# Preventive Effect of Polyphosphate on the Drip-Formation of the Thawed Fish Flesh

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**Abstract**

The preventive effects of polyphosphate and sodium chloride upon the drip-formation of the thawed fish flesh were ascertained by measuring the free- and centrifuge drip; and then the property enabling these salts to be preventive against the dripping was investigated chiefly.

The amount of the centrifuge drip was lesser when the pH value of flesh was under alkaline side. Both metal chelating agents and viscous matters were effective in preventing the dripping. Against insolubilization of salt-soluble protein, polyphosphate revealed protective; while sodium chloride, obviously accelerative.

Then, alkalinity and viscosity of polyphosphate, and its actions both in chelating metal and in stabilizing protein are considered to be participated collectively in the preventive effect of phosphate on the dripping. And the drip-formation is not to be considered resulting from the denaturation of protein alone.

One of the undesirable phenomena of frozen stored fish is the drip-formation on thawing. As to the origin of these drips, there are a variety of opinions, but it has not yet been made fully clear so far. And as a means of preventing the dripping, the method of dipping fish in buffer solution or in brine prior to freezing, has been suggested, and each of which or mixing both of which has been confirmed effective.[1-4] However, brine is not considered necessarily appropriate since it is known to facilitate the oxidative deterioration of lipids in frozen stored fish muscle.[5,6]

Upon this, the authors applied polymeric phosphates to the prevention of dripping of thawed fish, as phosphates have recently come widely used as water-holding agent and have been testified to have anti-oxidative property for lipids.[7,8] And tripolyphosphate was found to be very effective, being equal to the effect of sodium chloride. Accordingly, in the present experiment, the property enabling tripolyphosphate to be effective in the prevention of dripping was chiefly investigated and simultaneously the relation of drip formation with denaturation of protein was studied comparing the stabilizing effect upon protein with that of brine.

## Materials and Methods

*Preparation of samples*

Mackerel was chiefly used as the sample. The normal muscle was taken and minced to be mingled with aqueous solution of given substances and made in block of fixed size with the weight of 10 g. Dilute sodium hydroxide or hydrochloric acid was used for adjusting the pH value of flesh. A control sample in each experiment was prepared by the addition of water. Then it was taken in a vessel covered with plastic cloth and stored in a cold room at −10°C. Taking it out for a fixed period later, it was submitted to the measure-

ment of centrifuge drip or of protein content.

*Measurement of centrifuge drip*

The frozen sample was put into a drip tube as shown in Fig. 1 and centrifuged accurately at the speed of 1000 rpm 20 min at 5–10°C after thawing (at 13–15°C, 2 hr). The separated juice was decided to be the centrifuge drip, the drip % being expressed by the number of ml of drip per 100 g fllesh.

*Determination of protein*

Salt-soluble protein was measured by the Biuret method after extracting from the thawed flesh with 0.6 M pottasium chloride of pH 7.5. The extract was diluted 8 times with cold water and stood at 0°C overnight. The precipitate obtained was measured as actomyosin.

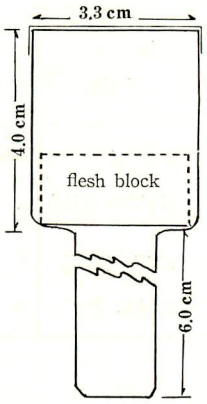
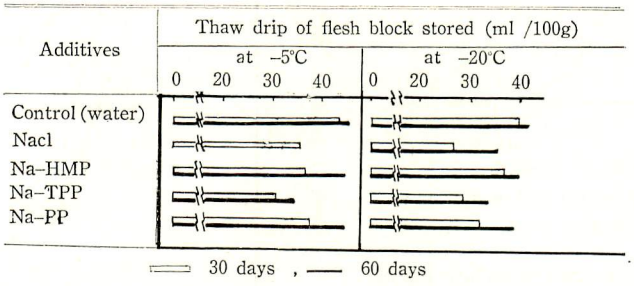



Fig. 1. Centrifuge tube for measurement of drip.

