STANDARDIZATION OF POLYPHOSPHATE TREATMENT FOR TINY PRAWNS (PARAPENAEOPSIS STYLIFERA) WITH SPECIAL REFERENCE TO ITS REHYDRATION CAPACITY AND ORGANOLEPTIC QUALITY

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ABSTRACT

In the present study, an attempt was made to explore the benefits of polyphosphate for enhancement of dried prawn (Parapenaeopsis stylifera) quality commercially known as “sode” in Maharashtra coast. Dip treatment in polyphosphate solution at different concentrations (viz., 3, 5, 7 and 10%) was given to peeled and undeveined P. stylifera for different durations (viz., 1, 2, 3, 4 and 5 min). Treated prawns were dried and subjected to rehydration capacity test and organoleptic evaluation. Among the different treatments, rehydration capacity was found to increase with the increased duration and concentration of treatment. Tiny prawns treated with sodium tripolyphosphate solution at the rate of 5% concentration for 5 minutes showed an increase in pH from acidic to alkaline, and had better quality with respect to rehydration capacity and textural attributes as compared to other concentrations and durations of polyphosphate treatment.

Keywords: Standardization, polyphosphate, sode, rehydration capacity, texture

INTRODUCTION

'Sode' is one of the solar-dried peeled and undeveined prawns, which is prepared by spreading on the beach or terrace and drying in the sun for two to three days depending upon the weather conditions. Since it is plain dried, it may be expected to have a hard texture after rehydration, which is usually observed in dried fish and shellfish products.

Polyphosphates have been used in meat and fish industries for improving the water holding capacity and texture of frozen and dried products (Mathen, 1970; Mathen and Pillai, 1970; Pearson and Tauber, 1984; Basu, 1990; King et al., 1990; Anjaneyulu et al., 1994; Simpson et al., 1994).

Polyphosphates have been used for improving the rehydration capacity of dried squid (Takahashi and Takei, 1956; Takei and Takahashi, 1961). Sen and coworkers (as quoted by Srikar, 1979) have demonstrated that the tenderness of dry mackerel is enhanced by treating the fish with sodium hexametaphosphate prior to drying. Basu (1990) reported that sodium

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tri-polyphosphate in dried mince meat products lowers the water activity \( (a_w) \) of the product, imparts bactericidal property, increases hydration of the protein and increases resistance to thermal denaturation of proteins. Meyer (as quoted by Srikar, 1979) found that polyphosphates added to the brine of herring immediately after harvesting and prior to further processing improves colour.

There are two possible mechanisms by which denaturation of protein is inhibited: (a) the phosphate is directly bound by the protein to increase the number of polar groups in protein \( (\text{PO}_4^- - \text{actomyosin}) \) resulting in an increase in solubility, and (b) phosphates and citrates complex calcium and zinc ions releasing polar groups (Linko and Nikkila as quoted by Srikar, 1979). The use of polyphosphate as flavour improver has been disputed. This is due to the fact that dipping into phosphate solution can mask some of the symptoms of deterioration. However, according to Tarr et al. (as quoted by Srikar, 1979), the enzyme that hydrolyses 5'-nucleotides is strongly inhibited by ethylene diamine tetraacetic acid (EDTA), pyrophosphate, KF and \( \text{ZnCl}_2 \) at 1 to 10 mmol levels. 5'-nucleotides are flavour intensifiers, which hydrolyse when treated with EDTA, pyrophosphate, KF or \( \text{ZnCl}_2 \) and thereby improve flavour.

The present work was taken up with an intention to develop a methodology for using polyphosphates to improve the rehydration capacity and texture of dried prawns.

**MATERIAL AND METHODS**

Freshly caught tiny prawns \( (Parapeneaeopsis stylifera) \) purchased at the local landing centres were brought under iced conditions to the laboratory and were prepared by peeling, deheading and thorough washing to produce the dried product (Flowchart 1).

