EVALUATION OF SEAFOOD QUALITY MARKET IN BAIXADA SANTISTA/SP*

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ABSTRACT

Two hundred and fifty-seven (257) fresh seafood samples from different points of the Baixada Santista production chain were analyzed for sensorial, microbiological, physicochemical, chemical and parasitological aspects. To collect samples, a partnership was established with Federal Inspection Service (FIS), Inspections Service of São Paulo State (ISSP), and Sanitary Surveillance Service (SSS) from eight cities of Baixada Santista region. This study aimed to facilitate implementation of public policies that improve quality of seafood marketed to the population of Baixada Santista region. Ninety-four percent of analyzed seafood presented at least one parameter in violation of present national law, indicating a risk to public health in all links of the fresh marine seafood production chain.

Keywords: Production chain; food security; safety

AVALIAÇÃO DA QUALIDADE DO PESCADO MARINHO COMERCIALIZADO NA BAIXADA SANTISTA/SP

RESUMO

Foram analisadas 257 amostras de pescado marinho resfriado, provenientes de diferentes pontos da cadeia produtiva da Baixada Santista, quanto aos aspectos: sensorial, microbiológico, físico-químico, químico e parasitológico. Para a coleta de amostras foram estabelecidas parcerias com o Serviço de Inspeção Federal (SIF), Serviço de Inspeção do Estado de São Paulo (SISP) e Serviços de Vigilância Sanitária (SEVISA) de oito municípios da região da Baixada Santista. Este estudo teve por objetivo subsidiar a implantação de ações de políticas públicas que resultem na melhoria da qualidade do pescado ofertado à população da Baixada Santista. Noventa e quatro por cento do pescado analisado apresentou algum parâmetro em desacordo com a legislação nacional vigente, indicando situação de risco à saúde pública em todos os elos da cadeia produtiva do pescado marinho resfriado.

Palavras chave: Cadeia produtiva; segurança alimentar; inocuidade

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INTRODUCTION

Healthy seafood is an important source of protein, minerals, vitamins and unsaturated fatty acids, especially omega-3. It is a highly perishable food whose quality is influenced by many factors including size, freshness degree, specie, capture method, onboard handling, capture zone, sex, reproduction period, chemical composition, handling and storage methods (ORBAN *et al.*, 2008). The process of seafood deterioration occurs by the action of microorganisms or endogenous enzymes, contamination by parasites, pathogenic bacteria, organic and inorganic compounds and/or possible sensory alteration (HUSS *et al.*, 2004).

The introduction of biological, physical and chemical hazards directly affects seafood quality and can occur during any stage of the production chain, from capture to the consumer's table (TEIXEIRA *et al.*, 2009; MACHADO *et al.*, 2010).

Although food contamination has many possible origins, principle causes are poor personal hygiene as well as the inadequate cleaning of utensils, equipment, and surfaces that come in contact with food (AZEVEDO *et al.*, 2008). Temperature control during food production and distribution steps is the most important factor in ensuring the quality of fishery products (BRAMOSRKI *et al.*, 2005).According to VIEIRA and SAKER-SAMPAIO (2004), ice that is utilized for seafood conservation must be from a recognized source to assure seafood quality. Present law (BRASIL, 1991) requires that all products of animal origin must have been submitted to previous inspection, but Sanitary Surveillance is also fundamental to sanitary-hygienic control of product that is being marketed (GONÇALVES, 2008).

The aim of this study was characterize sanitary marine seafood samples from many points along the production chain: boats, factories, open-air markets, fishmongers, markets, and supermarkets from Baixada Santista, SP, Brazil, using as tools sensorial, microbiological, physicochemical, chemical, and parasitological analysis.

MATERIAL AND METHODS

Sampling

A partnership was established with the Federal Inspection Service (FIS), Inspection Service of São Paulo State (ISSSS) and Sanitary Surveillance Service (SSS) of eight cities from Mata Atlântica Coast (Bertioga, Santos, Guarujá, São Vicente, Praia Grande, Mongaguá, Itanhaém, and Peruíbe) for sampling. These services evaluated during February of 2004 to February of 2006, 257 fresh seafood samples from the place where inspection service acts. The samples were taken randomly and the places of sampling were chosen by inspection service. Each sample was composed of only single fresh seafood (Table 1) from fishermen, market, and industry. Due to all these species of fish was not always present in establishment, it was sampled randomly one of each species described in Table 1 until complete a total of 3 kg per sample for fish whole or gutted, and 1 kg for fillet. Then, those samples were submitted to sensorial, physicochemical, chemical, microbiological, and parasitological analysis.

