DEVELOPMENT OF RECONSTITUTED SALTED AND DRIED FILLETS FROM TILAPIA

Narendra Narain, Sonia Maria Galdino Justino da Costa, and Maria Lúcia Nunes

Departamento de Tecnologia Química e de Alimentos,
Universidade Federal da Paraíba,
58.059 - João Pessoa - PB., Brazil

INTRODUCTION

In the North-East region of Brazil, the production of tilapia do Nilo (*Sarotherodon niloticus*) has been increasing lately. In the year 1973, this fresh water fish was introduced in the region where it found favorable growth conditions for development, and soon attained a status of prominence (Superintendência de Desenvolvimento de Pesca, 1987). However, tilapia is considered to be of low commercial value as consumers object to its earthy odor.

Traditionally, people of the North-East of Brazil are accustomed to consuming salted and dried meat products which are sold under a generic name of "Carne de Sol". Such products have well established identity and are regular items, even in sophisticated food supermarkets. Thus, in order to cater to the local market, it was thought appropriate to utilize tilapia for the elaboration of a salted and dried product with a longer shelf life while maintaining the process economically feasible. Tilapia was considered promising not only due to its high productivity in the region but also for its low fat content of less than 2%.

A quick salting process for fish has been described previously (Del Valle and Nickerson, 1968; Del Valle and Gonzalez-Inigo, 1968; Del Valle et al., 1973; Anderson and Mendelsohn, 1973). The process involves grinding of fish flesh with simultaneous addition of salt, pressing of the ground salted meat to form cakes, and finally, sun drying of the cakes. However, in the process, no ingredients other than salt were added for preparation of the salted and dried cakes.

The objectives of the present study were (1) to standar-
dize the processing conditions for the elaboration of reconstituted salted and dried fillets from tilapia, (2) to evaluate addition of other ingredients such as wheat flour and egg, in the formulation of product, and (3) to determine rancidity index before and after frying of products stored up to 90 days at ambient, refrigeration and freezing temperatures.

MATERIALS AND METHODS

Materials:

The tilapia do Nilo (Sarotherodon niloticus) was obtained from the municipality of Cuité-PB., Brazil. Refined iodine salt was the brand "Merlin" manufactured by "Companhia Industrial do Rio Grande do Norte", Macau-RN, Brazil, while refined corn oil was the brand, "Mazola", made by "Companhia de Refinações de Milho Brasil Ltda.", São Paulo-SP, Brazil. Large size grade A eggs were purchased locally and wheat flour was "Boa Sorte" manufactured by "Companhia Cabedelo Industria S.A"., Cabedelo-PB., Brazil.

Procedure for the preparation of reconstituted salted and dried fillets:

The fish were captured alive, washed with running water and transported to the processing plant under ice. After evisceration, deheading and cleaning, the fillets 18 cm (length) x 8 cm (maximum diameter) x 1 cm (thickness) were obtained manually. These were considered as control samples.

The flow-diagram for processing of reconstituted salted and dried fillets is shown in Figure 1. The ground fish (triturated meat) was divided for the two treatments. Treatment-I did not have the quick salting, pre-pressing and drying operations, and in this treatment, the salt concentration was only 2 or 3%. In treatment-I, addition of salt was done simultaneously with other ingredients, while in treatment-II, the salt was added at the level of 20 or 30% during the quick salting operation and the mixture was left for 30 min. The various formulations tried for elaboration of different products are presented in Table 1.
Figure 1. Flow-diagram for processing of reconstituted salted and dried fillets from tilapia.
Table 1. Composition (%) of ingredients for elaboration of different products.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat flour</td>
<td>10</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Egg</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Salt</td>
<td>30</td>
<td>30</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>30</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>p-hydroxybenzoate (methyl)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Pre-pressing was done by putting the mixture (ground fish and salt) in a cheesecloth and exerting torsion at the extremities. The pressing and molding operation was performed in a modified press (Figure 2).

Drying of reconstituted fillets was done initially at a temperature of 45±2°C for different time periods. However, in the final experiments, drying was at a temperature of 50±2°C for 16 hours. The reconstituted fillets and the control

Figure 2. Modified press
sample were packed individually in medium density (0.93 g/cm³) polyethylene bags under vacuum.