Fresh prawns

\[ \downarrow \]

Thorough washing

\[ \downarrow \]

Beheading

\[ \downarrow \]

Removal of shell

\[ \downarrow \]

Thorough washing

\[ \downarrow \]

Peeling

**Flowchart 1. General preparation of raw material**

Commercially available food grade sodium tri-polyphosphate obtained from Albright Moraji and Pandit Ltd. Mumbai, was used for the dip treatment. Different concentrations of sodium tri-polyphosphate were prepared in potable water by dissolving required quantities of sodium tri-polyphosphate. Prawns were divided into 16 lots (for 4 different concentrations; 4 lots have been used in order to standardize
polyphosphate treatment) and given dip treatment for various durations in different concentrations. The concentrations used were 3, 5, 7 and 10% for various durations such as 1, 2, 3, 4 and 5 minutes.

Polyphosphate-treated and untreated prawns were allowed to dry in the solar dryer for 2-3 days depending upon the weather conditions to a moisture content of 25%. Solar dryer of size 96 x 63 x 100 cm and having three trays of size 95.0 x 36.5 cm each with a capacity of 5 kg was used for the purpose. Air enters the drier at 20°C and leaves at 80% relative humidity with the collector temperature at 45° C.

The rehydration capacity of dried prawns was determined as per Suzuki (1981) with slight modification, without centrifugation. Weight of the polyphosphate-treated dried prawn was taken and then, they were dipped in potable water for one hour. During dipping, precaution was taken to see that all prawns were submerged in water. Afterwards, these were drained and adhered water was removed by wiping; the weight of prawns was taken to calculate the percentage rehydration capacity. Residual phosphate was estimated as total phosphorus as per Kanduri and Eckhardt (2002).

Rehydrated prawns were cooked in 1% salt solution. For this purpose, commercially available table salt was used. The product so prepared was subjected to organoleptic evaluation by a group of ten trained panelists using a 10-point hedonic scale, viz., Excellent-10, Very good-9, Good-8, ——, Very poor-1 as per Hiremath and Dhananjaya (1979). The pH of the polyphosphate-treated and untreated prawns was directly recorded using a pH meter (Sensex, USA).

The total volatile base-nitrogen (TVB-N) and total volatile acids (TVA) were estimated by the Convey microdiffusion method (Beatty and Gibbons, 1936). Proximate composition of the polyphosphate-treated and dried prawn (sode) was estimated as per Horwitz (1980). Microbiological analysis was done as per Collins and Lyne (1984). Wherever necessary, the experimental data were subjected to appropriate statistical analysis (Snedecor and Cochran, 1967). The significant differences observed are mentioned as p < 0.05.

RESULTS AND DISCUSSION

The TVB-N values of untreated, treated and treated dried prawn samples were 16.80, 16.78, and 16.81 mg%, respectively, while the total plate counts were 9.0x10^4, 1.0x10^4 and 1.85x10^4 cfu/g, respectively.

The results of this study clearly show that the rehydration capacity of polyphosphate-treated dried prawns was more than that of the control. Further, rehydration of polyphosphate-treated dried prawns showed increasing trend with respect to durations and concentrations (Fig. 1). Similarly, the longer the duration of dip treatment, the higher was the rehydration capacity of the dried prawns for all the concentrations, e.g., in 5% polyphosphate concentration, rehydration capacity was 92.31% and 95.83% after 1 and 5 minutes, respectively. It was found
Fig. 1. Rehydration capacity of dried prawns treated with different concentrations of polyphosphate for different durations

by Suzuki (1981) in the case of ethanol-treated, dried and then rehydrated marine beef that rehydration capacity of marine beef increased when different levels of NaHCO₃ were added to minced meat. Basu (1990) observed that polyphosphate increased the hydration of proteins and also increased the resistance to thermal denaturation of proteins up to 45°C in minced meat dried products.

The proximate composition of untreated, polyphosphate dip-treated and dried prawn is given in Table 1.

