The Organic Solid Residues of Fish Processing Industries in Santa Catarina Brazil: Production Scenarios and Technologies

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ABSTRACT


This document aims to characterize quantitative and qualitatively the organic solid residues produced by the fish processing industry in Itajaí and Navegantes cities. Santa Catarina State, Brazil. According to 73% of the 22 companies interviewed, the fish processing reaches an average of 60,000 t/year, generating approximately 30,000 t/year of residues. Of these industries, 68% declared that their residues are sent to fish flour industries, 23% of industries sent their residues to the city landfill, and 9% threw their residues directly into the Itajaí-Açú river, causing a significant impact on that environment. Such residues could be a rich nutritional source of food for humans and animals, once the average protein content, in dry matter, for the residue and fish flour are high (53.6% and 58.6% respectively), as well lipids (20.1% and 11.1%). Considering that 49% of the analyzed residues was within the limits established to Staphylococcus aureus and 58% to fecal coliforms, there would be a volume between 14,700 and 17,400 t/year of residues able to be turned into by-products that require good sanitary quality. The purpose of this study was to show the real potential to transform fish residues into by-products, since sanitary quality required was maintained. In this sense, applying industrial rates to 6 seafood categories, global scenaries of residues generation were also predicted. These actions correlated to Corporate Social-Environmental Responsibility Programme, can contribute to the fishing sector and improve the social and environmental quality in coastal areas, implementing fishery sustainability principles and ensuring the Food Security Programs like “Fome Zero”, from Brazilian Government.

ADITIONAL INDEX WORDS: Fishery industry, seafood by-products, corporate social responsibility.

INTRODUCTION

Daily fish processing industries generate significant amount of organic solid residues that are not often used in Brazil due to the restricted knowledge, on technological and sanitary procedures for its recovery, by the fishing sector and governmental agencies, besides the lack of Public Politics to promote and support these actions.

This research was carried out to evaluate the generating process and the flow of the discarded residues for fish processing industries from Itajaí and Navegantes cities, center-northern coast of Santa Catarina State (STORI, 2000). The industry of fish products represents 30% of Itajaí industrial park, employing people in the fishing, shipbuilding and provision industry (AMFRI, 1999). Including Navegantes city, it is the fourth largest fish harvesting area of Latin America, with prominence to the several fish factories that export their products (AMFRI, op.cit.). These industries compound the largest fishing industrial complex in Brazil, receiving 93% of the fish harvested and landed in Santa Catarina State (IBAMA/CEPSUL, 1999), responsible for 21.2% of the national capture between 1980 and 1994 (PAIVA, 1997).

Concerning annual variations in the fishing landings, an oscillation is expected in the fish processing and consequently in the generation of residues. Yearly variations are verified in the historical series of fish landings in Santa Catarina between 1980 and 1997, in an order of up to 60,000 tons (IBAMA/CEPSUL, 1993 and IBAMA/CEPSUL, 1999). The landings in the area of Itajaí presents values relatively stable according with the fishing statistics published by ICEPA (1998), with a mean estimate of 96.676 t/year and coefficient of variation of 5,6%.

With the purpose to verify the viability of the implementation of a Solid Residue Management System for the fishing sector, it was quantified and qualified the monthly discarded residue by this industrial sector, with prominence to the more representative fish categories in the processing. It was proposed in this research, therefore, to base guidelines for the improvement of the sanitary quality of the raw material in the companies (appropriate forms of manipulation and storage) as requirement for the rational recovery of residues and by-product production.