The following codes (Figure 1) were assigned for fillets stored at different conditions:

FINC: Fillets "in nature" stored at freezing temperature (-17±1°C) for 0, 30, 60 and 90 days.
FSR: Fillets salted, and stored at refrigeration temperature (8.5±1.5°C) for 0, 5 and 10 days.
FSC: Fillets salted, and stored at freezing temperature (-17±1°C) for 0, 30, 60 and 90 days.
FSSR: Fillets salted and dehydrated, and stored at refrigeration temperature (8.5±1.5°C) for 0, 30, 60 and 90 days.
FSSA: Fillets salted and dehydrated, and stored at ambient temperature (28±2°C) for 0, 30, 60 and 90 days.

Product Analysis:

Determinations of moisture, ash, fat, and salt content were according to methods described by A.O.A.C. (1982). Total protein and TBA analyses were according to methods described by Pearson (1975). Microbial counts were determined by methods described by the American Public Health Association (1976).

The desalting of reconstituted salted and dried fillets was carried out by leaching the products three times in boiling water. The product and water proportion was 1:20 with leaching for 10 min. The rehydration ratio was calculated by dividing the rehydrated weight by that of the dehydrated sample.

The sensorial evaluation was undertaken after desalting, rehydration, and frying of reconstituted fillets. Frying of fillets was done at a temperature of 200±5°C for 2 min. After frying, the reconstituted fillets were cut in cubes of 1 cm³ approximately, codified, and presented for evaluation. A panel of 10 trained persons evaluated products B and F for the preference test between the products.

RESULTS AND DISCUSSION

Chemical and Microbiological Composition:

Chemical and microbiological composition of fresh tilapia do nilo based on analysis of 5 samples in duplicates is
presented in the Table 2. The values are in agreement with those reported by Freitas (1979) for the same species. It should be noted that the low fat content (1.7%) makes tilapia suitable for quick salting process since one of the principal problems for quality of salted fish products is the rancidity. Furthermore, its low TBA value (0.34) also makes it more appropriate for elaboration of salted and dried products.

Table 2. Chemical and microbiological composition of tilapia.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Maximum value</th>
<th>Minimum value</th>
<th>Average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (%)</td>
<td>80.50</td>
<td>78.90</td>
<td>79.70</td>
</tr>
<tr>
<td>Protein (%)</td>
<td>17.86</td>
<td>17.75</td>
<td>17.80</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>2.00</td>
<td>1.32</td>
<td>1.70</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>0.81</td>
<td>0.79</td>
<td>0.80</td>
</tr>
<tr>
<td>pH</td>
<td>6.5</td>
<td>6.3</td>
<td>6.4</td>
</tr>
<tr>
<td>TBA No. (mg of malonaldehyde/1000 g)</td>
<td>0.35</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td>Mesophilic count (CFU/g)</td>
<td>7.9x10^5</td>
<td>5.6x10^5</td>
<td>6.7x10^5</td>
</tr>
<tr>
<td>Psychrophilic Count (CFU/g)</td>
<td>8.8x10^5</td>
<td>8.1x10^5</td>
<td>8.4x10^5</td>
</tr>
<tr>
<td>Molds and yeasts (CFU/g)</td>
<td>4.0x10^3</td>
<td>1.3x10^3</td>
<td>2.6x10^3</td>
</tr>
</tbody>
</table>

Salting:

In treatment-II, the two salt concentrations tried for a 30 min quick salting operation were 20 and 30%, and the moisture contents of the ground fish after the treatment were 60.6 and 59.4% respectively (Figure 3). Del Valle and Nickerson (1968) reported a moisture content of 57.7% for products treated with 20% salt. Since in the elaboration of reconstituted salted and dried fillets, there would further be operations like pressing and drying, the salting treatment at lower level of 20% was standardized. It is known that higher quantity of salt utilized in the treatment will result in greater difficulty in its removal during desalting and rehydration processes. Furthermore, salting at higher concentrations results in increased costs as well as adversely affects organoleptic characteristics such as texture and flavor.
Addition of Ingredients:

The formulations presented in Table 1 were designed to select optimal concentrations of different ingredients to develop a high quality product suited for the local market. While comparing products A and B, in the product A (prepared with 10% wheat flour), a difficulty in the formation of cohesive blocks after pressing and thus maintaining its integrity, was observed. It was therefore decided to standardize the wheat flour concentration at 20% in the formulation.

Formulations with and without egg (Products C and D) were tested to verify the eggs property of aglutenization. These experiments were performed in treatment-I to minimize the effect of other variable parameters or operations as in treatment-II. No noticeable effect due to the addition of egg was observed, however, its addition presented difficulties during drying, and hence its elimination was standardized in the formulation.