Sensorial analysis

Sensorial analysis evaluated freshness of seafood, using tables with points for organoleptic properties based on a numerical rating system, adapted by descriptive scales (SHEWAN and EHRENBERG, 1957; BRASIL, 1997a) for each specie analyzed, which classify the sample as excellent, good, average or unacceptable.

Microbiological analysis

For swab test was used three surface of fish sampled and for coliforms swabs were rubbed in two areas of 2 x 5 cm (10 cm^2) delimited by metallic molds in dorsal region of fish. Then, swabs were introduced in tubes, which contained 5 mL of 0.1% peptone water, followed by serial decimal dilutions. After this procedure, it was made inoculation in Petrifilm Plate (3M) that differ total from fecal coliforms (*Escherichia coli)*. For *Staphylococcus aureus* analysis, it was used Baird-Parker (BP) plates. The material was incubated at 35ºC for 48 hours and the result was express in colony forming unit/cm^2.

The *Salmonella* spp. research was performed by passing swab in all fish surface, followed by immersion in lactose broth and detection of deoxyribonucleic acid with polymerase chain reaction (PCR), using the system BAX ®. In this case, the result obtained was positive or negative for each sample.

Table 1. Fish species sampled for sensorial, physic-chemical, chemical, microbiological and parasitological tests.

Popular name	Scientific name	N	N/Presentation form
Acoupa weakfish	*Cynoscion acoupa*	3	1/whole 2/fillet
Albacore	*Thunnus alalunga*	2	2/whole
Angler	*Lophius gastrophysus*	2	2/gutted
Argentine croaker	*Umbrina canosai*	2	2/gutted
Argentine hake	*Merluccius hubbsi*	2	2/whole
Atlantic moonfish	*Selene setapinnis*	1	1/whole
Banded croaker	*Paralonchurus brasiliensis*	1	1/whole
Bandwing flying fish	*Cheilopogon exsiliensis*	1	1/whole
Bigtooth corvina	*Isopisthus parvipinnis*	26	14/whole 12/fillet
Black grunt	*Haemulon bonariense*	2	2/whole
Bluefish	*Pomatomus saltatrix*	4	2/whole 2/fillet
Bluespotted searobin	*Prionotus roseus*	9	7/whole 2/fillet
Brazilian codling	*Urophycis brasiliensis*	7	4/whole 3/fillet
Brazilian menhaden	*Brevoortia aurea*	2	1/whole 1/gutted
Brazilian sardinella	*Sardinella braziliensis*	28	28/whole
Brazilian stargazer	*Astroscopus sexspinosus*	1	1/fillet
Caribbean sharpnose-puffer	*Canthigaster rostrata*	1	1/gutted
Castin leatherjacket	*Oligoplites saliens*	3	3/fillet
Coney	*Cephalopholis fulva*	1	1/whole
Couma sea catfish	*Sciades couma*	1	1/gutted
False herring	*Harengula clupeola*	1	1/whole
Flathead grey mullet	*Mugil cephalus*	16	14/whole 2/fillet
Florida pompano	*Trachinotus carolinus*	2	2/whole
Great barracuda	*Sphyraena barracuda*	1	1/whole
Green weakfish	Cynoscion virescens	1	1/whole
King weakfish	*Macrodon ancylodon*	39	33/whole 6/fillet
Ray	*Dasyatis* sp.	1	1/whole
Ocean sunfish	*Mola mola*	2	2/fillet
Red porgy	*Pagrus pagrus*	1	1/whole
Rough scad	*Trachurus lathani*	1	1/gutted
Serra Spanish Mackerel	*Scomberomorus brasiliensis*	5	3/whole 2/fillet
Shorthead drum	*Larimus breviceps*	1	1/whole
Smalleye croaker	*Nebris microps*	4	4/whole
Southern kingcroaker	*Menticirrhus americanus*	16	14/whole 2/fillet
Striped weakfish	*Cynoscion striatus*	3	3/whole
Whitemouth croaker	*Micropogonias furnieri*	56	49/whole 7/fillet
Yellow drum	*Nibea albiflora*	1	1/whole
Yellowtail sanpper	*Ocyurus chrysurus*	5	5/whole
Total		**257**	**257**

