PANAMJAS
Pan-American Journal of Aquatic Sciences

Quality evaluation of frozen seafood (*Genypterus brasiliensis*, *Prionotus punctatus*, *Pleoticus muelleri* and *Perna perna*) previously treated with phosphates

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Abstract: Phosphates are natural components in almost all foods and are also used as functional food additives in food processing. In the seafood industry phosphates have a wide application for both fresh and frozen products and are proving many functional uses. The most important advantages of seafood phosphate treatment are increase water holding capacity, reduction of drip losses, nutrient retention and improve texture and tenderness. The objective of this research was to verify the potentiality of phosphates to reduce drip losses (after thawing, grilling and cooking) from important commercial species, pink cuskeel (*Genypterus brasiliensis*), searobin (*Prionotus punctatus*), mussel (*Perna perna*) and red shrimp (*Pleoticus muelleri*), with enjoyable sensorial attributes (appearance/color; juice/texture; flavour and taste) and utilizing phosphate quantities in accordance to international limits. Samples treated with 2% (searobin fillet) and 5% (pink cuskeel fillet, red shrimp and mussel) of phosphates solution (STTP: Sodium Tripolyphosphate; and BLEND: Sodium Tripolyphosphate + Sodium Tetra-pyrophosphate + NaCl) produced the greatest weight gains, lower phosphate concentration in final product and preference for phosphate treated product.

Key words: drip loss, water holding capacity, sensorial attributes, polyphosphates, legislation.

Resumo. Avaliação da qualidade do pescado congelado (*Genypterus brasiliensis*, *Prionotus punctatus*, *Pleoticus muelleri* and *Perna perna*) préviamente tratado com fosfato. Os fosfatos são componentes naturais de quase todos os alimentos e também são utilizados como aditivos alimentares funcionais no processamento de alimentos. Na indústria do pescado os fosfatos têm uma vasta aplicação tanto para produtos frescos como congelados e estão demonstrando sua funcionalidade. As principais vantagens do tratamento do pescado com fosfato são o aumento da capacidade de retenção de água, redução de perdas por gotejamento, a retenção de nutrientes naturais e melhoria de textura e maciez. O objetivo deste trabalho foi verificar a potencialidade dos fosfatos para reduzir perdas por gotejamento (após o descongelamento e cozimento), congrio rosa (*Genypterus brasiliensis*), cabrinha (*Prionotus punctatus*), mexilhão (*Perna perna*) e camarão vermelho (*Pleoticus muelleri*), mantendo os atributos sensoriais (aparência/cor; suculência/textura; odor e sabor) agradáveis e utilizando quantidades de fosfato de acordo com os limites internacionais. Amostras tratados com solução de fosfato a 2% (filé de cabrinha) e 5% (filé de congrio rosa, camarão vermelho e mexilhão) (STTP: Tripolifosfato de sódio; e BLEND: Tripolifosfato de Sódio + Tetrapirofosfato de Sódio + NaCl) produziram maiores ganho de peso, menor concentração de fosfato no produto final e a preferência por produto tratado com fosfato.

Palavras chave: perda por gotejamento, capacidade de retenção de água, atributos sensoriais, polifosfatos, legislação.

Introduction

Water is the largest portion, both volume and weight, in all edible seafood products. Fish proteins are more sensitive to changes during freezing, frozen storage, and thawing than others meats. Commercial practices have evolved to control, add and retain moisture during harvest, processing, distribution, storage and preparation (Schubring *et al.* 2003, Toldrá 2003).

Phosphates have a wide application in seafood industry as a quality-improving agent in aquatic product process; but it is forbidden to use it in some aquatic processes (Cui *et al.* 2000, Schnee 2000, Ünal *et al.* 2004, 2006). However, the effectiveness of phosphates in the properties of water retention in meat products depended on the type and on the amount of phosphates, as well as, on the type of product that was processed with their addition (Otwell 1992, 1993, Lampila 1992, 1993, Thorarinsdottir *et al.* 2004, Ünal *et al.* 2004, 2006).