METHODS

The universe of this study was formed by all of the industries of fish processing and fish flour industries from Itajaí and Navegantes. These industries were mapped in scale 1:10.000, to simplify the visitation process to the production lines and the application of companies characterization inquiry as regards: time of performance, maximum production capacity, main discard species in the processing lines and, consequently, as the join species in the processing lines and, consequently, the selection of the monthly variability in the fish flour industries from Itajaí and Navegantes cities. Santa Catarina State, Brazil. According to 73% of the 22 companies interviewed, the fish processing reaches an average of 60,000 t/year, generating approximately 30,000 t/year of residues. Of these industries, 68% declared that their residues are sent to fish flour industries, 23% of industries sent their residues to the city landfill, and 9% threw their residues directly into the Itajaí-Açú river, causing a significant impact on that environment. Such residues could be a rich nutritional source of food for humans and animals, once the average protein content, in dry matter, for the residue and fish flour are high (53.6% and 58.6% respectively), as well lipids (20.1% and 11.1%). Considering that 49% of the analyzed residues was within the limits established to Staphylococcus aureus and 58% to fecal coliforms, there would be a volume between 14,700 and 17,400 t/year of residues able to be turned into by-products that require good sanitary quality. The purpose of this study was to show the real potential to transform fish residues into by-products, since sanitary quality required was maintained. In this sense, applying industrial rates to 6 seafood categories, global scenaries of residues generation were also predicted. These actions correlated to Corporate Social-Environmental Responsibility Programme, can contribute to the fishing sector and improve the social and environmental quality in coastal areas, implementing fishery sustainability principles and ensuring the Food Security Programs like “Fome Zero”, from Brazilian Government.

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generated residues are joined. This way, the six more representative fish categories in the global processing (sardines, tunas, weakfish, whitemouth croaker, argentine croaker and shrimps) were selected for analysis. Specific income coefficients were applied for each production line and for each fish category to quantify the indeed generated residue. From these determinations, global sceneries of residues generation were established for each production line, being supposed, for effect of these calculations, that the whole volume of that fish species was allocated for a single production line, in the sense of evaluate the maximum potential of annual production of that residue type.

In the analyses of centesimal composition of fat (continuous flow ether extraction), proteins (method Kjeldahl) and humidity (gravimetric), samples from the categories: sardines, tunas, weakfish, argentine croaker and shrimps were used.

In order to evaluate the sanitary quality of these residues, companies were selected among those generating residues with potential for elaboration of by-products (high volume and nutritional quality), including fish of dark musculature (sardines and tunas) and fish of white musculature (weakfish, argentine croaker and hake). The samples were collected with sterilized gloves, conditioned in sterile plastic sacks and transported in thermal boxes for the microbiological analysis (APHA, 1992): counting of total heterotrophic bacteria, most probable number of fecal coliforms, most probable number of Enterococcus, counting of Staphylococcus aureus, presence or absence of Salmonella. In that way, it tried to fit these residues in the limits established for consumption (Edict N.01 of DINAL/MS 1987). Comparisons between the different types of collected residues were done using the nonparametric statistical Test U of Mann-Whitney.

RESULTS

Global Analysis of Fish Processing

Twenty two industries of fish processing were identified, 11 of wich were located in Itajaí and 11 in Navegantes. In agreement with data supplied by 73% of the interviewed companies, the processing represents a global mean value of 58.924,8 t/year of fish. The industries have a maximum production capacity of 570 t/day, what would correspond to an annual potential production of approximately 181.000 t. This amount extrapolates in three times the annual mean processing calculated, demonstrating that the installed capacity is evaluated for the intensive work in the peak of the harvests of the most abundant fish, staying idle during most of the year. The global processing of fish in time is shown in Figure 1, which is relatively stable during the year in function of the constant entrance of raw material to the industries.

High amount of processing can be observed in the autumn (March, April and May), when the fisheries of sardine and tuna are more expressive than the fisheries of other representative categories: weakfish, whitemouth croaker, argentine croaker, brazilian cod and chub mackerel. On the other hand, a less intense processing was observed in the months of December to February, related to the prohibition time for sardine harvest. Fish that contributes with 55% of the global mean processing, following by the tuna with 26% (Figure 2). The existence of other 14 fish categories composing, together with the two more abundant, about 99,2% of the global annual mean processing (58.924,8 t), is also evidenced (Figure 2). To apply the mean tax of use of 50% on this value, the global generation of residues would be around 29 thousand t/year. These values would be slightly underestimated, because some companies have not supplied the processing values.

In agreement with the current uses of the residues analysis declared by the companies, it was possible to observe that 68% of the industries sent direct its residues to the fish flour industries, 23% of the industries direct the residues to the landfill and 9% spills it directly in Itajaí-Açu river, what constitutes a serious environmental impact.