Physic-chemical analysis

The pH was determined according to the Analytical Standards of the Adolfo Lutz Institute from muscle of each fish sampled after homogenization (SÃO PAULO, 1985). Total volatile base nitrogen (N-BVT) was quantified by the method described by BRASIL (1998), modified for the use of trichloriacetic acid at a concentration of 7.5%. Substances reactive to thiobarbituric acid (TBA) were determined by Vincke's method (VINCKE, 1970).

Chemical analysis

Muscle homogenized of samples was submitted to chemical analysis. The content of inorganic contaminants (cadmium, chromium, copper, nickel and lead) was evaluated by the dry route digestion method (HORWITZ, 2000) and quantification by inductively coupled plasma optical emission spectroscopy (IPC OES). Arsenic was also analyzed by the dry method and via IPC OES (MELLO *et al*., 1999), while mercury was assessed by the method of MORGANO *et al*. (2005).

Parasitological analysis

Parasites were analyzed by microscopic observation and fillet inspection using a candling table. For nematodes Amato's technique (AMATO *et al*., 1991) was applied, whereas to identify trematodes, homogenization and the sedimentation technique described by COELHO *et al*. (1997) were used.

For all analysis, samples that present value in accordance with Brazilian law were submitted to percentage calculation considering the total of the samples analyzed and origin of seafood (boats, factories, open-air markets, fishmongers, markets, and supermarkets).

RESULTS

Sensorial Analysis

Sensory analysis, one of the most commonly used methods by which the Inspection Services rapidly evaluate the freshness of seafood, indicated that 92.99% (239/257) of total samples were classified as "Good" or "Excellent".

Considering all links of production chain, factories had the highest percent of samples rated "Excellent" (5.83% - 15/257) and "Good" (2.3% - 6/257); however, the other links in the chain most often presented the "Good" rating. Only one of the 257 (0.38%) of the boat samples analyzed was found to be "Average" by sensory analysis (Table 2).

Table 2. Summary results of sensorial, microbiological, physic-chemical, chemical and parasitological analysis.

Analysis	Test	Value (%)
Sensorial	Average	0.4 (1/257)
	Regular	6.7 (17/257)
Microbiological	*Salmonella* spp.	Absence (0/257)
	Staphylococcus aureus	Absence (0/257)
	Coliforms	86.0 (221/257)
	Escherichia coli	0.7 (2/257)
Physic-chemical	pH	51.4 (132/257)
	N-BVT	2.4 (6/257)
	TBARS	16.3 (42/257)
Chemical	Arsenic	59.0 (151/257)
	Chromium	6.0 (15/257)
	Mercury	0.8 (2/257)
	Cadmium	0 (0/257)
	Copper	0 (0/257)
	Nickel	0 (0/257)
	Lead	0 (0/257)
Parasitological	Anisakidae	18.2 (47/257)
	Ascocotyle longa	6.22 (16/257)

The "gutted" form of presentation at open-air markets, supermarkets, fishmongers, and market links (Municipal or Wholesaler) obtained a "Good" rating in 100% (257/257) of samples.

Microbiological analysis

Eighty-six percent (221/257) of samples showed values of total coliforms between 10^1 and 10^5 CFU cm^{-2}. Two samples found at open-air and market locations presented fecal contamination by *Escherichia coli* (Table 2).

Physic-chemical analysis

The pH varied from 5.73 to 7.88, while 51.36% (132/257) of samples showed values up to 6.8, the maximum level permitted by current Brazilian law (BRASIL, 1997a) as shown in Table 2. Only 1.94% (5/257) had a pH below 6.5, the fixed limit set for the internal condition of seafood muscle tissue (BRASIL, 1997a). Among links of the production chain, industry had the lowest numbers of seafood samples with an inadequate pH value, 2.33% (6/257).