According to Detienne and Wicker (1999), interactions of the polyphosphates with the muscular tissue and hydration and tenderization mechanism have not been completely understood. Some hypothetical factors discussed among several researchers have shown that the actions of the polyphosphates in the muscular tissue can happen due to (a) the increase of the pH of the meat, (b) the increase of the ionic force, (c) the quelation of metallic ions and (d) the dissociation of the actomyosin complex. The first and universal effect of all polyphosphate treatment is to increase the fish weight by retaining water. The weight gain is not only technological benefit but also represents to the producer a gain in weight of product sold. Polyphosphates should be added to fish only for technically justifiable purposes.

Little drip loss occurs when products are frozen quickly and stored properly, but if not, excessive drip loss can occur and render making the products unfit for consumption. It has been reported that the usage of polyphosphate dips increases water holding capacity of flesh and reduces drip and deterioration of the quality (Schnee 2000, Aitken 2001, Turan *et al.* 2003, Gonçalves 2005).

Polyphosphate treatment of fish before freezing often reduces the amount of thaw drip that is the liquid released when frozen fish is thawed. Good quality fish with properly frozen and cold stored, normally develops little thaw drip; therefore, application of polyphosphate to such material is generally only of slight value. The poor quality fish may drip much more after freezing and thawing stages and treatment will reduce the loss to some extend (Aitken 2001, Turan *et al.* 2003, Hunt *et al.* 2004).

The water holding capacity (WHC) involves an interaction between the protein or the proteic food and the water. The largest or smallest affinity of the protein with the water is also linked to other functional properties such as color, texture, firmness, softness and, above all, the juiciness (Sgarbieri 1996, Ordóñez-Peneda 2005).

The literature data showed that additional research is necessary to determine how phosphate treatments would affect yield losses for different sizes, cooked to reach a standard internal product temperature for common commercial species and sizes (Otwell 1993, Erdogdu *et al.* 2004, Garrido & Otwell 2004). No phosphate treatment is success unless the right product is used. Proper use of phosphate to influence the moisture content in seafood is currently in debate relative to regulatory concerns for adulterations vs. commercial concerns for "good manufacturing practices" (Tenhet *et al.* 1981 a,b, Lampila 1993).

Sodium tripolyphosphate (STPP) is one of the phosphates which belong to the family used in the seafood industry that can be used as humectant, i.e., substances that keep the moisture of the product. According to FDA (USCFR 2004), there is neither prohibition of the phosphates use in seafood nor a limit for their use. They can be used as a multifunctional substance without restrictions for specific alimentary products. The appropriate use will be controlled by the Good Manufacturing Practices. On other hand, International legislation (EPCD 1995, Codex 2001, CFIA 2004) liberates the use of phosphates in different seafood species, with multiple uses, but it cannot exceed the concentration from 0.1% to 1% with some restrictions.

Freezing and cooking can decrease the moisture content so as to adversely affect consumer acceptance. Studies have demonstrated that consumers prefer cooked seafood with higher moisture content (Otwell 1993, Teicher 1999).

The objective of this research was to verify the potentiality of phosphates to reduce drip losses (after thawing and grilling/cooking) from important commercial species, with enjoyable sensorial attributes and in accordance to international phosphates limits.

Materials and Methods

Raw material

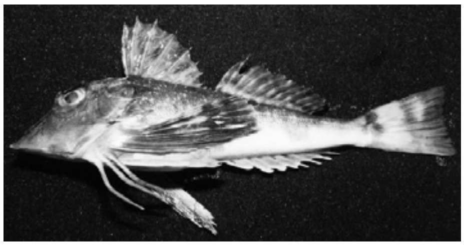
Fillets of pink cuskeel (*Genypterus brasiliensis*) and searobin (*Prionotus punctatus*), raw fresh red shrimp (*Pleoticus muelleri*) and mussel (*Perna perna*) (Figure 1) were obtained from Natubrás Pescados Ltda. (Piçarras, SC, Brazil).

All fillets were received in closed box with layers of fish fillets and ice (ratio 1:1) at 2°C. Fillets samples were washed in cold drinking water and divided by weight. Previous experiments showed that 150g and 120g representing weight for three fillets from pink cuskeel and searobin, respectively. Mussel samples were shelled and standardized in size 195 mussels per kilogram (half male and female). Shrimps samples were selected by size, de-headed, shelled but not deveined, standardized in size 133 shrimps per kilogram (counts/kg). For each experiment these weights were used, standarized (in triplicate) and immediately cooled on ice before being treated with phosphate and frozen. The seafood standardization was made due to the shape and thickness of the frozen fillets, shrimp and mussel, which are important factors that affect freezing process (Huan *et al.* 2003).

