treated and untreated prawn meat during storage. Moisture level in samples 1,3,4 and 5 are comparable while in 2 it is higher. The changes in moisture during storage are insignificant. The higher level of moisture in 2 is to be attributed again to the higher pH of the dip solution.

Figures 4, 5 and 6 depict the changes in WEN, NPN, and free $\alpha$-$NH_2$-N

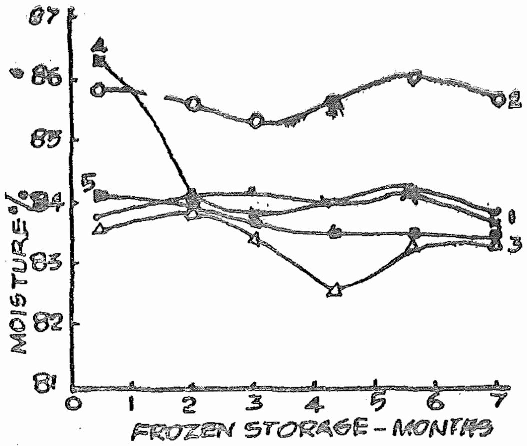


Fig 3. Changes in moisture content of phosphate treated and untreated prawn meat during frozen storage.

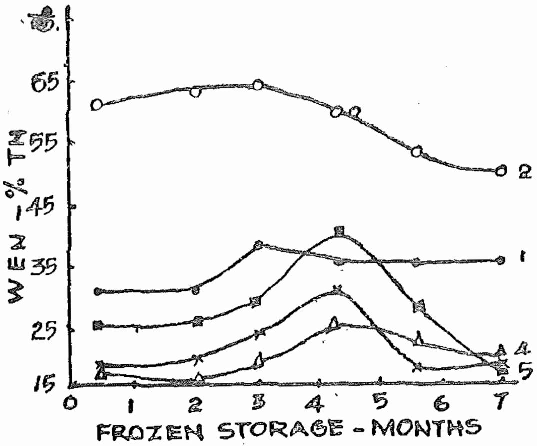


Fig 4. Changes in Water Extractable Nitrogen in phosphate treated and untreated prawn meat during frozen storage.

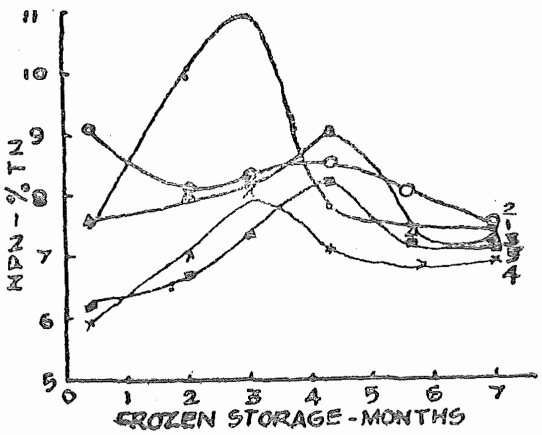


Fig 5. Changes in Non-protein Nitrogen in phosphate treated and untreated prawn meat during frozen storage.

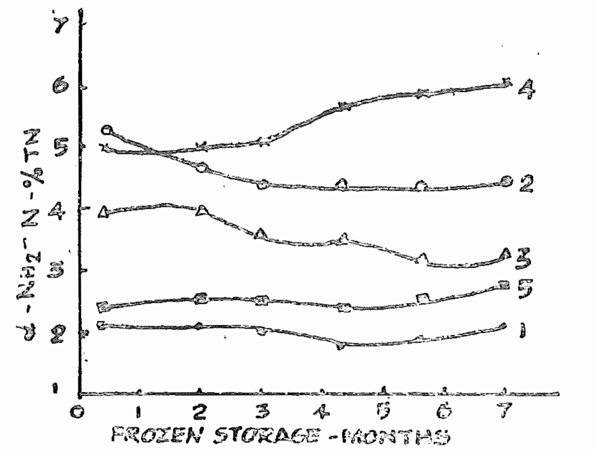


Fig 6. Changes in free $\propto$ – amino nitrogen in phosphate treated and untreated prawn meat during frozen storage.

during storage. It is seen from figure 4 that the values are highest in treatment 2 followed by 1, 5, 4 and 3; the values for 3 and 4 being roughly the same and only half that of 1 while in 2 it is nearly 100% more than in 1. These differences in WEN are presumably due to the changes in pH of the dipping solution and consequently of the dipped meat. 'Salting out' also might have played a role in bringing down the WEN in 3 and 4. The general pattern of change during frozen storage in all the five cases is an increase followed by decrease. The increase occurs in 5, 3 and 4 after 4.2 months and in 2 and 1 after 3 months of storage. From figure 5 it may be noted that the NPN values also change during storage and the general trend is an increase followed by a decrease. From figure 6 it is clear that the values for free $\propto$-$NH_2$ – N do not undergo much change during storage. The values are highest for 4 which is probably viciated by the interference of citric acid in the estimation. Liston (1964) showed from his studies on irradiated and unirradiated sole fillets that there is little endogenous proteolysis in white fish muscle due to cathepsin at refrigerator temperatures or even when muscle is exposed to higher storage temperature for short periods. Similar results were recorded by Partmann (1964) on sterile muscles stored for 18 and 57 days. At–23°C bacterial activity as well as the activity of both endogenous and bacterial enzymes are negligible.