The only difference in the formulations between products D and E was in the concentration of salt. Product D had 2% salt while product E had 3%. The formulation of 3% was standardized since products elaborated with this concentration in treatment-I resembled taste-wise to those desalted
and rehydrated products obtained from the reconstituted salted and dried fillets prepared in treatment-II.

Since wheat flour has been used as one of the ingredients, it was necessary to include a fungistat, methyl p-hydroxybenzoate, at a concentration of 250 ppm, in the formulation.

Pressing:

The objective of this operation was to give a form to the products, and at the same time, decrease its moisture content. A press designed for this purpose (Figure 2) was used. About 80 g sample was standardized for the final pressing which resulted into a triangular form of about 10 cm (length) x 6.5 cm (maximum diameter) x 1 cm (thickness).

Drying:

Initially, the reconstituted salted fillets were dehydrated in a forced air circulation cabinet dryer at 45±2°C for a period sufficient to attain about 20% moisture in the fillets. The drying time at 45±2°C was found to be 20 hours. To make the drying operation more efficient, the drying temperature was raised to 50±2°C and the drying time was optimized at 16 hours (Figure 4).

Figure 4. Effect of drying time at 50±2°C on moisture content of reconstituted fillets.
Desalting and Rehydration:

An evaluation of salt concentration in products B (elaborated with the addition of egg) and F (elaborated without egg) was undertaken after desalting and rehydration. Results (Table 3) demonstrate that there was practically no variation in the water retention capacity of the two products. Also no variation was evident in the weights of the two products after frying. The salt content after the third leaching in the two products was below 2%, which increased to about 3% after frying.

Preliminary sensory evaluation for the preference test between products B and F resulted in five members preference for product F, three members preference for product B, and two members did not find any difference between the products.

Table 3. Desalting, Rehydration and Salt Content of Reconstituted Fillets.

<table>
<thead>
<tr>
<th>Product</th>
<th>Treatment</th>
<th>No. of leaching</th>
<th>Salt content (%)</th>
<th>Rehydration ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Desalting</td>
<td>1</td>
<td>3.8</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2.9</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>1.8</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>Salt content (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>after frying</td>
<td>-</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Desalting</td>
<td>1</td>
<td>3.9</td>
<td>1.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>3.0</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>1.9</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>Salt content (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>after frying</td>
<td>-</td>
<td>3.0</td>
<td></td>
</tr>
</tbody>
</table>

Rancidity Index:

The rancidity index was assessed by determining the TBA (mg of malonaldehyde per Kg of sample) values of reconstituted fillets stored for different time periods and also before and after frying. Results are presented in Figures 5 and 6 for reconstituted fillets before and after frying, respectively.

The TBA values of various products at the time of their
preparation varied between 0.86 and 0.90. These low values demonstrated the excellent state of the products in relation to the oxidation of lipids. The TBA values of all products decreased until 30 days of storage (Figures 5 and 6). Minimal variation in TBA values was observed with further increase in storage period (60 and 90 days). The TBA value for the product FSSA, on 30 days of storage before frying was found to be higher (0.52) in comparison with product FSSR (0.25). The TBA values decreased on frying which was observed in all products tested. Data demonstrate that the storage conditions do not promote rancification in reconstituted salted and dried fillets.

CONCLUSIONS

Principal processing conditions for the elaboration of reconstituted salted and dried fillets from tilapia do Nilo have been standardized as: (1) quick salting of 20% for 30 min, (2) mixing of 20% wheat flour and 250 ppm of methyl p-hydroxybenzoate to ground fish after salting and pre-pressing operations, (3) drying at 50°C for 16 hours.

REFERENCES


Figure 5. Effect of storage time on the rancidity of reconstituted fillets before frying.

Figure 6. Effect of storage time on the rancidity of reconstituted fillets after frying.
tance trials with quick salted fish cakes. J. Food Sci. 38:246-250.


ACKNOWLEDGEMENTS

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Before trying...