Fish Categories Processing Analysis

Starting from the applied survey/table, in which 73% of the companies inserted monthly mean values of processing for fish species, were draw the processing curves for each category (Figure 3) and described as following:

1) Sardines (contained Clupeidae: Opisthonema oglinum and Sardinella brasiliensis): It is possible to see that the processing of sardines was relatively stable during the year, presenting a maximum value of 4.300 t in the month of April and monthly average of approximately 3.200 t. In the summer (time of the fishery prohibition - Edict IBAMA’3, of January 31, 1997) the processing reaches about 1.000 t, the verified production is due to the raw material imported (Venezuela, Morocco, Mexico and other countries). It was settled down an annual mean production of 32.268 t of sardines in this period, distributed among the lines of gutted production and flattened.

2) Tunas (contained Scombridae: Thunnus obesus, Thunnus alalunga, Thunnus albacares, Auxis thazard, with the prevalence of Katsuwonus pelamis): The curve of projected mean processing demonstrated high production of January to April with a maximum of 2.266 t the month of February, periods related to the elevation of the water temperature and occurrence of the resource in the area. Soon afterwards, the production decreases in the cold months, being around 850 monthly tons, from June to November. It was settled down an annual mean production of 15.450 t of Scombridae distributed between the lines of gutted production and canned loins.

3) Weakfish (contained Sciaenidae: Cynoscion leichiurus, Cynoscion striatus and Macrodont anchoydon): It is visualized
that the processing of obtaining weakfish has two different peaks, 316 t (in the month of May related to a larger entrance of
Cynoscion leiarchus) and 382 t in the month of August (related to the predominance of C. striatus and of M. ancyodon). A production average was observed around 190 t in the remaining
of the period. It was settled down an annual mean production of 2.270 t of weakfish distributed in the lines of gutted production,
flattened and filleted.

4) Whitemouth croaker: this category corresponds to Sciaenidae, Microgonias furnieri. The curve of projected
mean processing showed a maximum in the month of May with 375 t, followed by a fall in the month of June, increasing in
approximately 50 tons for the two following months, and presenting an average around 120 t for the other months of the
year. It was settled down an annual mean production of 2.125 t of whitemouth croaker distributed in the lines of gutted production,
chopped, flattened and filleting.

5) Argentine croaker: this category corresponds to Sciaenidae, Umbrina canosai. The processing mean annual
projected showed the maximum of the production in the month of May with 305 t, followed by a decrease in the month of June,
starting from which the production decreases smoothly until stabilizing around the 100 monthly tons. It was settled down an
annual mean production of 1,661 t of argentine croaker distributed in the lines of gutted production, chopped, flattened and filleting.

6) Shrimps (contained Penaeinae: Artemesia longinaris, Penaeus schimitti, Penaeus paulensis, Penaeus brasiliensis, Pleoticus muelleri and Xiphopenaeus kroyeri): The curve of
projected mean processing presents the lowest productions between February and April. Only 15 t on average are
processed in March, due to the fishery prohibition of most of the species (Edict N. 21 of February 11, 1999). In the
subsequent months an accentuated elevation of the production was observed, reaching the maximum in the month of October
(average of 125 t). It was settled down an annual mean production of 983 t of shrimp distributed in the production lines of
whole peeled shrimp or headless.

Production Lines Analysis

In a general way, the fish are classified by size and directed to the
production lines that look for a final product to attribute them a larger use in relation to the size of the raw fish. The
production lines are:

- Fishes in Filets or Meat: retreat of the fish's head, gut, fins, skin together with the scales and retreat of the number spine,
characterized by the great amount of muscle adhered to the residues (carcass). Mean income coefficient between 30 and
45%.
- Flattened Fishes: fish is opened in belly, heads, gut, skin, scales and fins are removed. Mean income coefficient
between 43 and 52%.
- Fishes in Pieces: the fish is cut in proportional pieces to its

height. Heads, guts, scales and fins are discarded. Mean income coefficient between 54 and 77%.
- Gutted fish: the guts and the scales of the fish are removed, could be removed the head. Mean income coefficient among
90 to 41%.
- Mollusks: gutted and cut in rings. Guts and shell are discarded. Mean income coefficient between 30 and 85%.
- Crustaceans: headless or totally peeled. Mean income coefficient between 65 and 37%.

