Processing of Bluefish, *Pomatomus saltatrix* Using Natural Smoke Flavouring as Coadjuvant

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ABSTRACT

The bluefish (Pomatomus saltatrix) constitutes the main fishing resource in Rio Grande do Sul (Brazil) coast in the autumn, winter and spring months. Considering that this fish is highly perishable, to have its shelf life increased an adequate treatment and processing are needed as soon as its capture occurs. Its use in the elaboration of a smoked product can represent considerable economic growth, if compared to its current "in natura" or frozen commercialization. A bluefish base smoked product was elaborated using natural smoke flavouring (known commercially as liquid smoke) defining the adjusted technological characteristics during the processing. The best form of liquid smoke application (immersion or sprinkling) was chosen sensorially by hedonic scale. The sprinkling of liquid smoke in the concentration of 20% on unskinned bluefish fillets showed better acceptance in the sensorial evaluation. A daily 49.5ºC pay-drying of 45 minutes before the liquid smoke application favored its larger penetration in the bluefish muscle. The thermal treatment used (52.8ºC for 45 minutes; 67ºC for 45 minutes and 80.8ºC for two and a half hours) was enough to get a product with good sensorial acceptance. The final yield of the used processing was of 39.58%, similar with the yield shown by other authors of other commercial species. The product must be kept under freezing temperature.

Key-words: bluefish, processing, smoked fish, liquid smoke

INRODUCTION

In Brazil, the exploration and use of fishery resources do not reach the economic and nutritional benefits, which would be expected. An alternative to improve the nutritional levels could be the use of cured products whose cost is lower than other conservation forms.

The quantity of each processed seafood species varies according to the quantity of species caught. Among seafood products, the bluefish constitutes one of the main pelagic resource, explored in the Rio Grande do Sul coast, but it has low commercial value.

In the south of Brazil, the common names for this species are "anchova" or "enchova". The "marisqueiro" denomination is also employed by some locals to identify the largest exemplars. In Argentina and Uruguay, it is known as "anchoa" or "anchoa de banco", and in the USA as bluefish. Scientifically it is named *Pomatomus saltatrix* (Linnaeus, 1766) and it is the only representative species of the Pomatomidae Family (Nion, 1991; Claus, 1995; Haimovici & Krug, 1996; Lucena, 1997).

Bluefish is a cosmopolitan species of the warm-temperate and subtropical regions in both hemispheres. In the Southwestern Atlantic, its commercial fishing was observed from Mar del Plata (Argentina) to Arraial do Cabo (Rio de Janeiro); however, in Rio Grande do Sul (between Torres and Chuí) its capture is more intense (Krug & Haimovici, 1989; Haimovici & Krug, 1996; Lucena, 1997).

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Figure 1 - The bluefish, *Pomatomus saltatrix*

If a part of the bluefish catches was used in the elaboration of smoked product, it could represent a considerably economic growth comparing to its commercialization by local seafood industries, mainly due to the ones which have been developing the frozen bluefish commercialization without a sophisticated processing.

Bluefish is a semi-fat seafood and highly perishable when commercialized in its fresh form, and, under tropical temperature it becomes rotten rapidly, so preservation methods are needed to increase its shelf life.

The fish smoking technique is, nowadays, employed with preservation purposes and also to obtain a product with a sensorial "*sui generis*" quality with excellent palatability (Ferreira & Oetterer, 1992; Rodríguez-Freyre, 1992; Morais, 1994; Oetterer, 1994; Ward, 1995).

Although, the smoked seafood processed by traditional methods is still very much used in most part of the world where seafood is exposed to smoke produced by incomplete combustion of some woods (Ward, 1995) this methods is being replaced by the use of natural smoke flavours (commercially known as liquid smoke) (Pszczola, 1995; Guillén, Manzanos & Ibargoitia, 1996; Schindler, 1997).