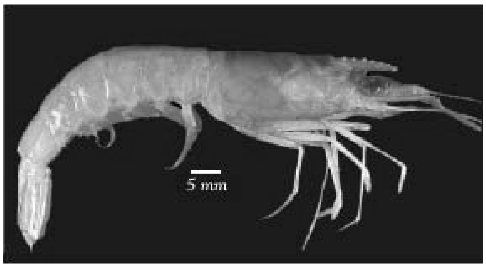
Phosphate application method

Samples of pink cuskeel fillets (tree fillets per treatment), shrimp and mussel (three groups of 300 g) were exposed to follow treatment: i) soaked in a 5% food grade sodium tripolyphosphate (STPP, Astaris); ii) soaked in a 5% blend solution (sodium tripolyphosphate + sodium tetra pyrophosphate + NaCl, Globalfood); iii) soaked in drinking water (control group). Samples of searobin fillets were exposed to the same treatment but at 2% phosphate concentration. The soaking time (120 min at 2°C) and phosphates concentration were chosen by previously experiments (Gonçalves 2005, Rech 2005, Rodrigues 2005, Pucci 2006). After soaking samples were drained for 30 seconds on a stainless steel mesh strainer (0.30 mm), weighed and submitted to a freezing process. Three replications for each group were accomplished.

Pink cuskeel, *Genypterus brasiliensis*



Searobin, *Prionotus punctatus*



Red shrimp, *Pleoticus muelleri*

Mussel, *Perna perna*

Figure 1. Seafood utilized (Costa *et al.* 2003 and Fish Base 2007).

Freezing method

For the individual freezing (IQF) samples were frozen under -30°C (ultrafreezer FREEGEL – FHBT300) until the core temperature reached -20°C (around 24 hours). For the best protection samples were submitted to glazing procedure, standardized following the industrial process (reaching plus 15% of weight) and according to methodology described by Gonçalves (2005) by dipping samples into a cold water container (1°C) for 10 seconds and then packaged in plastic bags, weighed and stored at -18°C for 15 days until the thawing and cooking process.

Drip loss evaluation

The quality parameters analyzed for this purpose were drip loss during thawing, after grilling (fish fillets) and cooking (shrimp and mussel), adapted from Campañone *et al.* (2002) and were expressed as DL:

$$DL = [(W_0 - W_F)/W_0] \times 100\ (\%) \quad \text{Eq. 1}$$

Where W_0 is the initial sample weight and W_F is the final sample weight (in grams).

Thawing loss of thawed samples was determined through the known weights of samples before and after thawing and expressed as % thawing loss (Eq. 1). Samples were thawed in a cold room (4°C) for 24 hours (according to Regenstein *et al.* 1993) and weighed to calculated drip loss after thawing (DLT). The cooking/grilling loss (DLG =

drip loss after cooking/grilling) was calculated as previously described for the thawing loss.

Changes on product weight were based on the difference of weights following the phosphate treatments, freeze–thaw cycle, and grilling/cooking–cooling procedure. Each experimental value represents the average of three determinations.

Grilling process

Samples were grilled using the standard cook procedure by García-Arias *et al.* (2003). Grilling of fillets was performed on a stainless steel grill. Grill thermostat was set at 350°C. Fish fillet grilling lasted 3 min. To ensure uniform grilling/heating, sample inside temperature was controlled using a quartz electronic thermometer, and the process ended when fillets internal temperature raised 60–70°C. To keep the fish from sticking, the grill was slightly sprinkled with salt, before grilling.

Cooking process

Samples were boiled using the standard cook procedure by Applewhite *et al.* (1993), where the water was brought to boiling, the shrimp added, the water boiled again and the shrimp boiled for 1 minute (total approximately 2 minutes); and for mussel samples, the cooking time was 4 minutes. After cooking, samples were drained on a stainless steel mesh strainer (0.30 mm) at room temperature (24°C) for 1 minute before being weighed. Preliminary experiments (Gonçalves 2005, Rech 2005) showed that yield loss did not change after 2 minutes during cooling at this room temperature.