## Results and Disccussion

*Effects of polymeric phosphates and sodium chloride on the prevention of drip*

Several polymeric phosphates and sodium chloride were examined for the effect to prevent drip. Results obtained are as shown in Fig. 2.




Na-HMP : Na-Hexamethylphosphate
Na-TPP : Na-Tripolyphosphate
Na-PP : Na-Pyrophosphate

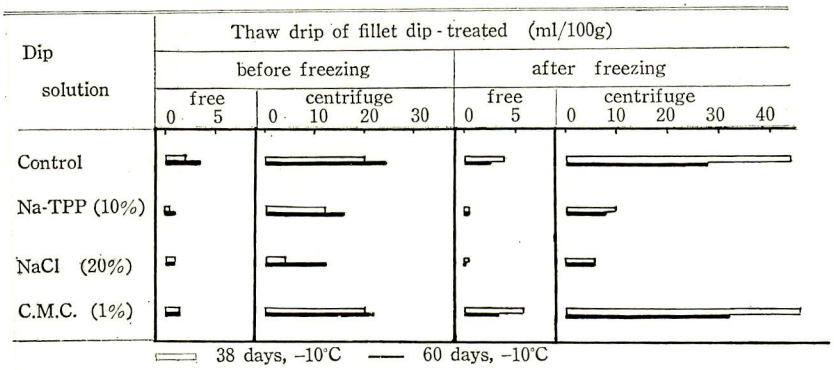
Fig. 2. Effect of addition of polymeric phosphates and sodium chloride on centrifuge drip of thawed mackerel flesh.

All of the added salts were preventive for dripping. Among phosphates, tripolyphosphate showed the most preventive effect, its effect being almost equal to that of sodium chloride.

This can be distinctly seen in Fig. 3 where the effects of dipping fillet of yellow sea bream in solution of these salts before and after freezing are illustrated. Therefore, the property enabled tripolyphosphate to prevent drip was investigated in the following experiments.

*The relation of drip quantity with pH value of flesh*

It has been already known that the water-holding capacity of flesh is influenced by pH value of flesh.[9, 10] The drip quantity too is in connection with pH value, as shown in Fig. 4. When pH value was about 5.0, the drip quantity was the largest, while it was rather small at other values, especially lesser on




C. M. C.: Carboxymethyl-cellulose.

Fig. 3. Effect of dip-treatment on thaw drip of yellow sea bream fillet.

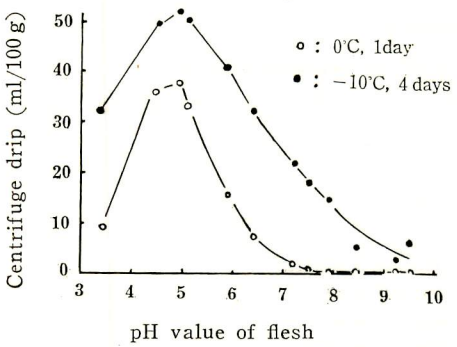



Fig. 4. Influence of pH value on thaw drip of minced flesh.

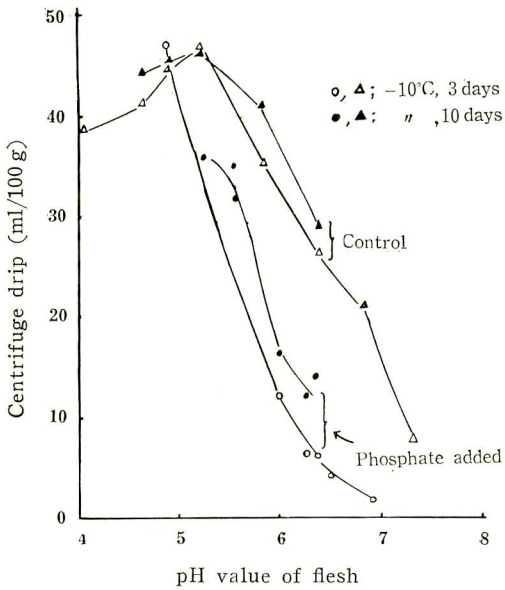



Fig. 5. Thaw drip of minced mackerel flesh with and without tripolyphosphate at different pH values.

the alkaline side. On the other hand, polyphosphate revealed slightly alkaline. Accordingly the alkalinity of phosphate is conceived to be contributive to its own preventive capacity of dripping.