As to the parameter total volatile base nitrogen (N-BVT), six of the total samples exceeded the quantity of 30 mg N/100 g of seafood (Table 2), the limit that qualifies fresh seafood as proper to consume (BRASIL, 1997b). In supermarkets 1.55% (4/257) of total samples presented unsatisfactory results for total volatile base nitrogen, of which 50% (2/2) were fillet.

TBA results varied from 0.08 to 23.39 mg of malonaldehyde kg^{-1} of seafood, while 16.3% (Table 2) of samples presented values greater than 2 mg MAL kg^{-1}, with rancid flavor characteristics and indicative of lipid oxidation in advanced stage.

Chemical analysis

Fifty-nine percent of samples (151/257) of different species sampled from distinct places showed at least one sample contaminated by a chemical element (BRASIL, 1998), which 58.75% (151/257) exceeded established limits for arsenic (from 0.09 to 35.08 mg kg^{-1}), 6.22% (16/257) for chromium (from 0.28 to 0.5 mg kg^{-1}), and 0.77% (2/257) for mercury (BRASIL, 1998). No sample showed contamination by cadmium, copper, nickel or lead. Although two samples were observed (swordfish and catfish) with mercury values above 0.5 mg kg^{-1}, the other samples presented acceptable values for total mercury (Table 2).

Parasitological analysis

Of the 257 samples analyzed, 24.51% (63/257) were found to be parasitized by nematodes of the family Anisakidae and trematodes of the species *Ascocotyle longa* (Table 2) which is classified as zoonotic.

Of the 49 samples parasitized by Anisakidae family nematodes, 8.16% (4/49) were *Anisakis* spp., 85.71% (42/49) *Contracaecum* spp., and 6.38% (3/47) *Pseudoterranova* spp., while the most parasitized fishes were of the families Scianidae and Mugilidae. The parasite *A. longa* was present in 100% (16/16) of the flathead grey mullet analyzed (*Mugil cephalus*).

DISCUSSION

Fresh marine seafood available to the population, marketed in open-air markets, municipal markets, and supermarkets of Baixada Santista presented poor quality that translates into the risk for the consumer, a fact that, according to PÉREZ *et al*. (2009), is probably attributable to negligence in maintenance of the low-temperature portion of the chain, which exposes the consumer to many hazards, thus requiring more attention from responsible agencies.

Although the seafood sampled from boats was ranked "Average" in only 0.4% of the cases, this initial link in the marine seafood production chain is a critical point, in contrast to the results found by PEREIRA and TENUTA-FILHO (2005), who observed reduction of seafood quality throughout the production chain, presenting the highest quality in boat seafood. Present research suggests the occurrence of inadequate practices on board, indicating a need to create and implement Good Onboard Practices, as used daily in the activities of properly operated fisheries (MACHADO *et al*., 2010).

All the gutted seafood obtained from the open-air markets, supermarkets, fishmongers and markets (Municipal or Wholesaler) was rated "Good", probably due to removal of significant loads of microorganisms normally presented, thereby removing contamination foci and unpleasant odors by washing fish in the establishment (OGAWA and MAIA, 1999).

Although a large portion of the seafood analyzed by sensorial analysis received a rating of "Good", it was not possible to discern a relationship between this analysis and the other physicochemical parameters evaluated. Sensorial analysis is based on general parameters and presents low specificity, since it permits classification of only seafood freshness degree as unacceptable, average, good and excellent, thus confirming the need for complementary analysis to determine seafood quality, by such means as microbiological, parasitological, chemical, and physicochemical analysis.

The results of microbiological analysis showed that all samples studied were in accordance with the established microbiological standards (BRASIL, 2001). The presence of total coliforms may or may not indicate contact with organic matter from fecal origin, highlighting deficiencies related to the hygiene of local and/or seafood handlers in all links of the production chain. Resolution RDC 12 (BRASIL, 2001), which specifies microbiological and sanitary standards for food in Brazil, does not consider this risk, but the climate conditions of region (temperature above 30°C in summer and rarely below 18°C in winter) may account for the faster proliferation of the initial microbial load (GERMANO and GERMANO, 1998), and thereby demonstrate the potential risk of the transmission of enteric pathogens to consumers.

