CONSUMER SURVEY OF POND RAISED CATFISH TO ESTABLISH A STANDARD LEVEL OF FLAVOR ACCEPTABILITY.

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Catfish off-flavors have frequently prevented the transfer of live catfish from the farm to the processor. Traditionally, the acceptability of fish from the farmer is based on the opinion of “taste testers” trained to recognize the variety of off-flavor bouquets that may be present in amounts from trace or threshold to very strong. The sensitivity of the “taste testers” palates increase with experience and are presumed to be more sensitive than that of the average consumer. As much as 90% of fish taste tested by some processors has been rejected due to off-flavor detection. With this high rejection rate based on off-flavor, processors have not been operating at peak production and consequently have lost man hours and money. To address this concern, it was the objective of this research to determine whether trained catfish “taste testers” have been overly sensitive to off-flavors, rejecting catfish when the fish flavor would readily have been very acceptable to the average consumer.

MATERIALS AND METHODS

SENSORY PANEL

Catfish consumers (persons who consume catfish at least once/month) were recruited from the Louisiana State university community of faculty, staff(including food service managers), and students and personnel from a local nuclear power plant(engineers, managers, trainers, secretarial staff). The total consumer panel, consisted of 56 persons, with each person evaluating duplicate samples of catfish provided by Cargill.

CATFISH SAMPLES AND PREPARATION

Catfish samples were provided by a local catfish processor and included fish containing no off-flavor(O) to varying amounts of off-flavor graded from threshold (th-lowest) to one(1), two(2) and three(3-highest) as determined by the “taste testers” at the processing plant. Fish fillet samples were baked from a frozen state at 325°F in pyrex dishes with lids for approximately 20-25 minutes until they lost opacity and were determined to be completely cooked but not over cooked. Samples were assigned random numbers and cut into approximately 30 g portions and placed in 5 oz plastic souffle cups with lids for presentation to panel members. Duplicate samples were assigned different numbers before presentation to the panel.
SENSORY EVALUATION

Using a randomized complete block design, each panelist was presented every sample in duplicate for evaluation of acceptability. Panelists were asked to complete a brief survey of personal history (form inclosed) before evaluating the catfish.

RESULTS

SENSORY PANEL DESCRIPTION:

Thirty one (31) members of the Louisiana State University Community participated in consumer panel. Of these, 10 were managers of various food service facilities on campus, 17 were either faculty or graduate students, and the remaining 4 were members of the housekeeping staff at LSU. Ten members of the faculty and graduate students were experienced in participating in food sensory analysis and were classified as the expert panel. The remaining 25 panelists were personnel from a local nuclear power plant facility. Of these 25, 17 were managers or engineers and the remaining 8 were from the secretarial staff. The total “overall” panel was 48% male and 52% female and consisted of every member participating from all groups. The age variations were divided into three groups with the following breakdown: 22 were age 0-30 (youngest-21), 27 were between 30-50 yr, and 7 were over 50 (oldest-62). Panelists were asked to designate a region of origin that they considered influenced their taste preferences with the following results: The largest group was local with 39 from South Central (Louisiana, Arkansas, and Texas). The other groups were 5-Southeast, 3-Northeast, 2-Midwest, 5-Southwest, 2-foreign countries, O-Northwest. Panelists were asked to give the number of times each month that they ate catfish with the following results: 11 - once/month, 10 - twice a month, 10 - three/month, and 24 - four or more times/month. Preference of cooking method was breaded and fried (68%), with other preferences including baked, broiled, or blackened.

ACCEPTABILITY SCORES:

The overall panel rated fish known to have no off flavor with 58% acceptability (Fig. 1). The fish with some off-flavor (th, 1, 2) all received higher acceptability scores with 82, 78, and 64%, respectively. The lower acceptability of the catfish having no off-flavor could be explained by the lack of experience of the panelists with the corny/buttery flavor associated with grain fed pond reared catfish. Catfish with level 3 off-flavor were scored the lowest with a 21% acceptability. The nearly 25% acceptability rating for these fish was not expected due to the very strong muddy/musty odor and flavor exhibited by the fish in this group.

Fish evaluated by the expert panel alone were more in linear agreement with the company taste-testers evaluation with 100% acceptability for the fish with no or threshold off flavor (Fig. 1). Level 2 and 3 fish were acceptable 70-75 % and level 3 was totally rejected by this group.
Acceptability scores of male and female panelists showed differences in preference for level of off-flavor (Fig. 2). Male panelists preferred some off-flavor, rating the threshold, level 1, and level 2 off-flavor higher in acceptability than the samples with no off-flavor. The female panel however, showed a preference for samples with level 1 or less off-flavor.

When the panel was divided among professions it was interesting to note that the food service personnel rated the threshold off-flavor at 100% acceptability (Fig. 3). The professional and academic panelists preferred some off flavor to no-off-flavor. Classified employees preferred samples with level 2 off flavor with level 1 and threshold coming in second and third in preference.