Chemical Analysis

The analyses of the residues from the most found fishes in processing industries results in compositions similar to those
found for the fish filets in general. In the samples of residues of sardines, they stood out ventral keels of O. oglinum, with
contents of 13,3% and 16,9% in proteins and fat respectively. Samples of head and fin showed present high content of proteins
(17,4% for O. oglinum and 14,4% for O. brasiliensis).

In the samples of residues from tuna stands out cooked heads, dark musculature associated to the spines and skin after
cooking and dehydrated gut of K. pelamis. These shows a fat content relatively low: 6,9%; 5,5% and 9,6% respectively. On the
other hand, the contents of proteins obtained were among the highest: 18,8%; 22,8% and 61,1% respectively.

Among the residues of weakfish evaluated (C. leiarchus and C. striatus), stood out the spine samples with muscle adhered
with content protein around 15,5% and fat content around 7,0%.

In the whitemouth croaker residues (M. furnieri), stood out the head with 10,8% in fat content and 14,1% in protein content
and the preopercular bones, with fat content of 3,3% and 19% in protein content.

The peels of the shrimp Artemesia longinaris demonstrated low content of fat and protein (0,3% and 5,3% respectively).

Microbiological Analysis

In a general way, the residues sampled showed a high degree of contaminants, as it can be observed in the Table 1. Many tests
extrapolated the sensibility of the method, not being possible to evaluate the exact number of microorganisms in the samples.
On the other hand, the absence of Salmonella in the samples indicates the potential of these residues as raw material.

The Test U of Mann-Whitney didn't point significant difference between the residues of the processing of the sardine
and of the tuna, both with high microbial numbers. However, the test showed differences in the residues of the tuna and
sardina processing in relation to the residues of the processing of white musculature fishes (weakfish, whitemouth croaker
and hake). Such verification demonstrates that residues of white musculature fish have a superior sanitary quality in
relation to that found for sardine and tuna residues, mainly related to analyses of Staphylococcus aureus and Enterococcus
(Table 1).

In agreement with the Edict N° 1 of DINAL/MS (1987), the limit recommended for consumption in natural of fecal
coliiforms is 100 MPN/g and for Staphylococcus aureus it is 1.000 FCU/g. In agreement with these patterns, about 58% of
the collected residues would be able for consumption as the fecal coliiforms and 50% for S. aureus (Table 1).

Residues Generation Scenaries

To estimate the generation potential of the several types of residues from the fish processing industries, were established
production scenarios (Table 2) for the several categories of residues, which are described as follow:

1) Sardines: the annual mean production of 32.269 t was allocated in the two possible sceneries of residues generation
for this category: gutted line and flat line. The mean income coefficient in the gutting for sardine, of 65%, implicates in a
generation of 35% of residues, in a scenery of 11.293 t of residues generated a year. Whereas, the line of flat sardine, have
a income coefficient of 52% that implicate in a generation of 47.8% of residues, with an established scenery of 15.424 t/year. In these residues the mean contents of fat and proteins were, respectively, 7.5 and 16.2%. Of the three sardine residues samples evaluated for microbiological contamination, just one was framed below the established limits for consumption in fecal coliforms and S. aureus.

2) Tunas: the annual mean production of 15.450 t was allocated in two sceneries of residues generation: gutted line and line of cooked loins for canning. The mean coefficient of use in the gutting for tuna is about 90%, implicating in a production of 10% of residues, in a scenery of 1.545 t/year. Whereas the production of loins, having presented a mean income coefficient of 42%, implicates in a 58% of residues production, giving a scenery of 9.816 t/year. The fat content verified for this residue was of 7.3%, with prominence for the high content of proteins (34.2%). Of the three samples of residues of tunas analyzed for microbiological contamination, two were framed below the established limits for fecal coliforms, however no one framed below the limits for S. aureus.