The liquid smoke has eliminated many problems associated with the traditional methods of seafood smoking, allowing more flexibility to the application methods and improving the color and flavour control, without the inconvenience of the sawdust use and smoking house cleaning. The pollution problems using wood smoke have been also eliminated by the fact that tar, resin and 3,4-benzo(a)pyren are eliminated in natural liquid smoke production. Some American, Canadian and European industries have been developing extensive liquid smoke line for fishes, mussels, crustaceans, meat, chicken and other sectors of food industries since 1960, summing up more than 40 patents. (Howard & Fazio, 1980; Schindler, 1994a; Schindler, 1994b; Guillén & Manzanos, 1996; Guillén & Manzanos, 1997).

Considering that in the southern region of Rio Grande do Sul, fishery is directed to bluefish, the main objectives of this work were: 1) to elaborate a smoked product using bluefish and natural liquid smoke flavouring; 2) to define the technological characteristics during its processing; and 3) to choose the best application method of natural liquid smoke flavouring.

MATERIAL AND METHODS

Material

Raw material: Bluefish species (*Pomatomus saltatrix*) were utilized as raw material. The species were caught by artisan fisherman in the Rio Grande do Sul coast, and landed in a warehouse near a water front located in the 4th Section of Lagoa dos Patos Bar (Rio Grande - RS - Brasil) during their harvest, considered between July and September.

Substructure: This work has been carried out in the Laboratories of Bioquímica Tecnológica de Alimentos, Análise Sensorial, Análise Química Instrumental, of the Departamento de Química of FURG, in Rio Grande (RS), Brasil.

Input: The natural smoke flavouring (liquid smoke) indicated to the liquid smoking process (Guillén, Manzanos & Ibargoitia, 1996; Morais *et al*, 1996; Schindler, 1997) was obtained from ADICON Indústria e Comércio de Aditivos Ltda (São Bernardo do Campo - SP - Brasil). It has following physical-chemical features: total acidity (as acetic acid: 14.0-16.0%), compounds of smoke flavour (15.0-22.0 mg/ml), carboniles (17.0-22.0%), density (1.12 Kg/l), resulting a brown liquid with a wood sawdust smoke flavour characteristic.

The chemical reagents for the analysis were P.A. quality.

Methodology

Experimental Process: The smoking process with liquid smoke of the bluefish fillets was produced according to the flowsheet presented in Figure 2.

Firstly cleaning and washing of "*in natura*" bluefish with fresh water were done, to eliminate all the dirt from shipping (as scale, remains of viscera, blood and skin mucus). Then the filleting process was manually done, and after having the skin removed the fillets were washed with fresh water, packed in polyethylene bags and kept under frozen temperature of -20°C, up to its use in the smoking process.

The liquid smoke application operation was carried out using two different processes:

(I) addition in brine with liquid smoke: The bluefish fillets were thawed and immersed in brine at 15% in the proportion of 1:2 (fish:brine). The liquid smoke was added in this brine at a concentration of 0.2% and 0.5%. The immersion time was of 60 minutes with shake following the drying process.

(II) sprinkling of liquid smoke over bluefish fillets: The bluefish fillets were thawed and immersed in brine at 20% in the proportion of 1:2 (fish:brine). Then the fillets were placed in a screen tray where the excess brine was drained off. Subsequently, they were placed in a heater and pay-dried at 50°C for 45 minutes (Step I) to promote a liquid smoke penetration. Then the liquid smoke was sprinkled in the fillet surface (both sides) with 20% and 40% of concentration, following the drying process. The drying process consisted of a time-temperature sequence obtained from the liquid smoke manufacturer: 45 min. at 54°C (Step II), 45 min. at 71°C (Step III) and 2h 30 min. at 82°C (Step IV).

In the final drying process, the tray was removed from the heater and the fillets were cooled to the room temperature, individually packed in polyethylene bags, labeled and stored. A portion of the smoked fillets was kept under refrigeration conditions (5°C) until the sensorial analysis (not beyond 12 hours) and the rest of the fillets were stored under frozen conditions (-20°C).