Acceptability scores based on region of food preference origin were somewhat different (Fig. 4). However, several of the groups were of small sample size (midwest and foreign countries). Panelists from the Southeast and South Central areas rated the acceptability quite similarly with greater than 60% acceptability for catfish with no, threshold, level 1, and level 2 off-flavor. Panelists from the midwest preferred all the samples with off-flavor to samples with no off-flavor. Panelists from the northeast preferred the no or low off-flavor with complete rejection of samples at level 3 off-flavor. Southwest panelists had the lowest acceptability rating of any group with 50% acceptability of catfish with no to level 2 off-flavor.

When the panelists were divided by age (Fig. 5), there was little difference in ratings of fish with no, threshold, and level 1 off flavor. However, samples of level 2 catfish off-flavor rated with a high acceptability by the two older groups of panelists. The oldest group of panelists even rated the level 3 off flavor sample with a near 60% acceptability. This could be explained first by the known fact that aging reduces sensitivity to flavor intensities with this group not perceiving the very strong off-flavor or secondlythat the older panelist prefer the wild catfish flavor over the pond raised corny flavor since the wild flavor is likely the way they expect catfish to taste.

**PROBABILITY HISTOGRAMS**

Probability histograms were constructed to predict consumer acceptability for varying levels of catfish off-flavor. The histograms with the largest sample base included the overall panel, the professional, tire academic, South Central region and the 30-50 yr. All of these panels showed similar histogram patterns with a density curve peaked at the threshold of off-flavor.

**CONCLUSION**

From the results of this experiment, it was evident that the current standards of this processor's taste-testers were much more stringent than the consumer panel required or even preferred. The results of this study indicated that what has recently been rated as threshold and level 1 off-flavor were definitely acceptable by this consumer panel and could presumed to be acceptable for processing. Catfish with level 2 off-flavor were nearly as well received but may be considered borderline at this time. Level 3 off-flavor was definitely not acceptable to most of the panelist.
REFERENCES


Procedures

Catfish sample graded by processor 0-3 off-flavor

Shipped to LSU

Cooked

Acceptability by Panel

Statistics
Fig. 1 Catfish Acceptability Expert and Consumer Panels

% Acceptability

OFF-FLAVOR

- none
- threshold
- one(1)
- two(2)
- three(3)
Fig. 2 Catfish Acceptability by Gender

<table>
<thead>
<tr>
<th>% Acceptability</th>
<th>Male</th>
<th>Female</th>
</tr>
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<tbody>
<tr>
<td>None</td>
<td>90</td>
<td>80</td>
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<tr>
<td>Threshold</td>
<td>80</td>
<td>70</td>
</tr>
<tr>
<td>One (1)</td>
<td>70</td>
<td>60</td>
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<tr>
<td>Two (2)</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Three (3)</td>
<td>50</td>
<td>40</td>
</tr>
</tbody>
</table>
Fig. 3  Catfish Acceptability by Profession
Fig. 4 Catfish Acceptability by Origin of Birth
Fig. 5  Catfish Acceptability by Age
Oysters commercially harvested September 1994 and April 1995 from Black Bay, Louisiana were processed as live boxed, shucked 1202. (packed in ice), and frozen half-shell products, and shipped by commercial refrigerated truck for irradiation processing at Food Technology Services, Inc. Live shellstock were held at the recommended temperature of 40°F from harvest through sampling. The ambient levels of *V. vulnificus in the oysters* were 4.6 X 10^5 MPN/g in September 1994 (water 80°F) and 1.5 X 10^5 MPN/g in April 1995 (water 69°F). Two 60 lb. boxes of live oysters were each treated at minimum levels of 0.0 (controls), 0.5, 1.0, 1.5 and 2.0 KGy (400 animals per dose). The dose ratios were calculated to be about 2: 1. Levels of *V. vulnificus*, total aerobic plate counts and % cumulative mortality were enumerated through day 14 post harvest for the September 1994 sample, and through day 28 post harvest for the April 1995 sample. Oysters treated with doses of 0.5 KGy and 1.0 KGy did not show significantly higher mortalities than the unirradiated control group, but did show a very significant 4 log reduction in levels of *V. vulnificus at 0.5 KGy* and 5 log reduction at 1.0 KGy 2 days post irradiation (4 days post harvest) for the September 1994 samples. The April 1995 samples were reduced to below detectable levels at all doses. Commercial shucking, washing/blowing and packing or freezing in the half-shell also reduced levels of *V. vulnificus* 3-5 logs by 14 days post harvest. Additional irradiation processing of these products reduced levels to below detectable MPN/g. Freezing shucked non-irradiated oysters cryogenically in CO2 and in blast freezers also showed significant 3 log reductions in *V. vulnificus levels* one week post freezing and 4 log reduction by 8 weeks post freezing. There was no significant difference between the two freezing methods.