However, as obvious in Fig. 5, by merely making, with dilute alkali, the pH value of flesh equal to that of flesh mixed with phosphate, such effect as that of phosphate could not be obtained. Therefore the preventive capacity of phosphate cannot be ascribed to its own alkaline property alone.

*Effects of chelating agents upon the drip quantity*

Polyphosphate is known to have chelating action against metal. Upon this, in order to examine the relation of this action with the preventive activity, the effect of ethylenediamine tetra-acetate (EDTA) most widely known as a chelating agent was compared with that of phosphate, the result of which is as shown in Fig. 6. Di-sodium EDTA being acidic salt, its preventive effect could not be observed, while as for tetra-sodium salt, the preventive effect was observed distinctly.

But its degree was seen far lower than that of phosphate. Therefore it might well be conceived that contribution of a chelating action of phosphate to its preventive capacity is rather weak, which can be surmised by comparing its effect with that in the flesh mixed with calcium chloride.

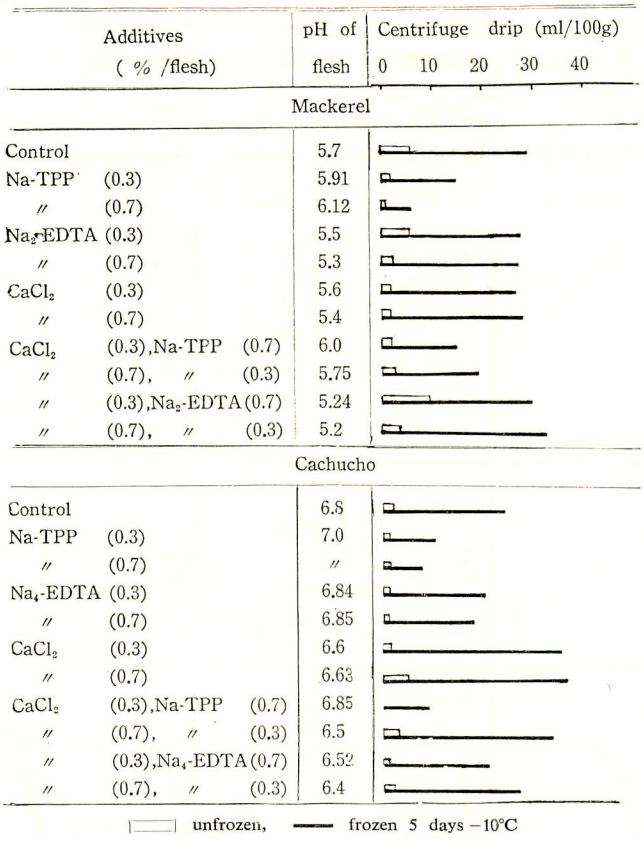



Fig. 6. Influence of EDTA & TPP on centrifuge drip of unfrozen, and defrosed fish flesh.

*Effects of viscous matters upon the drip quantity*

In order to examine the relation of viscosity of phosphate with its preventive effect of dripping, several kinds of viscous matters were compared in regard to the effects, the result of which is as shown in Fig. 7, where preventive capacity of gelatin, glycerin, propylene-glycol was respectively seen to be lower than that of phosphate,

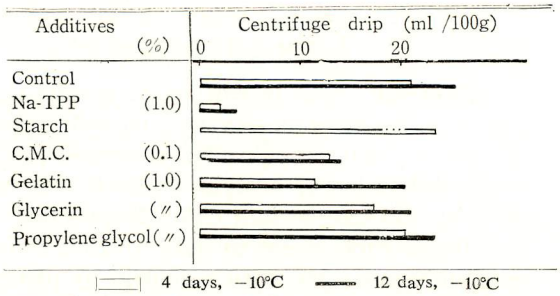



Fig. 7. Influence of addition of viscous matters on thaw drip of mackerel flesh.

while as to viscosity of those, each was rather higher than that of phosphate. Accordingly viscosity is not to be considered a significant factor of the controlling capacity of phosphate.