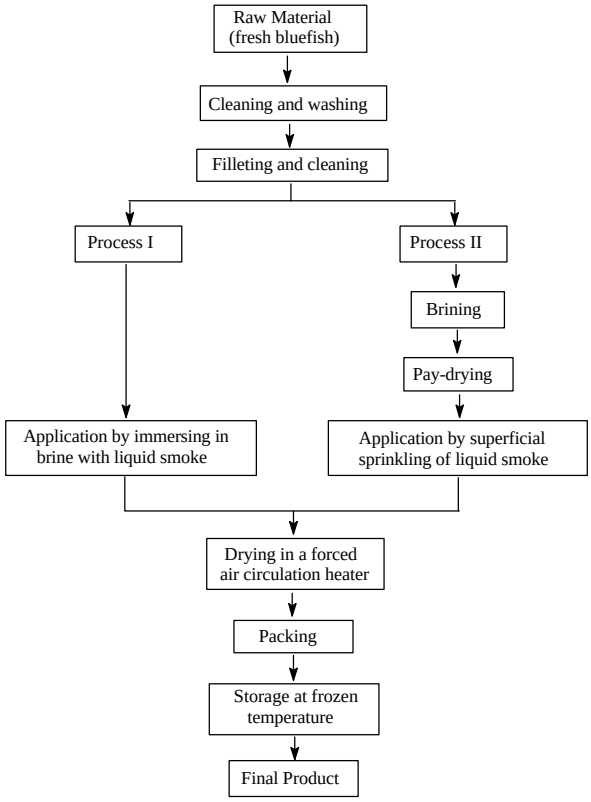

Figure 2. Bluefish fillet smoking operational flowsheet

Processing mass balance: The bluefish fillets were weighed after being filleted and during the process. These data showed the final process mass balance which later determined the process yield.

Sensorial analysis in the liquid smoke application: To define the liquid smoke concentration and the process which was better adapted to the final product, an affective method through a hedonic test was used. It consisted of a hedonic scale of 9 points, varying from "I liked it a lot" (9 points) to "I didn't like it at all" (1 point) (Teixeira, Meinert & Barbetta, 1987; Moraes, 1993).

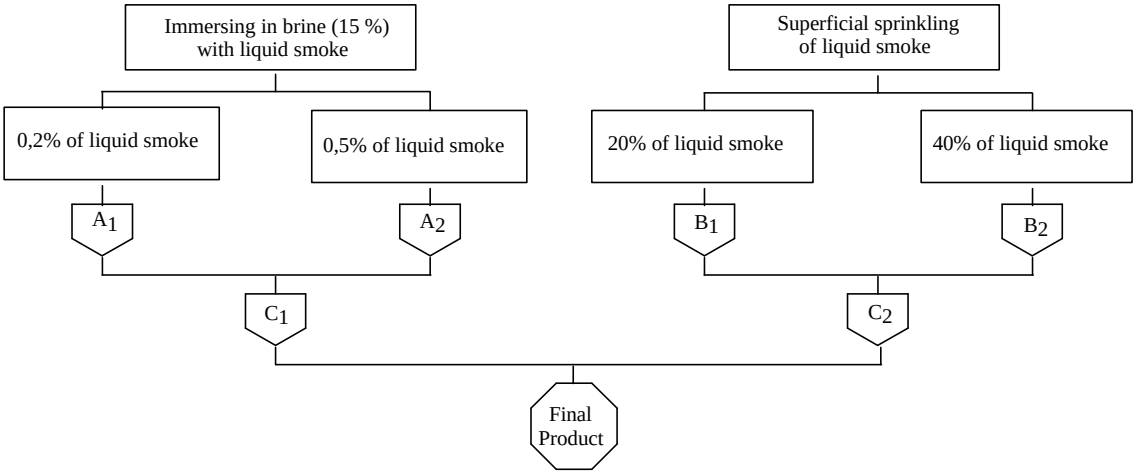

Figure 3. Sensorial tests scheme to choose the best liquid smoke application (A1: product elaborated with 0.2% of liquid smoke; A2: product elaborated with 0.5% of liquid smoke; B1: product elaborated with 20% of liquid smoke; B2: product elaborated with 40% of liquid smoke; C1: best concentration of liquid smoke from brine immersion method; C2: best concentration of liquid smoke from sprinkling method;