Figure 5. Effect of storage time on the tenacity of reconstructed fillets

Storage (Days)
Figure 6. Effect of storage time on the rancidity of reconstituted fillets after frying.
INTRODUCTION

Imported seafoods are becoming an increasingly important source of product for America's seafood consumer. Imported seafoods have continuously represented over 50 percent of the total edible seafood supplies in the U.S. since 1966. From 1966 to 1987, imports increased at an average annual rate of approximately 5 percent, in contrast to the domestic landings rate of increase of about 2 percent. Yet the rate of increase in imports is becoming even greater. Since 1980, imports of edible seafood seafood products have increased at an average annual rate of over 6 percent, compared to a decline of about 2 percent for domestic landings. Imports of edible seafood products reached a record 6.6 billion pounds (round weight) in 1987, which accounted for 63 percent of the total U.S. seafood supplies.

Although imports are important to U.S. seafood suppliers in general, imported product is even more important in meeting the demand for certain key Southeastern species. Faced with a growing domestic demand for high-quality finfish and shellfish products and stable sources of domestic product, suppliers of key Southeastern species will need to become better informed of import product sources, product form, seasonal
availability and obtainable volumes. This information will be particularly important to seafood suppliers wishing to begin import activities or expand existing operations. In addition, regional fishery managers need this information to gain a better appreciation for how imported seafood is becoming an increasingly important element of the domestic seafood market.

The purpose of this paper is to describe general trends in imports for selected seafood products arriving at Southeastern U.S. ports of entry. These trends will be discussed in terms of volumes, seasonality, fresh versus frozen, product form, and country of origin. The major ports of entry will also be identified.

DATA

The paper presents import data collected by the National Marine Fisheries Service (NMFS). These data were originally reported in the New Orleans "Goldenrod" Market News Report. Imports of many shellfish and finfish products are reported each Wednesday in the New Orleans Market News Report by port of entry, species, fresh or frozen, product form (i.e. whole, fillet, loins, other), country of origin, and volume received. "Whole" refers to product received eviscerated and/or head off. Although seafood imports are reported on a Wednesday, a lag of several days between product actually passing U.S. Customs and being reported in the Market News Report may occur. Import weight presented is product weight (i.e. weight of items received by Customs regardless of product form -- not converted to whole weight). Where possible, import volumes are compared to regional NMFS landings data for each species. "Country of origin" refers to country where product was first landed and exported (not transshipped).
A primary objective of the study was to compile the data, which had never been databased, and examine trends in imports of species key to the Southeast U.S. region. For the purpose of the study, only marine tropical and subtropical species (i.e. freshwater and cold water marine species are not included), arriving from primarily Latin American countries of origin, and entering Southeastern ports of entry (i.e. Brownsville/Port Isabel, TX; New Orleans, LA; Tampa, FL; Port Everglades, FL; Miami, FL; West Palm Beach, FL; Savannah, GA; Charleston, SC) were utilized. In addition, only data from fresh and frozen product were analyzed (e.g. canned/cured products excluded). Imports of shrimp products were also not included in the study since these data are already comprehensively reported in the monthly NMFS report entitled "Shrimp Statistics".

NMFS Market News data for 1983-1987 were utilized which included eight ports of entry, 54 countries of origin, and 68 finfish and shellfish species (Table 1). For the sake of brevity, only 18 species are reported in this study.

