Benefits from using seafood preservatives

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Introduction

This report discusses the uses of phosphate and non-phosphate (bicarbonate) as preservative reagents in the food industry. The main purpose is to provide a close look at non-phosphate food preservatives to illustrate how chemical technology can benefit society.

Phosphate and non-phosphate food preservatives

Sodium tripolyphosphate (STPP) has been commonly used for preserving seafood products for years[1]. The phosphate-based preservative retains food tenderness and moisture that is lost during storage and transportation. The essence of using STPP is to create a highly basic environment for seafood products that are generally neutral. The difference in pH is the driving force that transfers the aqueous solution of STPP into the seafood's internal cells. The solution of STPP inside the food rehydrates and extends shelf-life by adding surface protection in a cold environment.

Over decades, numerous toxicology studies have examined the safety of phosphate-based food preservatives. These studies have been reviewed by several panels of internationally recognized experts, including the Joint FAO/WHO Expert Committee on Food Additives and the Select Committee on GRAS Substances (SCOGS). Worldwide regulatory approval has been granted to phosphate-based food additives.

Unfortunately, the processed products may have a bitter taste due to the addition of phosphate solution. After years of research, non-phosphate food preservatives were introduced with advantages over STPP. The non-phosphate food preservatives are mainly Sodium

[1] Sodium tripolyphosphate(STP or STPP or TPP) is $Na_5P_3O_{10}$.

Bicarbonate($NaHCO_3$)[2]. Using the same mechanism, absorbed aqueous Sodium Bicarbonate also creates a highly basic environment for seafood products. However, non-phosphate solution is more efficient than phosphate solution in improving taste and preserving appearance, color and texture. Essentially, non-phosphate additives provide the same function but they are more widely acceptable than phosphate based compounds because of the bicarbonate anion[3].

Because the preservation reagents can improve the appearance of seafood like shrimp and scallops, there is some concern that unscrupulous salespeople may sell products that are not fresh to consumers who cannot see the signs that the items have started to deteriorate. Also, the chemicals essentially add water to the seafood, making customers pay for water at the price of shrimp. Therefore, abusing the uses of additives for storing water inside seafood products is unethical. The temptation to increase the sale weight of a product distorts the main purpose of using additives as preserving agents.

Success of non-phosphate preservative

In early 2000, Aura Barter LTD. introduced MTR-79, a non-phosphate food preservative. After only 2 years, MTR-79 has gained acceptance by most of Thailand's seafood merchants (especially shrimp processors). Within only 2 years, MTR-79 sales increased rapidly to capture about 35% market share for Thailand's consumption. With the attractive advantage over phosphate in providing higher preservative efficiency and natural appearance and taste, MTR-79 has become the preferred preservation agent for all seafood processors. It is widely exported from Thailand to seafood processing companies in Vietnam, China and European Union.

[2] Non-phosphate preservatives contain 30% NaHCO3(CFR Section 184.1736-safety code of direct substance in food), 25% NaCl (CFR Section 182.1) and 27% Natural Substance (Dextrins 70:30).

[3] The amount of Phosphate residue in food is strictly controlled globally. Bicarbonate anion is safe and preferred for use in foods.

Phosphate-based preservatives (mostly STPP) are favored in the United States due to taste preferences. Americans like firm, crunchy shrimps while others prefer soft shrimp[4]. The use of phosphate compounds is governed by FDA as published in CFR section 182.1[5].

Comparison of MTR-79 and STPP

TABLE 1: COMPARISON OF MTR-79 AND STPP FOR SEAFOOD PRODUCTS

DESCRIPTION	MTR-79	STPP
Increasing Weight	12 - 14 %	10 - 12 %
Reduce Cook Loss	Good	Good
Reduce Drip Loss	Good	Good
Reduce Freeze loss	Good	Good
Taste	Natural	Bitter Taste
Appearance (for cooked item)	Look Natural	Transparency (looks like not ready cooked)
Preserving Color	Look Natural/Good	Moderate
Preserving Texture	Natural Passed	Un-natural (Crispy)
EU Regulation	Passed	Not Allowed
USFDA Regulation		Limited P_2O_5 (Concentration not more than 0.5% in shrimp)

[4] If you've tried dim sum or shrimp dishes in Chinese restaurants, you will know how crunchy shrimp tastes like. It feels like they bounce in your mouth as you sink your teeth into the firm flesh

[5] The Code of Federal Regulations (CFR) is the codification of the general and permanent rules and regulations published by the executive departments and agencies of the federal government of the United States.

Table 1 shows that MTR-79 is a better reagent for preventing dehydration in food processing. It also preserves natural taste and good appearance. FDA requires the P_2O_5 residue, i.e. the concentration of P_2O_5 remaining in the shrimp to be less than 0.5%. The reason for controlling the residue of P_2O_5 is because phosphorous pentoxide reacts vigorously with water and water-containing substances, thus it can cause severe burn to the mucous membrane and respiratory tract even at low concentrations. Therefore, MTR-79, an P_2O_5 free reagent, provide safer final products than STPP.

Experimental results

Generally, 4 kg of MTR-79 is added to 80L of water at a controlled temperature, (5° to 7° Celsius below room temperature) soaking the seafood products. One to three percent table salt is added based on desired taste. Table 2 presents the weight gain in raw shrimp and cooked shrimp given by the manufacturers.