Panelists (n = 30) were asked to participate in each analysis. The samples for tasting were heated on an electric furnace and maintained at the temperature of 50°C. The results were analyzed statistically through bilateral Student t-test for dependent samples.

According to the scheme as shown in Figure 3, initially a preferential analysis of the smoked fillets first by immersion with liquid smoke in concentration of 0.2% (product A1) and 0.5% (product A2) and then by superficial sprinkling of liquid smoke at concentration of 20% (product B1) and 40% (product B2) was made. This test was made to verify which liquid smoke concentration better adapted to the product.

After these tests, the smoked fillet by immersion on brine with liquid smoke (better concentration: product C1) was compared with the smoked fillet by sprinkling (better concentration: product C2) to verify sensorially the best method of liquid smoke application.

RESULTS AND DISCUSSION

Table I shows the physical analysis of bluefish. This was similar to Lucena (1997) who studied the structure of the bluefish supply by size class, through the measures that had been taken in the occasion of the landing (in seafood processing industries and in the warehouse near a water front). The average size of the bluefish captured in years 1992, 1993, 1994 and 1995 was 44.88; 43.36; 42.63 and 41.9 respectively (in centimeters).

The average size of the bluefish captured by the coastal fleet in these periods showed a decreasing trend. Lucena (1997) reported that the presence of smaller species in the months of the bluefish capture could be related to its migratory behavior.

With relation to filleting, yields were 46.95% on the weight of the entire fish and this result coincides with the one observed by Contreras-Guzmán (1994) i.e. 46.4 ± 2.6 %, for bluefish unskinned fillet, and was above the average value, mentioned by the same author for marine fishes, which was 42.23%.

The average grades given by the tasters in the sensorial tests are presented in Table II.

The results showed that in the applied tests, all the samples were accepted by the tasters with marks above 5 (which corresponded to the indifference concept).

Table I - Physical analysis of bluefish

Physical Characteristics	Sample size	Minimum value	Maximum Value	Mean ± Standard Deviation value
TL (cm)	66	30.00	43.50	36.55 ± 3.35
TW (g)	66	349.00	1190.50	718.51 ± 174.96
FW(g)	66	184.00	576.80	336.67 ± 84.35
Y (%)	66	37.43	65.88	46.95 ± 4.24

TL: Total length; TW: Total weight; FW: Fillet weight; Y: Filleting Yield.

Table II - Results of Student t-test in the sensorial tests

Variables		(n)	Notes means	Standard Deviation	Probability*
TEST	BRI02	30	7.633	1.066	
1	BRI05	30	7.733	0.827	0.732
TEST	SPR20	31	8.32	0.832	
2	SPR40	31	7.83	0.778	0.0195
TEST	BRI02	30	7.53	0.973	
3	SPR20	30	8.60	0.621	0.000019

*Significative difference if p<0,05 (bilateral Student t-test); BRI02: Brine with 0.2% of liquid smoke; BRI05: Brine with 0.5% of liquid smoke; SPR20: Liquid smoke sprinkling at 20%; SPR40: Liquid smoke sprinkling at 40%

A significant difference It was observed in test 2 among the samples (p=0.0195), defining a preference for the smoked sample that used the liquid smoke sprinkling in the 20% concentration (grade 8.32).