For each species, the average monthly distribution import volumes are discussed. The term "availability" is used in each of these discussions. This term implies that the volumes of imported product arriving each month reflects the relative availability of the species in the original country of origin. The reader should note however, that this discussion does not account for volumes of a given species which may have been exported to other destinations not reported by NMFS Market News.
<table>
<thead>
<tr>
<th>Table 1: Finfish and Shellfish Species Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albacore</td>
</tr>
<tr>
<td>Amberjack</td>
</tr>
<tr>
<td>Sea Bass</td>
</tr>
<tr>
<td>Cobia</td>
</tr>
<tr>
<td>Conch(^1)</td>
</tr>
<tr>
<td>Congrio</td>
</tr>
<tr>
<td>Corvina(^1)</td>
</tr>
<tr>
<td>Stone Crab</td>
</tr>
<tr>
<td>Lobster(^1)</td>
</tr>
<tr>
<td>Mahi Mahi(^1)</td>
</tr>
<tr>
<td>Drum, Black(^1)</td>
</tr>
<tr>
<td>Drum, Red</td>
</tr>
<tr>
<td>Flounder</td>
</tr>
<tr>
<td>Grouper(^1,2)</td>
</tr>
<tr>
<td>Grouper, Black</td>
</tr>
<tr>
<td>Grouper, Red</td>
</tr>
<tr>
<td>Grouper, Yellowedge</td>
</tr>
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<td>Grouper, Warsaw</td>
</tr>
<tr>
<td>Whiting</td>
</tr>
<tr>
<td>Kingclip(^1)</td>
</tr>
<tr>
<td>Langostinos</td>
</tr>
<tr>
<td>Mackeral, King(^1)</td>
</tr>
<tr>
<td>Mackeral, Spanish(^1)</td>
</tr>
<tr>
<td>Marlin(^1)</td>
</tr>
<tr>
<td>Mullet</td>
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<tr>
<td>Octopus</td>
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<td>Pomfrets</td>
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<td>Pompano(^1)</td>
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<td>Scallops(^1)</td>
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<td>Shark(^1,2)</td>
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<td>Shark, Thresher</td>
</tr>
<tr>
<td>Sheepshead</td>
</tr>
<tr>
<td>Snapper(^1,2)</td>
</tr>
<tr>
<td>Snapper, Black</td>
</tr>
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<td>Snapper, Lane</td>
</tr>
<tr>
<td>Snapper, Mutton</td>
</tr>
<tr>
<td>Snapper, Mangrove</td>
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<tr>
<td>Snapper, Red</td>
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<td>Snapper, Spotted</td>
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<td>Snapper, Tomato</td>
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<td>Snapper, Vermillion</td>
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<td>Snapper, Yellowtail</td>
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<tr>
<td>Squid</td>
</tr>
<tr>
<td>Swordfish(^1)</td>
</tr>
<tr>
<td>Tilefish(^1)</td>
</tr>
<tr>
<td>Tongue</td>
</tr>
<tr>
<td>Triggerfish</td>
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<td>Trout, Sea(^1,2)</td>
</tr>
<tr>
<td>Trout, Sand</td>
</tr>
<tr>
<td>Trout, Spotted</td>
</tr>
<tr>
<td>Trumpeter</td>
</tr>
<tr>
<td>Tuna</td>
</tr>
<tr>
<td>Tuna, Big Eye</td>
</tr>
<tr>
<td>Tuna, Yellowfin</td>
</tr>
<tr>
<td>Mahoo</td>
</tr>
</tbody>
</table>

\(^1\) Species discussed in this study.

\(^2\) Species discussed in aggregate, without details presented on individual species of grouper, snapper, or shark.
DISCUSSION

All Species

The total volume of imports for the 68 species arriving in the Southeast U.S. ports of entry increased from 17.4 million pounds in 1983 to 70.4 million pounds in 1987 (Figure 1). This represents an approximate fourfold increase or an annual percentage increase of 42 percent over the 5-year period. Monthly volumes varied considerably. Although the seasonal distribution of imported product varies by species, monthly 5-year averages indicate that import volumes for all species remain fairly consistent from month to month, with the late summer and fall months accounting for a slightly larger share of the volume for an average year.

As the total volumes of imports have increased, so have the numbers of species imported. Although snapper, grouper, seatrout, swordfish, and mackerel continue to be important mainstays, new species such as congrio, dorado, pomfrets, corvina, kingklip, mako shark, and others are being imported in increasing amounts. In 1983, a total of 32 species were being reported by Customs (Figure 2). By 1987, the number of species had risen to 60. The growing strength of the U.S. seafood market has provided inroads for some of these lesser known, "non-traditional" species. Development of markets for such species may become increasingly important if the domestic demand for seafood continues to grow at current paces.

Prior to 1986, the volume of frozen seafood products imported into the Southeast U.S. exceeded that for fresh products. In 1983, the volume of frozen exceeded fresh product by nearly threefold (Figure 3). However, in 1986 and 1987, fresh imports exceeded frozen by approximately 25 percent.
FIGURE 1
IMPORTS OF KEY SPECIES INTO SOUTHEASTERN PORTS OF ENTRY: 1983-87

DATA SOURCE: MRF Market News Reports

FIGURE 2
NUMBERS OF KEY SPECIES IMPORTED INTO SOUTHEASTERN PORTS OF ENTRY 1983-87

DATA SOURCE: MRF Market News Reports
Seafood is imported in a variety of product forms. Brokerage reports indicate that product is received in whole form, fillets, loins, portions, and "other". The latter term refers primarily to shellfish products, such as crab meat, lobster tails, and scallop meats. The predominant product form for all species in general imported during the 1983-87 period was whole product. However, the importance of this product form declined following 1986 (Figure 4). For example, whole product represented 93 percent of the seafood imports in 1983, but declined to 58 percent in 1987. A rapid increase in the import volume of fillets (6.8 million pounds in 1986 to 15.5 million pounds in 1987) suggests an increase in demand for the more processed finfish products. Although the advent of reporting miscellaneous product forms in 1986 somewhat clouds the message statistically, the data suggest that the import market is responding to an increased market demand for prepared (i.e. filleted) finfish product.