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Acknowledgements:
Michael Rabalais and Darren Duet for research technical assistance; Motivatit Seafoods, Fox Seafoods, Leavins Seafoods, RD Seafoods, Morgan Seafoods, Cowart Seafoods and Food Technology Services, Inc. for commercial harvesting, processing, shipping and irradiation processing of Louisiana oysters.

Presented to the Seafood Science and Technology Society of the Americas 1995, November 5-9, Humacao, Puerto Rico.
METHODS

This study evaluated the feasibility and effectiveness of actual commercial level harvesting, processing, packaging and shipping of live shellstock in 60 lb (200 count) boxes, cases of shucked 12 oz containers of fresh oysters (12 per case), and cases of 1/2 shell frozen oysters for commercial irradiation processing.

- Shellstock oysters were commercially harvested in September 1994 (end of spawning season) from Louisiana, shipped by refrigerated truck (40°F) to Florida and Virginia for further processing and packaging, and from there to Food Technology Services, Inc. for irradiation processing.

  - In Florida, ten 60 lb. boxes of 200 count live shellstock and 8 cases of 12 each 12 oz. shucked fresh oyster were commercially packaged.

  - In Virginia, the oysters were shucked on the half shell, shrink-wrapped, on a Styrofoam tray for 6 half-shell oysters and cryogenically package quick frozen (PQF) with CO2.

- At Food Technology Services, Inc. two 60 lb. boxes of live shellstock oysters were each treated with minimum levels of 0.0 (controls), 0.5, 1.0, 1.5 and 2.0 KGY (400 animals per dose).

  - Two cases of 12 oz. fresh shucked oysters were each treated with minimum dose levels of 0.0 (controls) 1.0, 1.5 and 2.0 KGY.

  - Sixteen PQF trays of 6 half-shell oysters/tray were each treated with minimum dose levels of 0.0 (controls), 1.0, 2.0, 3.0 and 5.0 KGY.

  - Eight samples of 12 washed and blown oysters were vacuum-packed in non-permeable Mylar bags and commercially package quick frozen (PQF) by two commercial methods: CO2 cryogenic freezing at -600F and blast freezing at -200F. The were not subjected to further irradiation processing. One 12 oyster bag from each freezing method was sampled each week post freezing for 8 weeks.

  - The processed oysters were returned to NSU by commercial refrigerated truck (40°F) and analyzed for MPN/g V. vulnificus, total APC, and % cumulative mortality (liveshellstock only).

  - This was repeated in April, 1995 for live shellstock and fresh shucked oysters to evaluate % mortality at the beginning of spawning season.
RESULTS

Live Shellstock Irradiated Oysters
- Doses of 0.5 and 1.0 KGy showed significant 5 log reduction in levels of *V. vulnificus* (4.6 x 10^6 to 4.6 and 2.3 MPN/g respectively) without causing significant increases in mortality as compared to the controls through 14 days post harvest (shelf life for live oysters).

Fresh Shucked Irradiated Oysters
- There were no detectable levels of *V. vulnificus* in irradiated fresh shucked oysters, even at the lowest dose of 1.0 KGy.
- Even non-irradiated controls dropped from 4.6 x 10^6 to < 5 MPN/g by 14 days post harvest on ice in cold storage at 40°F; by 17 days at 40°F, there were no detectable *V. vulnificus* in non-irradiated controls.

Half-Shell Frozen Irradiated Oysters
- There were no detectable levels of *V. vulnificus* in any of the irradiation-processed frozen half-shell oysters, even at the lowest dose of 1.0 KGy; non-irradiated controls dropped to <10 MPN/g after 2 months.

Shucked, Washed and Blown Oysters Vacuum-Packed in non-permeable Mylar Bags and PQF by CO2 Cryogenic Freezing and Blast Freezing
- Levels of *V. vulnificus* dropped significantly by 3 logs from 4.6 x 10^5 MPN/g to 2.5 X 10^2 in CO2 frozen and 2.1 X 10^2 in blast frozen 5 days post freezing. By 8 weeks post freezing, levels of *V. vulnificus* had dropped 4 logs to 9 MPN/g in both freezing methods.