3) Weakfish: the annual mean production of 2.270 t was allocated in three sceneries of residues generation: gutted line, flattened and filleting. The mean income coefficients were positioned between 44 and 57%, implicating therefore in a generation from 43 to 57% of residues, generating production scenery of about 1.000 t/year. The fat contents and of proteins obtained on average for this category were, respectively, 6.5% and 16%. Of the three samples evaluated for microbiological contamination, two samples came below the established limits for fecal coliforms, and the three samples were framed below the established limits for S. aureus.

4) Weakfish: the annual mean production of 2.124 t was allocated in four sceneries of residues generation, to know: gutted lines, chopped, flat and filleting. With mean income coefficients varying between 35 and 55% in function of the production line and with consequent amounts between 45 and 65%, the volumes of residues of this category, independent of the production line, are locate between 950 and 1.400 t/year. The mean content of fat obtained for this category was 7.1%, while the one of proteins was of 16.6%. This category was not analyzed for microbiology examination.

5) Whitemouth croaker: the annual mean production of 1.661 t was allocated in four sceneries of generation of residues: gutted lines, chopped, flat and filleting. The mean income coefficient for whitemouth croaker, was between 34 and 55%, generated production scenery between 747 and 1.105 t of residues a year, depending on the production line (filleting always with larger productions of residues). This category was not evaluated in the chemical analysis. Two whitemouth croaker samples were evaluated microbiological examination, of which just a sample was inside of the established limits for consumption in fecal coliforms; however, both are framed inside of the established limits for S. aureus.

6) Shrimps: the annual mean production of 983 t was allocated in two sceneries of residues generation: line of whole peeled shrimp or headless. The mean income coefficient for peeled shrimp, of 53.2%, implicates in a generation of 46.8% of residues: scenery of 460 t/year. The mean coefficient of use for headless shrimp was of 63%, what implicated in a generation of 37% of residues: scenery of 363 t/year. Low contents of fat and proteins were verified in residues of A. longinaris: 0.26% and 5.28%, respectively. This category was not analyzed for microbiology.

DISCUSSIONS

As highlighted by this study, the sector of fish processing was dominated, in the time of this work, by 22 companies. The annual mean processing of fish is about 60.000 t. Although most of the companies have been interviewed (including the totality of the largest companies of fish processing), this value should be slightly underestimated by the non-inclusion of 27% of the companies. This amount corresponds to 61% of the total landings in the area of Itajaí/Navegantes (CEPSUL: 96.676 t), which could produce a volume corresponding of 30.000 t of residues a year.

It was possible to visualize the types, amounts and qualities of the generated residues. It is stood out that these calculations had exploratory character, once that exact values were difficult of being obtained due to the existence of an updated historical registration in most of the interviewed industries. These values can be altered by environmental and economical variables, as: times of fisheries prohibition; unpredictability of the capture (population variation and reflex of the overexploitation); disputes of the market; differences between the size classes and the taxes of use, in their respective production lines etc.

The six main fish categories processed in the area are, in order of processed volume: sardines (54.8%), tunas (26.2%), weakfish (3.9%), whitemouth croaker (3.6%), argentine croaker (2.8%) and shrimps (1.7%). The sum of the residues generated, if each category was allocated in the line of larger residues generation, would be of 28.568.8 t/year.

Moreover, the evaluated residues could serve as rich nutritional source, once that the fat contents were between 6.45% and 7.54% and the protein contents 15.97% and 34.22%. However, if the content of proteins of the tuna residues stimulates its use, the level of contamination restricts it, so that, for its use, would be imperative a change in the lines of production and/or procedures in the sense of warranting a better sanitary quality.