Major sources of imported product also changed over the 5-year period. In both 1983 and 1987, six countries provided at least 70 percent of the seafood import volume, while the remaining 30 percent was exported to the southeastern U.S. from a number of other countries. The leading six countries, however, changed following 1983 (Figure 5). In 1983, the major country of origin for imports was Mexico (31 percent), followed by Costa Rica, Peru, Honduras, Belize, and Bahamas. By 1987, three new countries had moved into the top six, with all six contributing a more equal share of the seafood export market to the U.S. Mexico was still the leading source in 1987, followed by Ecuador, Costa Rica, Panama, Peru, and Chile. Other countries exporting lesser volumes to the U.S., include Venezuela, Honduras, El Salvador, and Argentina.
FIGURE 3
IMPORTS OF KEY SPECIES INTO
SOUTHEASTERN PORTS OF ENTRY: 1983-87
FRESH vs FROZEN

![Bar Chart](image)

DATA SOURCE: NMFS Market News Reports

FIGURE 4
IMPORTS OF KEY SPECIES INTO
SOUTHEASTERN PORTS OF ENTRY: 1983-87
WHOLE vs FILLETS

![Bar Chart](image)

DATA SOURCE: NMFS Market News Reports
Snapper

Imports of all species of snapper into Southeastern U.S. ports of entry increased from 4.8 million pounds in 1983 to 14.0 million pounds in 1987 (Figure 6). This reflects an average annual percentage increase of 33 percent. Snapper imports nearly doubled from 1984 to 1985. The significance of these imported products to meeting domestic demand for snapper is suggested by comparing southeast snapper landings to imports. As imports increased during the 1983-87 period, landings of snapper in the southeast declined by annual average rate of 6.8 percent. Imports exceeded landings volume for the first time in 1985. Landings of snapper declined dramatically in 1987, as import volume continued to rise. The monthly distribution of snapper imports is somewhat variable, with peak 5-year averages occurring in April, July, and September (Figure 7). Imported snapper products are apparently not as readily available in the winter months.

Market News data identifies several species of snapper being imported into Southeastern ports of entry. Those include black, lane, mutton, red, spotted, vermilion, yellowtail, and "tomatoe" snapper. In addition, a large category of unclassified volume is reported. In 1987, the unclassified snapper imports represented 88 percent of the total volume, followed by red (9 percent), yellowtail (2 percent), and lane (1 percent). The remaining species represented only a small volume of the total.

Import volume of fresh snapper consistently exceeded that for frozen products. In 1983, fresh snapper imports represented 68 percent of the total snapper imports (Figure 8). By 1987, fresh snapper imports
FIGURE 5
IMPORTS OF KEY SPECIES BY COUNTRIES OF ORIGIN: 1983 and 1987

1983: 17.4 million lbs
1987: 70.4 million lbs

DATA SOURCE: NWF Market News Reports

FIGURE 6
SOUTHEAST U.S. SNAPPER LANDINGS AND IMPORTS: 1983-87

DATA SOURCE: NWF data, import product weight given. All species included.
FIGURE 7
FIVE-YEAR AVERAGE MONTHLY DISTRIBUTION
OF SOUTHEAST U.S. SNAPPER IMPORTS

![Bar chart showing the average monthly distribution of Southeast U.S. snapper imports from January to December.]

DATA SOURCE: NMFS Market News Report
Data pertains to 1983-87.

FIGURE 8
IMPORTS OF SNAPPER INTO SOUTHEASTERN
PORTS OF ENTRY: 1983-87
FRESH vs FROZEN

![Bar chart showing the comparison of fresh and frozen imports of snapper from 1983 to 1987.]

DATA SOURCE: NMFS Market News Reports
accounted for 87 percent of the total. Frozen snapper imports in 1987 (1.8 million lbs.) were only slightly higher than reported for 1983 (1.6 million pounds).

Snapper is primarily imported in whole form. In 1987, 12.6 million pounds of whole snapper was imported to southeastern U.S. ports of entry, which represented 90 percent of the total snapper import volume (Figure 9). This percentage distribution between whole and filleted product has remained relatively constant during the 1983-87 period.