Phosphate determination

The method for the determination of phosphates in processed seafood is capable of confirming the use of STPP. Quantitative results should preferably be reported in terms of a total concentration of pyrophosphate + tripolyphosphate (expressed as % P_2O_5). Thus, phosphates concentrations (P_2O_5%) in raw and phosphate treated samples were obtained by colorimetric determination (spectrophotometry), which is used when the amount of phosphorus is small. The procedure was followed the methodology of Instituto Adolfo Lutz (1985) and were done in triplicate.

Sensorial evaluation

A quantitative descriptive analysis (QDA) was performed with the presence of a staff of 40 non-trained panellists randomly recruited and pre-screened by a familiarity with eating grilled fish fillets and boiled shrimp and mussel. Judgments were based on sensory attributes (appearance, flavour, taste and texture) of grilled and boiled samples and were asked to use an unstructured 9 cm line scale to grade the samples. Each person received 3 hot samples at 50°C for evaluation (Teixeira *et al.* 1987, Dutcosky 1996).

Statistic analysis

The results were analyzed using the statistical package SPSS (version 13). For their interpretation the analysis of variance (ANOVA) was used. The significant difference ($p<0.05$) among treatments was evaluated with Tukey's test.

Results

Phosphates action and weight variation

According to Turan *et al.* (2003) neither phosphate usage nor glazing treatment was effective when used by itself to prevent drip loss in frozen rainbow trout. However, the combination of glazing + packaging did prevent drip loss and protect the moisture content of the inner and surface layers of the product.

Thorarinsdottir *et al.* (2004) proved that the effectiveness of phosphates in the properties of water retention in meat products depended on the type and on the amount of phosphates, as well as on the type of product that was processed with their addition.

As expected, treatment with phosphates solution caused an increase in weight of both samples, due to a net increase in moisture content as a consequence of water binding properties of proteins (Figure 2). Searobin fillets retained more moisture than pink cuskeel fillets, inclusively after thawing and grilling procedure. Mussel samples retained more moisture than shrimp samples after thawing and cooking procedure. Blend phosphate promoted higher moisture uptake than STPP. These results were in agreement to muscle phosphates content founded in all samples (Table I).

Its interesting notes that searobin fillet is thinner than pink cuskeel fillets which phosphate diffusing into the tissue with more efficacy (Figure 2). Care should also be taken when phosphates are applied to fish with different thickness, different parts of muscle, different species and the content of initial moisture.

Commercial experience and researches has demonstrated that phosphates can enhance sensory quality and increase consumer appeal for shrimp. The proper use of phosphate in most shrimp results in better product performance and does indeed provide sensory benefits to the consumer. The acceptable or optimal level was 5-8% (target uptake) (Garrido & Otwell 2004).

An increase of weights was observed for all groups (shrimp, mussel, pink cuskeel and searobin) after immersion in water (3%, 1%, 0%, 11%), in STPP solution (7%, 17%, 5%, 18%) and in Blend solution (9%, 20%, 7%, 18%) respectively. The blend solution promotes more weight increase than others groups (Figure 2) and for mussel and searobin the phosphate action was more intense.

Similar results were obtained by Erdogdu *et al.* (2004) for shrimp (8.6%) in the same size (135-155) and 4% STPP solution. According to Schnee (2000) optimum results are obtained if fillets or pieces of meat are dipped or washed raw in a 2 to 6% phosphate solution until approximately a 0.5% phosphate addition results in the product. Some fish species need less than one minute dipping time to reach this addition, but others do not exceed this level even after prolonged exposure. Phosphate solutions are most effective and controllable when used in direct contact with the fish meat and they should only be used once. Phosphates do not penetrate skin or bones. For better penetration the meat or fillets can also be phosphated by tumbling in vacuums or with injection.