Residues of white musculature fishes (weakfish, argentine croaker and hake) showed superior sanitary quality to that found for sardines and tunas residues. The absence of Salmonella ssp. in the samples shows an optimistic result for the elaboration of by-products. Considering an amount of 30.000 t/year in residues, there would be a mass of 14.700 - 17.400 t/year of capable residues for elaboration of by-products that demand good sanitary quality, and residues with low fat content (surimi and concentrated proteic), once 49% to 58% of the residues came inside of the established limits for the legislation. Still, contaminated residues could be directed to the silage and the fish flour, still standing out other technologies, still very little spread: leather production starting from the skins, quitosana production, production of shark cartilage, production of carbonate of calcium and extraction of polyunsaturated fat acids.

Although the companies don't follow a rigid quality control in the final disposal of these residues, it is already possible to visualize the evaluated residues as a potential resource for the elaboration of high quality by-products.

CONCLUSIONS

There is a real potential of use of the residues, since the companies observe a more cautious manipulation, a better aggregation of the residues in the productive process and appropriate forms of packaging (e.g. use of cold camera), so that the sanitary qualities and the nutritional contents of the residues are conserved, warranting the quality patterns demanded for the elaboration of by-products.

The processing of the residues could reduce the idle capacity of the industrial fishing sector and increase the generation of jobs and income in the companies, stimulating the productivity with environmental quality and for diversifying the market of by-products in opposition to the increase of the capture of fish, whose stocks (in general) already are find overexplored.

The growth of the fishing sector faces a serious difficulty today: the raw fish shortage excels, and the low perspective of increase of it readiness in mean period. Therefore, the use of residues for the production of by-products, connected to a Corporate Social Responsibility Program, could contribute to the invigoration of the fishing sector, with gains for the environment and society. These actions would contemplate
Table 1. General results of the microbiological analyses.

<table>
<thead>
<tr>
<th>Type of Residue</th>
<th>Total Coliforms (MPN/g)</th>
<th>Fecal Coliforms (MPN/g)</th>
<th>Enterococci (MPN/g)</th>
<th>Salmonella (25 g)</th>
<th>Staphylococci (UFC/g)</th>
<th>Total counting (UFC/g)</th>
<th>Counting Anaerobes (UFC/g)</th>
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<tbody>
<tr>
<td>Sardine A</td>
<td>&gt;1.600</td>
<td>&gt;1.600</td>
<td>&gt;1.600</td>
<td>absent</td>
<td>&gt;20.000.000</td>
<td>&gt;2.000.000.000</td>
<td>&gt;20.000.000</td>
</tr>
<tr>
<td>Sardine A</td>
<td>&gt;1.600</td>
<td>540</td>
<td>&gt;1.600</td>
<td>absent</td>
<td>19.000.000</td>
<td>&gt;2.000.000.000</td>
<td>20.000.000</td>
</tr>
<tr>
<td>Sardine C</td>
<td>23</td>
<td>23</td>
<td>31</td>
<td>absent</td>
<td>145</td>
<td>4.500.000</td>
<td>20.000</td>
</tr>
<tr>
<td>Tuna A</td>
<td>&gt;1.600</td>
<td>&gt;1.600</td>
<td>&gt;1.600</td>
<td>absent</td>
<td>20.000</td>
<td>&gt;2.000.000.000</td>
<td>100.000</td>
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<tr>
<td>Tuna C</td>
<td>1.600</td>
<td>41</td>
<td>540</td>
<td>absent</td>
<td>32.450</td>
<td>14.700.000</td>
<td>100.000</td>
</tr>
<tr>
<td>Tuna C</td>
<td>&gt;1.600</td>
<td>21</td>
<td>1.600</td>
<td>absent</td>
<td>7.600</td>
<td>11.700.000</td>
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<td>110</td>
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<td>absent</td>
<td>&lt;100</td>
<td>21.600.000</td>
<td>1.140.000</td>
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<tr>
<td>Weakfish B</td>
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<td>9</td>
<td>79</td>
<td>&lt;100</td>
<td>27.000.000</td>
<td>&lt;100.000</td>
<td>2.000</td>
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<tr>
<td>Weakfish D</td>
<td>1.600</td>
<td>49</td>
<td>33</td>
<td>absent</td>
<td>1.600.000</td>
<td>1.600.000.000</td>
<td>&lt;10.000</td>
</tr>
<tr>
<td>Argentine croaker B</td>
<td>1.600</td>
<td>1.600</td>
<td>70</td>
<td>absent</td>
<td>1.600.000</td>
<td>1.600.000.000</td>
<td>2.000</td>
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<tr>
<td>Argentine croaker C</td>
<td>&gt;1.600</td>
<td>31</td>
<td>350</td>
<td>absent</td>
<td>&lt;100</td>
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<td>Hake D</td>
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<td>390.000</td>
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</tbody>
</table>