The major countries of origin for snapper products has remained relatively constant over the past five years. In 1983, Costa Rica and Mexico contributed 44 and 30 percent, respectively, of the total volume of snapper imports reported (Figure 10). Brazil and Venezuela were also major sources of product. By 1987, Mexico remained the most important single source of snapper, with Venezuela and Costa Rica each supplying 18 percent of the volume arriving at southeastern U.S. ports of entry. Panama and Guatemala provided 12 and 5 percent, respectively. The Central American region has, therefore, become the leading source of snapper products for the southeastern U.S. region. Approximately 86 percent of the total volume of snapper imports arrived through Miami. The remaining volume arrived through Brownsville and Port Everglades.

**Grouper**

The volume of grouper imports into the southeastern U.S. increased dramatically during the 1983-87 period. Grouper imports increased from .5 million pounds in 1983 to 8.9 million pounds in 1987 (Figure 11). This represents an average annual increase of 122 percent over the five-year period! Grouper landings in the Southeast region remained stable through 1986, but decreased to 9.5 million pounds in 1987.
FIGURE 9
IMPORTS OF SNAPPER INTO SOUTHEASTERN PORTS OF ENTRY: 1983-87
PRODUCT FORMS

DATA SOURCE: NMFS Market News Reports

FIGURE 10
IMPORTS OF SNAPPER BY COUNTRY OF ORIGIN
1983 AND 1987

DATA SOURCE: NMFS Market News Reports
This represents an annual average decrease in grouper landings of 5.8 percent since 1983. Grouper imports are relatively more abundant in the fall months, with April also being an important month for grouper import arrivals (Figure 12).

Several varieties of grouper are imported from Latin American sources. In 1987, the species reportedly imported were black, red, yellowedge, and warsaw grouper. As with snapper, the majority of grouper imported were unclassified by Customs. This unclassified category represented 96 percent of the total grouper imports in 1987. Yellowedge and red grouper represented 2 and 1 percent of the total, respectively.

Import volumes of fresh grouper have dominated the southeastern grouper import market since 1984 (Figure 13). However, the rate of increase in fresh imports declined dramatically from 1986 to 1987. During the same period, frozen grouper imports increased from 1.4 million pounds to 1986 to 3.3 million pounds in 1987, after having remained stable for 1983 to 1985. Currently unavailable data for 1988 will be needed to determine if the increased importance of frozen grouper will continue.

Grouper imported in whole form remained the most important product form during the 5-year period. However, filleted grouper accounted for 33 percent of total import volumes in 1987. Loins and portions were of less importance, representing only 2 percent of the total (Figure 14).

During the 1983-87 period, three countries provided over 80 percent of the imported grouper product arriving at southeastern U.S. ports of entry (Figure 15). Mexico was the most important source of grouper product from 1983 to 1987, providing approximately one half the total
FIGURE 11
SOUTHEAST U.S. GROPER LANDINGS AND IMPORTS: 1983-87

DATA SOURCE: NMFS data. Imports product weight given. All species included.

FIGURE 12
FIVE-YEAR AVERAGE MONTHLY DISTRIBUTION OF SOUTHEAST U.S. GROPER IMPORTS

FIGURE 13
IMPORTS OF GROUPER INTO SOUTHEASTERN PORTS OF ENTRY: 1983-87
FRESH vs FROZEN

![Graph showing imports of grouper into southeastern ports of entry: 1983-87, comparing fresh vs. frozen.]

DATA SOURCE: MFS Market News Reports

FIGURE 14
IMPORTS OF GROUPER INTO SOUTHEASTERN PORTS OF ENTRY: 1983-87
PRODUCT FORMS

![Graph showing imports of grouper into southeastern ports of entry: 1983-87, comparing product forms.]

DATA SOURCE: MFS Market News Reports
supply. Costa Rica and Chile provided an additional 12 and 10 percent, respectively, in 1987. Ecuador also became an important source by 1987, providing 7 percent of the total volume exported to the southeastern U.S. The remaining 20 percent was supplied by Ecuador, Dominican Republic, Argentina, Panama, Guyana (in order of importance), and others. Miami served as the major port of entry for grouper products. Approximately 82 percent of the grouper imports arrived through Miami, with 18 percent arriving in Brownsville. Lesser volumes arrived in Savannah, Port Everglades, West Palm Beach and New Orleans.