On the basis of the results of tests 1 and 2, a third sensorial test was done to verify which method of liquid smoke application would make it possible to get a product of better acceptance. A significant difference was observed among the samples (p=0.000019) in test 3, indicating a preference for the smoked sample that used the sprinkling liquid smoke at 20% of concentration (grade 8.6). In this test the contact of the bluefish fillet with liquid smoke in brine promoted a bigger penetration of the flavour in the muscle, while the one, by sprinkling produced a flavour and golden coloration in the surface of the fish (ADICON, 1996; Shindler, 1997).

Rodrigues & Tobinaga (1996) state that before the liquid smoke process, it is necessary for the fish muscle to show an unsaturated surface, flavouring thus a high diffusion velocity of liquid smoke in fish muscle.
In this work an unsaturated surface was obtained with a pay-drying of 45 minutes at 49.5^{o}C.

Morais *et al* (1996) considered the thermal handling a basic stage in the process of liquid smoking, because it promote the smoke penetration, the formation of the color on the surface of the muscles and gives a better appearance of the final product.

According to Figure 4, a similar behavior among the rejoinders was noticed, guaranteeing, this way, the validity of the obtained results. However, the temperature observed in step I (49.5 ± 0.5^{o}C), in step II (52.8 ± 1.8^{o}C), in step III (67.0 ± 2.3^{o}C) and in step IV (80.8 ± 2.0^{o}C), was not accurately to that initially proposed (I: 50^{o}C; II: 54^{o}C; III: 71^{o}C and IV: 82^{o}C), probably due to the low interval of time between each step, or due to the opening the heater every 15 minutes to take the temperature, not reaching the desired one.

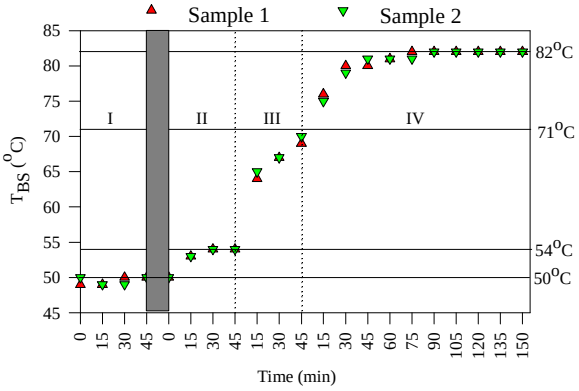

Figure 4 - Dried bulb temperature in function of the drying time (I, II, II e IV: Steps of drying: Stripe Bar: moment of liquid smoke application).

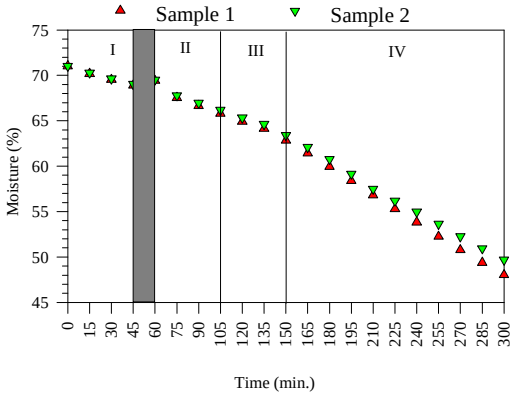

Figure 5 - Loss of moisture (%) in function of the drying time (I, II, II e IV: Steps of the drying; Stripe Bar: moment of liquid smoke application)

From the data of Figure 5, a loss of moisture around 30% and a similar behavior among the repetitions were observed, showing the validity of the data.

The mass balance of the process of liquid smoking of bluefish fillets is shown in Figure 6 which agreed with the results presented by Ramírez-Saldaña (1978) who studied the process of smoking of some species of marine fish.