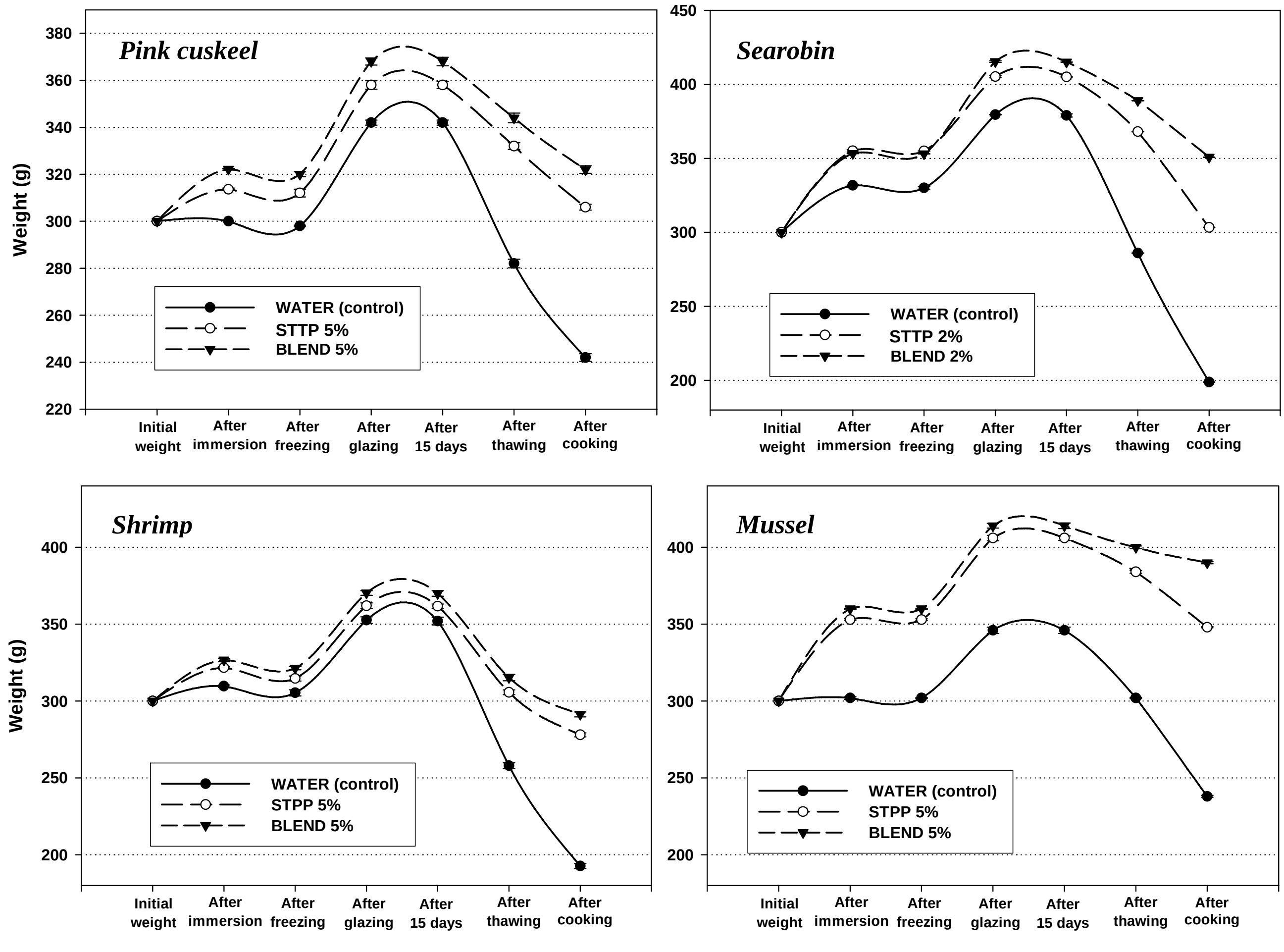


Figure 2. Weight variation during freezing, thawing and cooking.

Phosphate concentration

Tenhet *et al.* (1981b) comment that natural variation in phosphorous level occurs and breakdown of STPP during treatment and frozen storage could interfere in phosphate determination. The results obtained for samples treated with phosphates (STPP and Blend) are shown in Table I. Phosphates (P_2O_5 %) were detected in all samples but at lower percentage than the international legislation (0.5% to 1%).

Heitkemper *et al.* (1993) comment that STPP is the most commonly used phosphate in the processed shrimp industry and current legislation limit in USA its use in accordance with Good Manufacturing Practices, but the potential exists for economic fraud through mislabelling or excessive use of STPP.

Table I. Phosphate concentration (P_2O_5%).