All evaluated samples showed an absence of *Salmonella* spp. and *Staphylococcus aureus*, while only two presented contamination by *E. coli*. However, *E. coli* presence, which is an apt fecal contamination index, demonstrates a need for greater attention related to hygiene in all links of the seafood production chain.

The pH results reveal the presence of conditions favorable to the survival and development of microorganisms, indicating risk to health due to the ingestion of raw or insufficiently cooked seafood. The lower pH incidence of seafood inadequate in relation to industry standards could be due to the fact that establishments in that region possess their own warehouse, minimizing the risk of seafood exposure to inadequate temperatures, in addition to the rapid flow presented by the steps in unloading vessels and transporting their products to industry.

Although the pH parameter in isolation does not reflect food quality, it should be emphasized that the occurrence of a pH above the legal limit was observed in links that market a higher quantity of product, namely the supermarkets and wholesaler markets. BRAMOSRKI *et al*. (2005) also observed negligence and misinformation in large supermarkets as to the importance of temperature control of refrigeration equipment, which can change pH values, showing the need for sanitary surveillance service to control and enforce the law in these establishments, especially those that serve many consumers. According to NUNES *et al*. (1992), more attention should be paid to storage and distribution conditions, especially in light of the greater distance and/or longer times required for delivery of these products to supermarkets, open-air markets, fishmongers, and wholesaler markets, representing moments of higher risks.

Although six samples exceeded the 30 mg level of total volatile base nitrogen/100 g of seafood, only one sample was rejected by sensory analysis and showed legally inadequate pH, indicating the importance of realization of several analyses to evaluate product quality.

Even when fillet presented unsatisfactory total volatile base nitrogen values, sensory acceptance presented by some samples could be explained as a function of drainage or minimization of undesirable odors in this type of product presentation, due to washing after cutting or by lixiviation due to direct contact of muscle with water of ice fusion (KELLEHER *et al*., 1994).

The municipal market and fishmonger samples also presented seafood with total volatile base nitrogen level above the established limit (BRASIL, 1997a), indicating conservation problems and/or inadequate handling procedures. This fact becomes even more worrisome when taking into account the high number of total coliforms and possible *E. coli* presence at the locations sampled, giving rise to public health problems.

Many studies (KITAHARA *et al*., 2000; FU KUMOTO and OLIVEIRA, 1995; DAMATO *et al*., 1997; PEREIRA *et al*., 2002) have reported mercury values in fish and bivalve mollusks near those of the present study, indicating vulnerability of aquatic systems and the need for continuous monitoring to ensure the safety of the seafood supply.

The arsenic results found were similar to those observed in 2006 by DENOBILE *et al*. (2006) in shark samples marketed in São Paulo. Research realized in Spain (BORDAJANDI *et al*., 2004) with different types of seafood samples acquired in the distribution center of Huelva city, presented values similar to the present research for cadmium, copper, lead, arsenic, and mercury.

Even with contamination of at least one sample originating from different species and from distinct locations of sampling, it was not possible to identify a contamination focus, since application of the Epidemiological Survey identifies only the sampling place and not the capture area (origin) of analyzed species.

In Brazil, parasites of the family Anisakidae may be considered an emergent zoonosis because of the increase of raw seafood in Asian and fast-food restaurants (GERMANO and GERMANO, 1998), which highlight the concerns prompted by the findings of the present study. According to TORRES *et al*. (2000), the prevalence of a determinate zoonosis is specific because it is related to the dietary habits of each country.

The 100% prevalence of the *Ascocotyle* (*Phagicola*) *longa* parasite reported in Brazilian, Venezuelan, and United States mullets by QUIJADA *et al*. (2005) is similar to our present result.

TORRES *et al*. (2000) highlighted that zoonotic helminthiasis has attracted the attention of researchers worldwide and has led numerous research institutions to elaborate epidemiological control programs. The present study detected the presence of parasites of the family Anisakidae in fishes from the families Scianidae, Brazilian sardinella (*S. janeiro),* bumper (*C. chrysurus*), Brazilian codling (*U. brasiliensis*), coney (*C. fulva*), Argentine hake (*M. hubbsi*), bluewing searobin (*P. punctatus*), Pacific bearded brotula (*B. clarkae*), and sea mink (*M. americanus*), corroborating to PÉREZ *et al*. (2012) but contrary to the findings of HUSS *et al*. (2004), who affirms that only cod and herring comprise part of the life cycle of this parasite.