Figures 7 and 8 show the changes in salt solubility of the proteins and the myosin content respectively during frozen storage. Salt solubility is initially 80 to 85% in all the samples which remains almost unchanged in 3 and 4 for the full storage period while it falls in 2, 1 and 5 after 4 2 months and remains at that level, i. e, between 70–75%. This observation

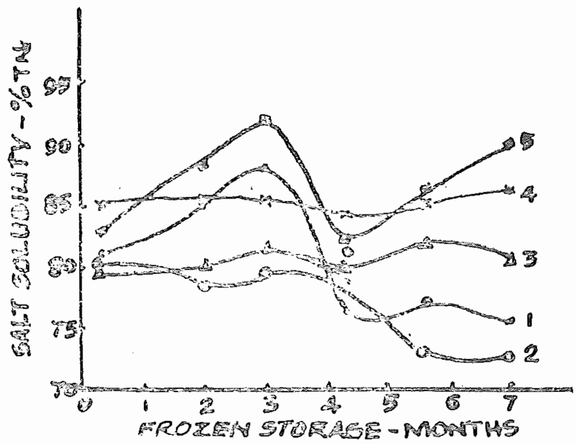


Fig 7. Changes in the solubility of the proteins in 5% Nacl in phosphate treated and untreated prawn meat during frozen storage.

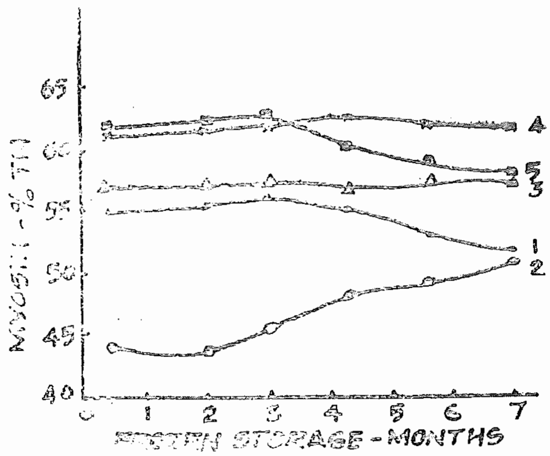


Fig 8. Changes in the myosin content of phosphate treated and untreated prawn meat during frozen storage.

shows that polyphosphate solutions neutralised with sodium dihydrogen phosphate or citric acid have protective effect on denaturation as measured by salt solubility. Similar protective effects are reported by Ohta and Nishimoto (1963). Dyer *et al* (1964) found no difference in extractable protein from treated and untreated fillets of cod while Love & Abel (1966) concluded that effect of polyphosphate on denaturation of proteins is slight and indefinite. Tanikawa *et. al (loc. cit.)* however, found decrease in myosin content of phosphate treated cod. Of samples 3 and 4, denaturation is less in 4 which again is supported by the results of Nikkila *et al* (1965) who showed that citrate affects denaturation less than phosphates. The influence of the phosphate absorbed during the dip (nearly 2%) is supposed to be insignificant when added to the 5% sodium chloride solution used for extraction. Studies carried out on the solubility of proteins in prawns stored at-18°C (Fatima and Magar, 1965) show a regular decrease and within 7 months reaches half the original value. However, in this stndy the fall in protein extractability is not so sharp probably due to the lower storage temperature (-23°C). Figure 8 shows that the changes in myosin are almost similar to salt solubility.

Figure 9 gives the changes in the volume of drip while figures 10, 11 and 12 give the amounts of TN, NPN and free $\alpha$-$NH_2$-N lost from 100g frozen material during thawing. The volume of drip decreases in the following order 1-5-4-3-2. The pattern noticeable in the drip volume is that all the treated samples remain comparable while the control remains distinctly different with high levels. The largest volumes of drip are observed after 3 months in 1, 4 and 5 and after 2 months in 2 and 3. Similarly in the loss of soluble nutrients 2, 3 and 4 are comparable while 5 and 1 remain different In all the cases the general trend in loss of soluble nutrients is an increase upto 2 to 4.3 months followed by fall. The treatments especially 2, 3 and 4 reduce loss of nitrogenous constituents in the drip considerably in addition to improving thawed and cooked yields. This may probably account for the slightly better flavour characteristics of treated prawns.