TABLE 2: WEIGHT DATA FOR BLACK TIGER SHRIMP WITH DIFFERENT TREATMENT

Treatment	Weight Before Dipping (kgs)	Weight After Dipping (kgs)	Gain Wt. After Dipping (%)	Number of shrimp/lb		P_2O_5 Residue (remained after treatment)	Appearance
				Bef. Dipping	Aft. Dipping		
No treatment	100	100	0	39-40	39-40	0.25-0.35	Natural
Polyphosphate (3 hours)	100	110	10	43	39	> 0.50	Transparent
MTR-79 (3 hours)	100	111-112	11-12	44	39	0.25-0.35	Natural
MTR-79 (4 hours)	100	113-115	13-15	45	39	0.25-0.35	Natural

Table 2 shows that MTR-79 yields higher weight gain than STPP (from 11% to 15%) and has the same number of shrimp per pound after dipping. The residue of P_2O_5 stays at 0.25-0.35% for MTR-79, the same as in untreated shrimp. Shrimp processed with STPP, on the other hand, has more P_2O_5 residue(>0.50%).

TABLE 3: WEIGHT DATA OF PEELED BLACK TIGER SHRIMP AFTER COOKED

Treatment	Weight Before Dipping (Kgs)	Weight After Dipping (Kgs)	Gain Wt. After Dipping (%)	Weight After Cooked (Kgs)	Number of shrimp/lb		P_2O_5 Residue (remained after treatment)	Appearance
					Bef. Dipping	Aft. Cooked		
No treatment	100	100	0	90	35	39-40	0.25-0.35	Natural
Polyphosphate (3 hours)	100	110	10	97	38	39-40	> 0.50	Transparency
MTR-79 (3 hours)	100	111-112	11-12	98-99	39	39-40	0.25-0.35	Natural
MTR-79 (4 hours)	100	113-115	13-15	99-101	40	40	0.25-0.35	Natural

According to Table 3, after cooking, shrimp lose their weight from 100 to 90 kg without any treatment. MTR-79 helps to prevent water loss during cooking and keeps the weight almost the same before and after cooking (98-101 compared to 100 kg raw shrimp).

Societal and economic benefits of using food preservatives

Preservatives like phosphate and non-phosphate are widely used in many types of food products. Preservatives enhance the quality of preserved foods significantly. Improvement due to preservatives allows people in non-coastal regions to have fresh and tasty seafood, that they could not have had without preservatives.

TABLE 4- SHRIMP IMPORT DATA IN 2010 AND 2011 FOR THE UNITED STATES

Type of product (Shrimp)	2010			2011		
	Thousand lbs	Metric tons	Thousand USD	Thousand lbs	Metric tons	Thousand USD
Shell-on(heads off)	0.500×10^6	0.23×10^6	1.73×10^6	0.49×10^6	0.22×10^6	1.94×10^6
Peeled						
Canned	3400	1550	10000	2500	1100	7600
Raw	0.42×10^6	0.19×10^6	1.54×10^6	0.46×10^6	0.21×10^6	1.96×10^6
Other	0.22×10^6	0.99×10^5	0.77×10^6	0.22×10^6	0.98×10^5	0.96×10^6
Breaded	0.92×10^5	0.42×10^5	0.23×10^6	0.96×10^5	0.44×10^5	0.29×10^6
Total	1.23×10^6	0.56×10^6	4.28×10^6	1.27×10^6	0.58×10^6	5.15×10^6

Source: U.S Deparment of Commerce, U.S Census Bureau

To determine the economic benefits of using preservatives, we consider their use for shrimp as an example. Phosphate and non-phosphate additives were used for about 5×10^5 tons of shrimp in 2011. Assuming that additives increase the weight by 10% and assuming that this loss occurs during storage and transportation, we then have the same 5×10^5 tons of shrimp with better taste and better preservation. Therefore, we preserve 5×10^4 tons of shrimp that we would have lost through dehydration with a cost of 2×10^4 tons of food additives, that is four tons of additives per 100 tons of seafood product. One ton of wholesale shrimp costs $8600 and one ton of preservative is $1300. Roughly, we would lose shrimp that is worth 400 million dollars through dehydration per year if we don't use preservatives, without taking capital and operating costs into account. Therefore, using preservatives on seafood products can save the consumers a large amount of money.

Conclusion

Water constitutes a high percent of the weight of seafood products, especially shrimp. In frozen condition for transportation or storage, the products lose water significantly. Using the right amount of phosphateor non-phosphate food additives not only helps to prevent dehydration in the product but also helps to preserve taste and appearance. Generally, food additives, especially non-phosphates help to provide high-quality frozen seafood products.

However, the temptation to abuse food additives for extra weight makes food preservatives a disreputable product. Customers pay for water at the price of shrimp. The National Oceanic and Atmospheric Administration (NOAA) is trying to control the amount of food preservatives used in seafood products. Phosphate-based reagents leave a P_2O_5 residue, that is hazardous for consumers. Non-phosphate based additives, on the other hand, don't leave any residue in food; thus it is impossible to trace the amount of preservatives that was used. Research is directed at making new food preservatives that do not increase the weight of a seafood product. Such a preservative would permit control of food preservatives and food safety for consumers.

Improvement in chemical technology allows us to have higher quality foods at lower cost. Development in chemical technology can economically provide safety and quality improvement for seafoods.

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