According to EIRAS (1994), in fish the prevalence of *Anisakis* spp. is much higher and more uniform than *Pseudoterranova* spp. Although, the present study found higher occurrence of *Contracaecum* spp., in agreement with REGO *et al*. (1983), SÃO CLEMENTE *et al*. (1995), RODRIGUES *et al*. (2011) and PÉREZ *et al*. (2012). Some authors (BOILY and MARCOGLIESE, 1995; SÃO CLEMENTE *et al*., 1995) hypothesize that *Contracaeum* spp. is only involved with seafood esthetics, causing disgust among consumers. Other authors (ISHIKURA *et al*., 1992; PELLOUX *et al*., 1992; SÃO CLEMENTE *et al*., 1996) found that these parasites have an important impact on public health and report the presence of eosinophilic granuloma, formed by *Contracaecum* spp. larvae in humans, demonstrating the zoonotic power of this parasite. Therefore, prophylaxis is the best treatment for anisakiasis (PEREIRA *et al*., 2000).

Although utilization of the candling table for parasite detection is recommended (ADAMS *et al*., 1994; SILVA and SÃO CLEMENTE, 2001), in present study this method was inefficient because 15%(10/65) of the samples found negative by this technique were positive when microscopy was utilized, thus corroborating the results observed by PÉREZ *et al*., 2012 and RODRIGUES *et al*., 2011. So, candling-table use by the Inspection Service can result in false negatives.

European Community law (directive of council 91/493; Decision of Council of 19th January, 1993; Directive 93/143) does not permit the sale of seafood or any of its parts that have parasites, specifies which visual controls must be performed to accomplish the detection of these parasites and, for all fishery products destined for raw consumption, establishes a requirement to freeze the product at a temperature under -20ºC for 24 hours.

In Brazil, Article 445 of the Regulations for Industrial Sanitary Inspection of Animal Products, states that seafood muscle which presents mass parasitic infestation, whether or not it can damage the health of consumers, must be condemned

(BRASIL, 1997a); however, the presence of only one parasite of the family Anisakidae has zoonotic potential. Given that national law does not specify what constitutes a mass infestation, proper inspection is hampered, a context that needs a legislative review to avoid misinterpretation. In this manner, the safety of food for consumption can be ensured.

According to UBEIRA *et al*. (2000) and FERRER (2001), sanitary risks must be minimized via the contribution of the Sanitary Surveillance Authorities to obtain products safe for consumption, but it is also necessary to warn consumers about the risks of raw seafood intake.

When elaborating seafood quality programs to ensure safety, it is essential to consider the approach of production chain, and count on the active participation of all involved in this agribusiness: fisherman, government agencies (research and health), market outlets and consumers (MACHADO *et al*., 2010).

The following critical points were identified in the production chain of the seafood marketed in Baixada Santista: inspection service quantification and qualification; human resources training deficiencies involved in the capture, handling and sale of fishery products; lack of an effective liaison between research and both the Inspection Service and Sanitary Surveillance; use of sensory analysis by official agencies as the only tool to evaluate in a rapid manner the seafood freshness, and the lack of consumer knowledge in relation to seafood quality. These critical points contribute directly to the epidemiological establishment of foodborne diseases.

It is the responsibility of the Inspection Services to guarantee the safety of the seafood available for consumption. To this end it is necessary to implant public policy programs that enable realization of research of parameters to identify the physicochemical, microbiological, chemical and parasitological limits for different seafood species; to adopt sensory analysis associated with complementary analysis reports (microbiological, parasitological, chemical and physicochemical) by inspectors to evaluate seafood quality; and to achieve the training and commitment of all authors involved in production chain, culminating in the availability of safe seafood to the consumer.

CONCLUSIONS

Based on the results of sensorial, physicochemical, chemical, microbiological, and parasitological analysis, only 6.2% (16/257) of samples analyzed could be destined to consumption. For that reason, it is important to use other analysis beyond sensorial test in inspection to guarantee seafood safety for consumers.

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