SAMPLES		Phosphate (P_2O_5 %) (mean ± sd)	International Legislation* (P_2O_5 %)
pink cuskeel fillets	raw (control)	0.090 ± 0.001	GMP (USA) 0.5% (Canada) 0.5% (European Union) 1% (Codex)
	STPP 5%	0.145 ± 0.007	
	Blend 5%	0.345 ± 0.020	
Searobin fillets	raw (control)	0.097 ± 0.004	
	STPP 5%	0.194 ± 0.018	
	Blend 5%	0.213 ± 0.019	
Shrimp	raw (control)	0,323 ± 0,003	GMP (USA) 0.5% (Canadá) 0.5% (European Union) 1% (Codex)
	STPP 5%	0,421 ± 0,005	
	Blend 5%	0,457 ± 0,003	
Mussel	raw (control)	0,092 ± 0,006	
	STPP 5%	0,114 ± 0,016	
	Blend 5%	0,230 ± 0,030	

* EPCD (1995), Codex (2001), USCFR (2004), CFIA (2004).

There is a risk of producing false-negative and-positive results when inorganic polyphos-phatesare to be quantified in fish and meat. Inorganic di- and triphosphates (limit of detection < 0.5 mg/kg) are neither naturally present in fishnor the product of a degradation reaction during storing/transporting of the animal/tissue or a processing of the sample. Traces of inorganic polyphosphates are to be considered as an indication that the sample has undergone a previous treatment with polyphosphates (Kaufmann *et al.* 2005).

Drip loss evaluation

Phosphates had the strongest effects on yield after thawing and thermal process (i.e., grilling and/or cooking) when compared with control sample. Drip loss after thawing (Table II) was higher for untreated samples when compared to samples treated with phosphate. Drip losses after thawing for searobin fillets samples was higher than pink cuskeel fillets and higher for shrimp treatments, but in lower proportion when phosphates were used and it can be suppose that phosphates had different actions for each seafood product and each specie had different behaviour.

According to Erdogdu *et al.* (2004) STPP treatment involves a diffusion process, and the amount of STPP reaching inside the samples was less in the larger size because of higher diffusion thickness. Theirs results showed similar results for shrimp treated with 4% STPP (20.3%) and control (26.8%); and comment that as size decreased, the final moisture difference between STPP concentrations decreased. It is expected that larger surface-to-volume ratio of small shrimp resulted in better absorption of STPP into the volume. This drip loss could be due to the freezing process or to shrimp size that has a direct influence on thawing drip loss.

According to Schnee (2000) cooking losses for frozen seafood are usually 10 to 30%. All data presented in Table II had high drip loss (after thawing/cooking) but when treated with phosphates showed lower losses. Phosphates blend were more effective to prevent yield losses (retained more moisture) compared to STPP.

Aitken (2001) comment that fish treated with phosphates before freezing often reduces the amount of thaw drip (i.e, liquid released when frozen fish is thawed).

Good quality fish, properly frozen and cold stored, normally develops little thaw drip; therefore application of polyphosphate to such material is generally only of slight value but stored at too high a temperature may have a high thaw drip loss, and again polyphosphate treatment before freezing can reduce the loss, but this does nothing to prevent the corresponding deterioration in flavour and texture; there is no substitute for good cold storage. The higher drip loss showed by control groups indicate that then freezing process (ultrafreezer at -30°C for 24 hours) could interfered.

Poor quality fish when frozen and thawed may drip much more, and treatment will reduce the loss to some extension, but this is not sufficient reason for using polyphosphates; poor quality fish should not be frozen, since the product will be poor irrespective of treatment. For these experiments, all samples were used as fresh as possible.

Table II. Drip loss.

	Treatments	*Drip loss* (%)	
		DLT	**DLC**
pink cuskeel	**Control**	17.54 ± 1.79^a	14.20 ± 1.63^a
	Treated with 5% STPP	7.26 ± 1.43^b	7.83 ± 1.26^b
	Treated with 5% Blend	6.52 ± 1.07^b	6.40 ± 1.63^c
searobin	**Control**	24.53 ± 0.09^a	$30.\ 45 \pm 0.04^a$
	Treated with 2% STPP	9.14 ± 0.04^b	17.60 ± 0.12^b
	Treated with 2% Blend	6.30 ± 0.04^c	9.83 ± 0.03^c
shrimp	**Control**	26.70 ± 0.42^a	25.30 ± 1.25^a
	Treated with STPP	15.50 ± 0.56^b	9.10 ± 0.30^b
	Treated with Blend	14.80 ± 0.58^c	7.72 ± 0.44^c
mussel	**Control**	12.70 ± 0.71^a	$21.\ 20 \pm 0.75^a$
	Treated with STPP	5.40 ± 0.32^b	9.40 ± 0.12^b
	Treated with Blend	3.38 ± 0.18^c	2.50 ± 0.73^c

Note: mean±sd (n = 03); same letters in the column are not significantly different ($p \geq 0.05$).