Organoleptic evaluation (Fig. 2 and 3) of dried prawns dip-treated with and without polyphosphate indicated that appearance, colour, taste and flavour were not influenced significantly by variations in concentrations and durations of dip

Table 1: Proximate composition (%) of initial peeled and undeveined, polyphosphate dip-treated and dried prawns

<table>
<thead>
<tr>
<th>Process</th>
<th>Moisture</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peeled and undeveined</td>
<td>76.26</td>
<td>20.18</td>
<td>1.45</td>
<td>2.26</td>
</tr>
<tr>
<td>Polyphosphate dip-treated</td>
<td>77.38</td>
<td>18.15</td>
<td>1.37</td>
<td>3.18</td>
</tr>
<tr>
<td>Dried</td>
<td>25.49</td>
<td>61.48</td>
<td>4.51</td>
<td>8.49</td>
</tr>
</tbody>
</table>
Fig. 2. Organoleptic evaluation of dried prawns

Fig. 3. Organoleptic evaluation of dried prawns treated with different concentrations of polyphosphate for different durations
treatment, and the values ranged between 6.0 and 6.8. For the same concentration, with increased duration of dip treatment, increased scores for texture were recorded over the control (6.25), e.g., for 3% dip treatment, scores were 6.6 to 6.8 after 1 and 5 minutes of dip treatment, respectively. Similar, trends were observed for other concentrations. Among the different concentrations, 5% for 5 minutes had the highest score for texture followed by 7% for 3 minutes, 10% for 2 minutes and 3% for 5 minutes.

After rehydration, the pH of the polyphosphate dip-treated prawn showed an increasing trend with respect to durations and concentrations, and the pH of the control sample was found to be lower than the polyphosphate-treated samples (Fig. 4). Acidic pH of the control sample leads to greater shrinkage of prawn muscle and results in poor rehydration capacity. Polyphosphate dip treatment to the prawns before drying increases the pH of the muscle. Pearson and Tauber (1984) have reported similar results in the case of ham and other cured products, and they opined that only alkaline phosphates were effective for improving the water binding of cured product.

Although the dip treatment in 7% sodium tri-polyphosphate for 3 minutes and in 10% sodium tri-polyphosphate for 2 minutes had higher rehydration capacity than in 5% sodium tri-polyphosphate for 5 minutes, it was observed that there was deposition of polyphosphate on the surface of dried prawns treated with 7% sodium tri-polyphosphate for 3 minutes and 10% for 2 minutes, whereas the polyphosphate deposition was not noticed in dip-treated prawns in 5% sodium tri-polyphosphate for 5 minutes. Pearson and Tauber (1984) have reported the occurrence of crystals on the surface of cured meat and it could be prevented by reducing the level of phosphate.

![Fig. 4. pH values of rehydrated prawns untreated and treated with different concentrations of polyphosphate for different durations](image-url)
in the cure. Legal limits for added residual phosphates are set at 0.5% of the finished product.

Difficulty was encountered in the solubilisation of sodium tri-polyphosphate in the higher concentrations, i.e., 7 and 10%. Therefore, it was decided on the basis of these difficulties, organoleptic evaluation and rehydration capacity, to consider a dip treatment of 5% sodium tri-polyphosphate for 5 minutes. The polyphosphate percentage in the dried prawns was below the 0.5% limit. Similarly, it has been worked out by Takahashi and Takei (1956), and Takei and Takahashi (1961) that a dip treatment in 5-10% of Na₂HPO₄ solution for 5 minutes, or in a mixed solution of 5% of hexa-meta-phosphate and sodium tri-polyphosphate or tetra-polyphosphate (2:1) for 5 minutes improves the rehydration capacity of dried squids. It was also observed by Sen and others (as quoted by Srikar, 1979) that the tenderness of dry mackerel increased by treating the fish with sodium hexa-meta-phosphate prior to drying. Basu (1990) observed that the texture of fish cake (from minced meat) could be improved by treating the minced meat with polyphosphate prior to drying.

Different polyphosphate treatments given to prawn were found to be significantly different (p < 0.05). From the above discussion and comparison between organoleptic qualities of different polyphosphate treatments, it can be concluded that the treatment of tiny prawns with sodium tri-polyphosphate solution at 5% concentration for 5 minutes increases the pH of the prawn, and enhances the quality with respect to rehydration capacity and textural attributes.

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REFERENCES