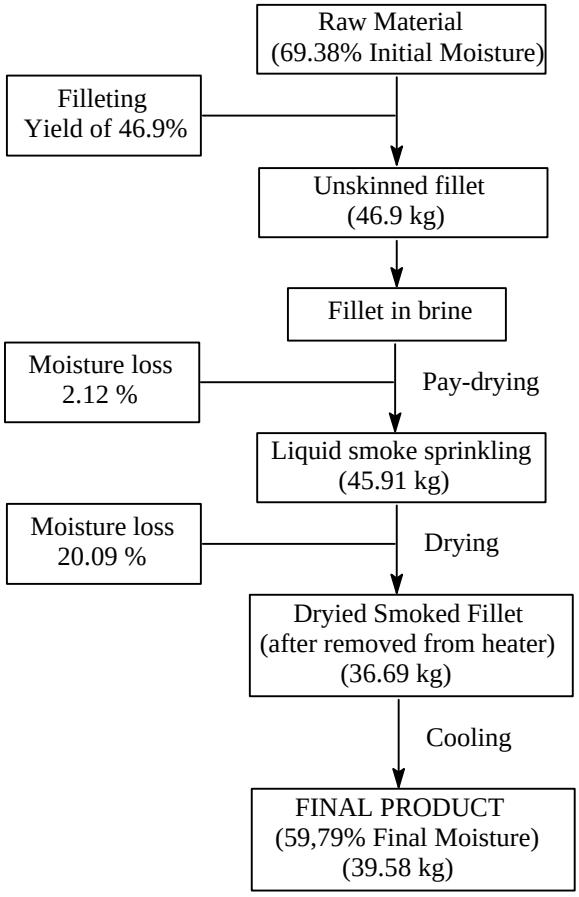

Figure 6 - Mass balance for elaboration of smoked bluefish fillet

CONCLUSIONS

- A smoked bluefish was made using natural liquid smoking flavouring.
- The application of liquid smoke on the surface by sprinkling with the concentration of 20% of the original solution on unskinned bluefish fillets presented a better acceptance in the sensorial analysis, when compared to the immersion in brine with liquid smoke in concentration of 0.2%.
- The pay-drying step at 49.5°C for 45 minutes (step I), before the liquid smoke application, favored a bigger penetration of the same one in the muscles of the bluefish which is according to literature data.
- The thermal treatment in different steps (II: 52.8°C for 45 min.; III: 67°C for 45 min.; and IV: 80.8°C for 2 h30 min.) was enough

to get a product with good sensorial acceptance.

- The mass balance performed along the process showed that a yield around 40% was obtained for the smoked product.

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RESUMO

A anchova constitui o principal recurso pesqueiro na costa do Rio Grande do Sul nos meses de outono, inverno e primavera. Considerando que este pescado é altamente perecível, para poder prolongar sua vida-de-prateleira necessita-se de um tratamento e processamento adequados tão logo ocorra sua captura. Sua utilização na elaboração de um produto defumado pode representar um crescimento econômico considerável, se comparado com sua atual comercialização na forma "*in natura*" ou congelada. Foi elaborado um produto defumado à base de anchova utilizando aroma natural de fumaça (conhecido comercialmente como *fumaça líquida*), definindo as características tecnológicas adequadas ao longo do processamento. A melhor forma de aplicação (imersão ou aspersão) foi escolhida sensorialmente através de escala hedônica. A aspersão da *fumaça líquida* na concentração de 20% sobre os filés de anchova sem pele apresentou melhor aceitação na análise sensorial. Uma pré-secagem de 45 minutos a 49,5ºC antes da aplicação da fumaça líquida favoreceu uma maior penetração da mesma no músculo da anchova. O tratamento térmico utilizado (52,8ºC por 45 minutos; 67ºC por 45 minutos e 80,8ºC por 2 horas e 30 minutos) foi suficiente para obter um produto com boa aceitação sensorial. O rendimento final do processamento utilizado foi de 39,58%, coincidindo com o rendimento mostrado por outros autores para outras espécies comerciais. O produto foi estocado a -20ºC.

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