Sensorial evaluation

According to Shahidi & Botta (1994) sensory quality of seafood is defined as a complex set of characteristics including appearance, aroma, taste and texture. Thermal processing changes the sensory and textural properties of fish, partly due to the denaturation of proteins.

Texture is considered to be the most important sensory quality since it may change dramatically during extended cooking while the characteristic flavour develops relatively early during the process and does not change substantially after prolonged heating (Erdogdu & Balaban 2000).

The thermal process during grilling fillets was higher (350°C for 3 min) and could change the sensorial evaluation. For shrimp and mussel the temperature was lower. The sensorial results (Table III and Figure 3) showed an improvement quality for all samples after phosphates treatment, but lower for fish fillets when compared to shrimp and mussel.

Polyphosphates cannot significantly improve the eating quality of fish, although claims in this respect are often made. Excessive treatment of small products such as thin fillets can even result in undesirable flavour changes and sloppy texture (Aitken 2001).

Panellist's evaluations indicated preference for the treated product and did not found significant differences between fish fillets phosphates treatment except in searobin fillets (taste and texture, Table III) where blend was the best treatment.

A distinct preference for phosphated shrimp than mussel was verified. Shrimp samples had the best notes when compared with mussel samples maybe due the fact of panellists were familiarized more to shrimp than mussel in their diet.

The retention of moisture and ability to hold water in cooked product can provide a consumer benefit in terms of texture (higher notes). For other sensorial attributes there was no distinct objection to phosphated product.

It can be observed that soaking seafood samples in phosphate solution prior to cooking resulted in their tenderization compared to controls.

It has been concluded that phosphate resulted in the weakening of muscle fibre structure and the swelling of its protein gel systems, thus increasing water holding capacity. Sensory panellists commented the texture of product treated with phosphate as juicy or similar to fresh product.

In all cases, panellists generally felt the phosphated seafood meet their expectations and they liked and judged the products to be high quality and valued more than non-phosphated product. These expectations were in accordance with results obtained by Applewhite *et al.* (1993).

Then, we could conclude that phosphates are an indispensable additive for the maintenance of the functional properties of the seafood myofibrillary proteins which helps the preservation of the muscle integrity, inhibits the drip loss and helps to prevent the economic loss during the thawing and the cooking.

Table III. Sensory evaluation of cooked samples.

Sensorial attributes	Control	treated with STPP	Treated with Blend
Pink cuskeel fillets			
Appearance	2.96 ± 1.27[a]	3.83 ± 1.01[b]	4.04 ± 1.12[b]
Flavor	3.54 ± 0.93[a]	3.79 ± 1,10[a]	3.54 ± 1.10[a]
Taste	3.13 ± 1.12[a]	3.54 ± 1.28[a]	3.58 ± 1.35[a]
Texture	2.71 ± 1.16[a]	3.88 ± 1.15[b]	3.79 ± 1.06[b]
Searobin fillets			
Appearance	2.95 ± 0.92[a]	3.95 ± 0.92[b]	4,08 ± 0.77[b]
Flavor	3.31 ± 0.66[a]	3.82 ± 0.88[b]	3,98 ± 0.75[b]
Taste	2.97 ± 0.90[a]	3.62 ± 1.11[b]	4,07 ± 0.84[c]
Texture	2.82 ± 1.02[a]	3.82 ± 1.02[b]	4,26 ± 0.64[c]
Shrimp			
Appearance	5.45±0.39[a]	6.80±1.05[b]	6.91±1.08[b]
Flavor	5.91±0.79[a]	6.55±0.58[b]	6.49±0.80[b]
Taste	5.55±0.43[a]	6.56±0.45[b]	6.92±0.62[c]
Texture	5.50±0.75[a]	7.50±0.41[b]	7.89±0.40[c]
Mussel			
Appearance	2.90 ± 1.48[a]	4.70 ± 1.42[b]	5.85 ± 1.14[c]
Flavor	2.55 ± 1.50[a]	4.55 ± 0,89[b]	5.15 ± 1.23[b]
Taste	2.65 ± 0.99[a]	4.45 ± 1.23[b]	5.55 ± 1.15[c]
Texture	2.45 ± 1.32[a]	5.00 ± 1.05[b]	5.65 ± 0.99[c]