**Mahi-Mahi (Dolphin)**

Mahi-mahi imports remained below 1 million pounds through 1985, doubled in 1986, and increased dramatically to 7.4 million pounds in 1987 (Figure 16). Monthly distribution of imported product is fairly even, with peak 5-year average months being April, May, and June (Figure 17). Landings of mahi-mahi in the southeast region have been fairly stable, with production increasing from 318,000 pounds in 1983 to 507,000 pounds in 1986. Landings then increased to 645,000 pounds in 1987. Import volumes exceeded landings for the first time in 1985.

Prior to 1986, mahi-mahi was imported primarily as frozen product (Figure 18). In contrast to snapper and grouper, however, the majority of mahi-mahi imported into southeastern ports of entry since 1985 has been fresh product. In 1986, fresh product represented 74 percent of the total import volume. This increased to 83 percent in 1987.

Prior to 1987, the composition of the total volume of mahi-mahi imports was not consistently dominated by either whole or filleted product. However, whole product accounted for 84 percent of the total volume in 1987, as compared to 74 percent in 1986 (Figure 19 ). The
FIGURE 15
IMPORTS OF GROUPER BY COUNTRY OF ORIGIN: 1983 AND 1987

DATA SOURCE: NRFS Market Share Reports

FIGURE 16
SOUTHEAST U.S. DOLPHIN (MAHI-MAHI) LANDINGS AND IMPORTS: 1983-87

DATA SOURCE: NRFS Market Share Reports. Import product weight given.
FIGURE 17
FIVE-YEAR AVERAGE MONTHLY DISTRIBUTION
OF SOUTHEAST U.S. MAHI-MAHI IMPORTS

DATA SOURCE: NOAA Market News data.
Data refers to 1983-87.

FIGURE 18
IMPORTS OF MAHI-MAHI INTO SOUTHEASTERN
PORTS OF ENTRY: 1983-87
FRESH vs FROZEN

DATA SOURCE: NOAA Market News Reports
dramatic increase in the volume of whole product may be due to the
versatility demanded by a strengthening domestic restaurant market
for mahi-mahi, although market data are not available to support this
hypothesis.

A shift in countries of origin has occurred for mahi-mahi during
the 1983-87 period (Figure 20). Approximately 99 percent of the mahi-
mahi exported to the southeastern U.S. ports of entry in 1983 originated
from oriental countries. Taiwan and Japan provided 65 and 34 percent,
respectively, of the total volume in 1983. By 1987, however, Central
and South American sources were dominating the market. Ecuador and
Costa Rica accounted for 51 and 40 percent, respectively, of the total
volume of mahi-mahi import volume in 1987. The remaining 9 percent
came primarily from Peru. All reported mahi-mahi imports arrived through
Miami.

SUMMARY

As the demand for seafood in the U.S continues to strengthen,
increased pressure will be exerted on domestic seafood suppliers to
find alternative sources of seafood. The import market will likely
continue to grow in importance in the near future. Specifically, an
increased dependence on Latin American countries has developed for
providing supplies of tropical/subtropical finfish and shellfish species
to a growing U.S. seafood market.

The volume of seafood imports arriving at Southeastern U.S. ports
of entry has increased steadily since 1983. Along with this increase
in volume has been an increase in the diversity of species. Many non-
traditional species have become important components of the species
FIGURE 19
IMPORTS OF MAHI-Mahi INTO SOUTHEASTERN PORTS OF ENTRY: 1983-87
PRODUCT FORMS

<table>
<thead>
<tr>
<th>Year</th>
<th>Whole</th>
<th>Fillets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1984</td>
<td></td>
<td></td>
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<tr>
<td>1985</td>
<td></td>
<td></td>
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<tr>
<td>1986</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DATA SOURCE: NOAA Market News Reports

FIGURE 20
IMPORTS OF MAHI-Mahi BY COUNTRIES OF ORIGIN: 1983 AND 1987

1983: 1.18 Million Lbs
1987: 7.4 Million Lbs

DATA SOURCE: NOAA Market News Reports
complement available to domestic seafood suppliers. The market continues
to be dominated by fresh product, imported in whole form. However,
this relationship may vary from species to species. In addition, the
apparent monthly "availability" of imported finfish and shellfish varies
by species. A knowledge of these and other aspects of the imported
seafood market may be useful to domestic seafood suppliers wishing
to enter the import market or expand existing seafood importing
activities.