* The letters indicate different industries from where the samples were collected.

directly in the improvement of the environmental quality of the coastal areas (decrease of the movement and burring of residues in landfills), in the implementation of more efficient productive processes (better use of the raw material, use of species of low commercial value), gain social and improvement of the image of the companies in the society (by-products production at low prices, jobs generation, environmental and social marketing) and improvement of the acting of the company (profit enlargement, and conquest of new markets). These actions would incorporate the beginnings of the Industrial Ecology and Eco-efficiency, enlarging the possibility of sustainability of the fishing sector.

A great possibility of social return exists in the production of institutional feeding, as school snack, or feeding hospital, as well as in the interfaces generation with social politics, as Food Security Program “Fome Zero”, of the Brazilian government, that it has been receiving the cooperation of several Brazilian industries in the donation of victuals to lacking families. Contrasting with the delay of the Brasilian fishing sector, other industries in the donation of victuals to lacking families. This work incorporated the beginnings of the Industrial Ecology and Eco-efficiency, enlarging the possibility of sustainability of the fishing sector.

ACKNOWLEDGEMENT

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LITERATURE CITED


Table 2. Scenries of generation of residues for fish category and production line.

<table>
<thead>
<tr>
<th>Categories (CV)</th>
<th>Mean production (t/year)</th>
<th>GUTTED (41 - 90%)</th>
<th>CHOPPED (54 - 77%)</th>
<th>FLATTENED (43 - 52%)</th>
<th>FILLETED (30 - 45%)</th>
<th>LOIN (30 - 45%)</th>
<th>PEELED (37 - 65%)</th>
<th>Content fat</th>
<th>Content Proteins</th>
</tr>
</thead>
<tbody>
<tr>
<td>SARDINE (41.4%)</td>
<td>32.267,76</td>
<td>11.293,72</td>
<td>11.393,72</td>
<td>15.423,99</td>
<td>20.000.000</td>
<td>145</td>
<td>4.500.000</td>
<td>7.54%</td>
<td>16,23%</td>
</tr>
<tr>
<td>TUNA (16%)</td>
<td>15.452,9</td>
<td>1.545,29</td>
<td>1.545,29</td>
<td>1.094,54</td>
<td>1.278,48</td>
<td>8.916,32</td>
<td>21.600.000</td>
<td>7.31%</td>
<td>34,22%</td>
</tr>
<tr>
<td>WEAKFISH (18.1%)</td>
<td>2.270,83</td>
<td>985,54</td>
<td>985,54</td>
<td>1.094,54</td>
<td>1.278,48</td>
<td>8.916,32</td>
<td>21.600.000</td>
<td>7.31%</td>
<td>23,38%</td>
</tr>
<tr>
<td>WHITEMOUTH CROAKER (8.5%)</td>
<td>2.124,15</td>
<td>951,62</td>
<td>1.008,97</td>
<td>1.115,18</td>
<td>1.384,95</td>
<td>32.267,76</td>
<td>21.600.000</td>
<td>7.31%</td>
<td>15,97%</td>
</tr>
<tr>
<td>ARGENTINE CROAKER SHRIMP (42.8%)</td>
<td>1.661,47</td>
<td>747,66</td>
<td>747,66</td>
<td>937,07</td>
<td>1.104,88</td>
<td>1.661,47</td>
<td>21.600.000</td>
<td>7.31%</td>
<td>34,22%</td>
</tr>
</tbody>
</table>

CV: flotation of generation of residues, expressed as variation coefficients around the average, tends as base to the flotation of capture of the species between 1990 and 1997 (IBAMA/CEPSUL, 1999) and being considered the generation of residues as function of the capture and of the landing.