Note: same letters in the line are not significantly different ($p \geq 0.05$); mean±sd; n = 40

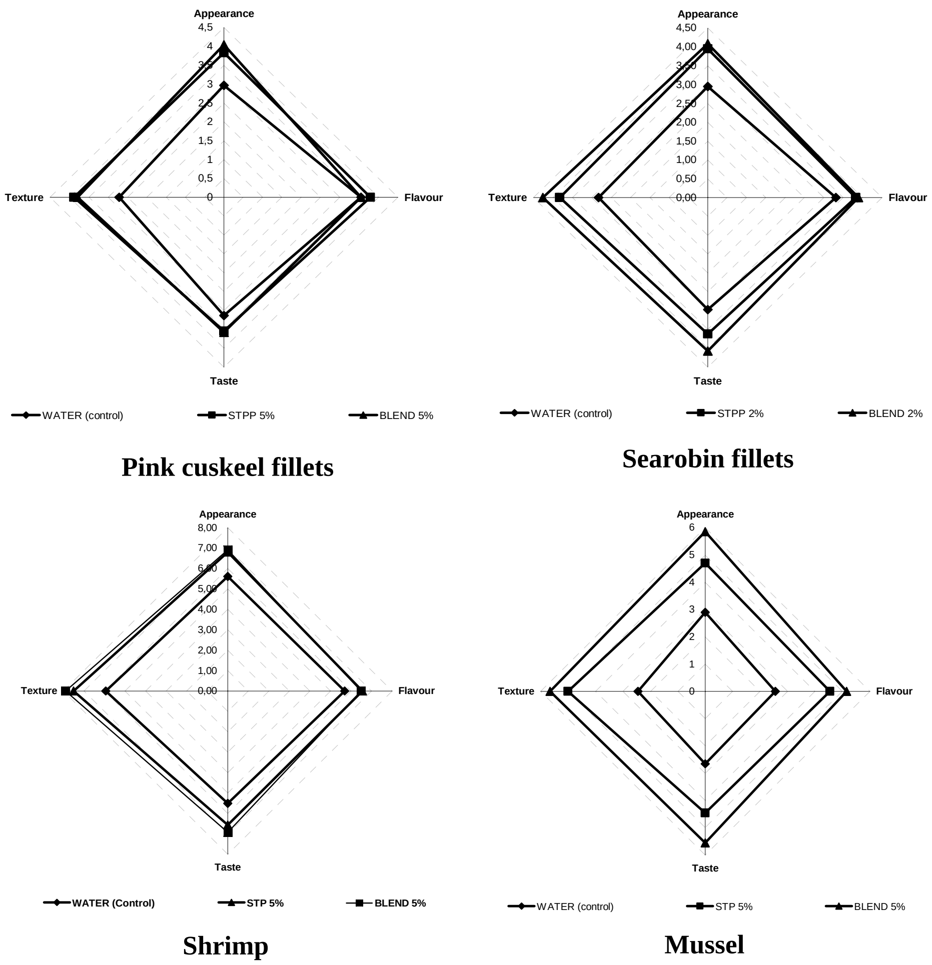


Figure 3. Sensorial evaluation of cooked samples.

Conclusions

Results indicated that dipping: i) searobin and ii) pink cuskeel fillets, shrimp, mussel in 2% and 5% STPP and Phosphate Blend solutions, respectively, can be used to prevent the large thawing and cooking-related yield losses.

Panellists evaluation have demonstrated a similar preference for fish fillets treated with phosphates, and a distinct preference for shrimp and mussel treated with phosphates, mainly blend treatment in both samples.

Phosphate treatment should be just enough to produce the desired technological effect and no more. The continued use of phosphates to treat seafood remains in question. Proper use has not been appropriately defined in commercial practice or regulation. The responsibility to resolve this situation in the best interest of commerce and consumers will rely on industry action.

Acknowledgements

The author gratefully acknowledges Mr. José Félix Duarte, Mr. Eduardo José da Borba Duarte, for having opened the company Natubrás Pescados Ltda. for the execution of this work and to Eng. Estevam Martins for kindly support during the practical execution of this work.

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Received February 2008
Accepted April 2008
Published online August 2008