*The relation of preventive effect of dripping with the stabilization of protein*

As a main cause of dripping, denaturation of protein has hitherto been mentioned. Then, it was examined whether the prevention of dripping by phosphate is due to the action to stabilize protein, the result of which is illustrated in Fig. 8, where phosphate is seen provided with the capacity to stabilize protein. Therefore this action might well be considered performing a part of contribution as the preventive capacity of dripping.

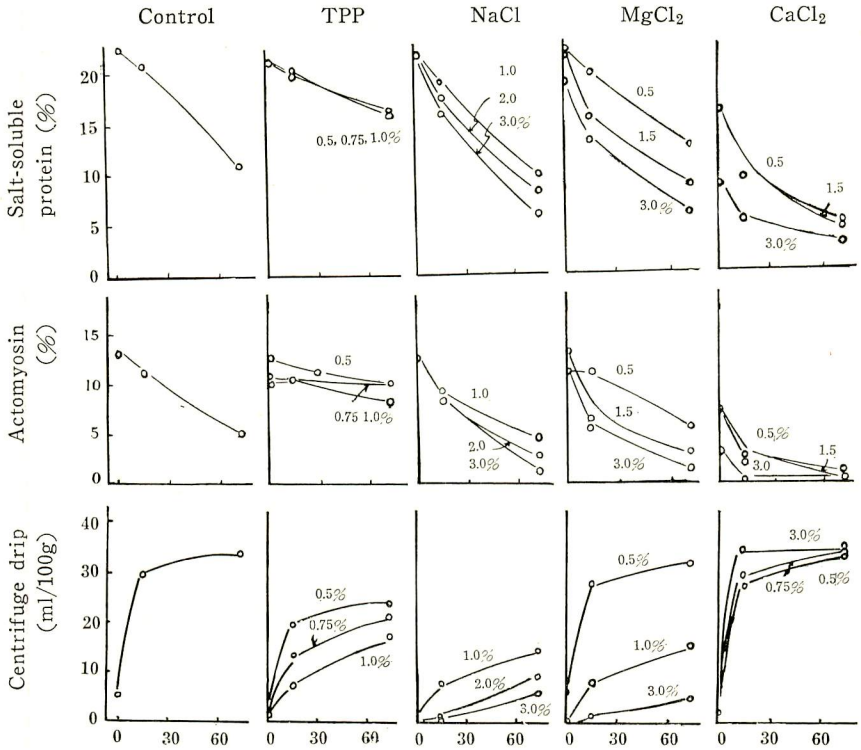



Fig. 8. Effect of addition of salts on thaw drip and protein denaturation of frozen-stored mackerel flesh.

However, what is worthy of special note is that the results of comparative experiments of chlorides were entirely opposite to those obtained in the case of phosphate, that is, chloride performed rather significant counter action against the stabilization of protein, while it was remarkably effective in the prevention of drip, and magnesium chloride revealed the similar tendency.

These facts seem to indicate that there exists utter difference between the mechanisms of prevention of drip by phosphate and by salt, leaving a problem to be solved concerning opinion that the cause of dripping should be ascribed to the denaturation of protein.

## Conclusion

Polymeric phosphates, particularly tripolyphosphate is applicable as a preventive agent of drip of thawed fish. Alkalinity and viscosity of polyphosphate, and its actions both in chelating metal and in stabilizing protein are supposed collectively contributable to the preventive effect of polyphosphate on dripping.

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