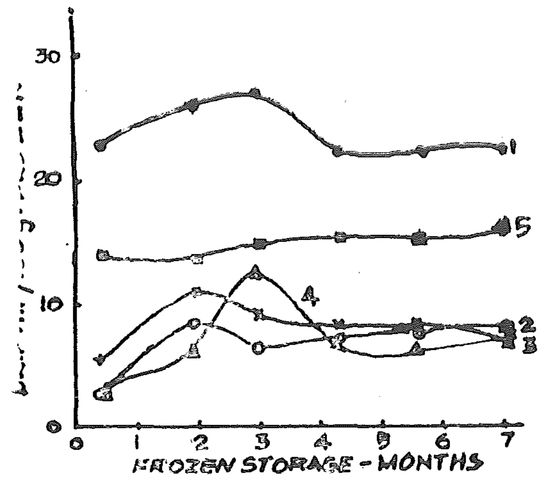


Fig 9. Changes in the drip volume of phosphate treated and untreated prawn meat during frozen storage.

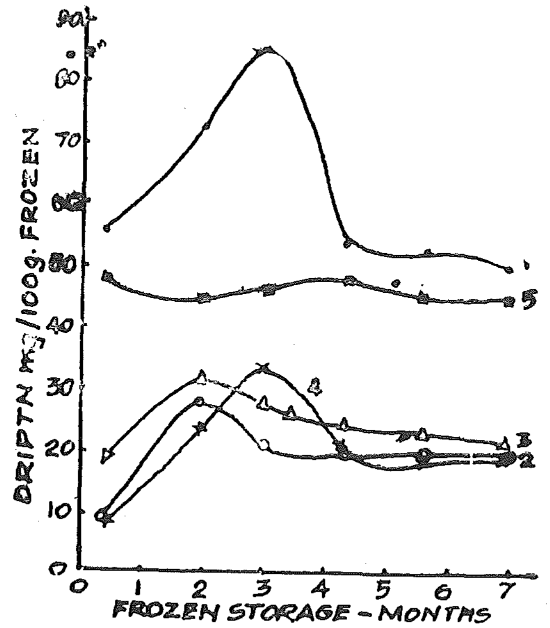


Fig 10. Changes in total nitrogen of the drip in phosphate treated and untreated prawn meat during frozen storage.

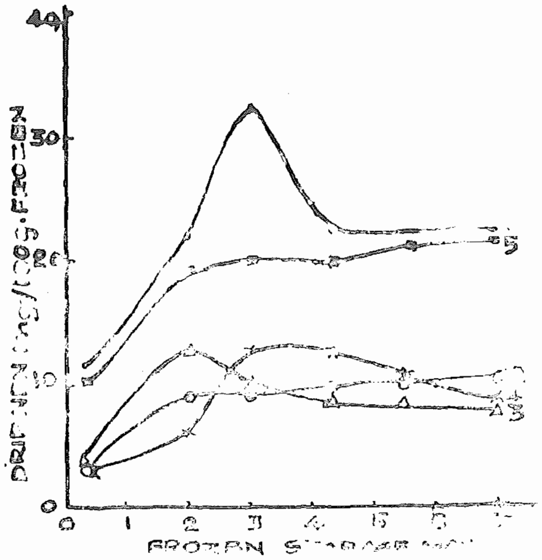

Fig 11. Changes in Non-protein Nitrogen of the drip in phosphate treated and untreated prawn meat during frozen storage.

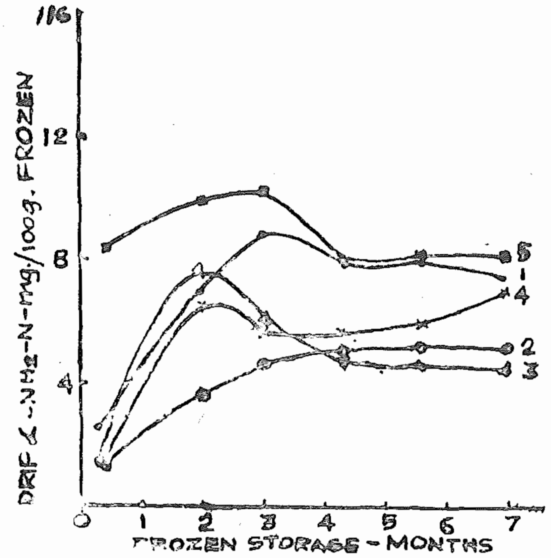


Fig 12. Changes in free ∝ - amino nitrogen of the drip in phosphate treated and untreated prawn meat during frozen storage.


## Summary

Treatments with neutral solutions of tripolyphosphate improves thawed and cooked yields and helps to retain them during frozen storage in peeled and deveined prawns and gives protective effect to the proteins from denaturation as measured by the salt solubility of proteins, while the other biochemical changes remain comparable to these in untreated samples.



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