CONCLUSIONS/ RECOMMENDATIONS

- 0.5 and 1.0 KGy are effective in greatly reducing or eliminating *V. vulnificus* from live, fresh shucked or frozen oysters commercially.
- High mortalities even in control live oysters were mainly attributed to the weakened physiological state of the oysters in September and April, and the cold storage temperature of 40°F.
- Frozen shrink-wrapped half-shell oysters irradiated even at the lowest dose level of 0.5 KGy show complete elimination of *V. vulnificus*, and have practically unlimited shelf-life. These Products have the greatest large retail market potential for a processed half-shell oyster.
- Freezing of processed shucked and washed oysters either cryogenically or in blast freezers without further irradiation processing also shows tremendous reduction of *V. vulnificus* levels from 10^5 to 10^2 within 2 months of frozen storage.
THE EFFECT OF IONIZING IRRADIATION ON V. vulnificus POPULATION IN LIVE SHELLSTOCK OYSTERS

Harvested September 20, 1994 (Water Temp. 83°F)

Irradiated September 22, 1994

Days Post Harvest

Log MPN V/g

0.0 KGY  ■  0.5 KGY  □  1.0 KGY  □  1.5 KGY  □  2.0 KGY
CUMULATIVE MORTALITY FOR LIVE SHELLSTOCK OYSTERS TREATED WITH IONIZING IRRADIATION

Harvested September 1Q, 1994 (Water Temp. = 80 °F)

Irradiated September 22, 1994

Cumulative % Mortality

Days Post Harvest

- 0.0 KGy
- 0.5 KGy
- 1.0 KGy
- 1.5 KGy
- 2.0 KGy
THE EFFECT OF IONIZING IRRADIATION ON V. vulnificus POPULATION IN LIVE SHELLSTOCK OYSTERS

Harvested April 24, 1995 (Water Temp. 69°F)

Irradiated April 27, 1995

LogMPN Vg

Days Post Harvest

0.0 KGY ■ 0.5 KGY ■ 1.0 KGY ■ 2.0 KGY
CUMULATIVE MORTALITY FOR LIVE SHELLSTOCK OYSTERS TREATED WITH IONIZING IRRADIATION

Harvested April 24, 1995 (Water Temp. 69 °F)

Irradiated Anri127.1995

Days Post Harvest

<table>
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<th>Days</th>
<th>0.0 KGy</th>
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<th>1.0 KGy</th>
<th>2.0 KGy</th>
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<tr>
<td>7</td>
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THE EFFECT OF DIFFERENT DOSE IONIZING IRRADIATION ON *V. vulnii* POPULATIONS IN SHUCKED OYSTERS 12 oz. CONTAINERS

Harvested September 20, 1994 (Water Temp. 83°F)

Irradiated September 22, 1994

Log MPN Vv/g

Days Post Harvest

- 0.0 KGy
- 1.0 KGy
- 1.5 KGy
- 2.0 KGy
THE EFFECT OF IONIZING IRRADIATION ON V. vulnificus POPULATIONS IN SHUCKED OYSTERS IN 8 oz. CONTAINERS

Harvested April 24, 1995 (Water Temp. 69°F)

Irradiated April 27, 1995

Log MPN/v/g

DAYS POST HARVEST

■ 0.0 KGy ■ 1.0 KGy ■ 1.5 KGy □ 2.0 KGy
THE EFFECT OF IONIZING IRRADIATION ON *V. vulnificus* POPULATIONS IN OYSTERS ON THE HALF SHELL (FROZEN)

Harvested September 16, 1994 (Water Temp. 85°F)

Irradiated September 22, 1994

![Log MPN Vv/g vs Days Post Harvest graph showing irradiation effects](image)
THE REDUCTION OF *V. vulnificus* IN CO2 AND BLAST FROZEN SHUCKED OYSTERS

Harvested September 16, 1994 (Water Temp. 85°F)

![Graph showing the reduction of *V. vulnificus* in CO2 and blast frozen shucked oysters over weeks post harvest.](image-url)
Vibrio Vulnificus: Past, Present, and Future Control Strategies

Mark L. Collins, MPA
Florida Department of Environmental Protection

I would like to thank Dr. Otwell for inviting me to participate in the Tropical and Subtropical Seafood Sciences and Technology Society of the Americas 20th Annual Conference. As way of introduction, I am Mark Collins, Environmental Program Administrator, in the Bureau of Marine Resources Regulation and Development, Florida Department of Environmental Protection. The Bureau’s activities include classification of the states shellfish waters, inspection of shellfish and crab processing plants within the state, assessment and enhancement activities for the states shellfish resources, and aquaculture lease activities.

Most of my talk this afternoon will focus on past, present, and future control strategies to control illnesses caused by the marine bacteria Vibrio vulnificus.

Since 1925, the present shellfish sanitation program has operated as a cooperative program between state and local health agencies, and the U.S. Public Health Service. Individual state agencies classified growing waters, inspected processing plants, and patrolled closed growing waters. The U.S. Public Health Service provided technical support and evaluated individual state programs. In 1982, state agencies formed the Interstate Shellfish Sanitation Conference (ISSC) in order to provide input into changes for the National Shellfish Sanitation Program (NSSP)(FDA Compliance Policy Guide 7158.04, 1988).
Grover Starling (1988) quotes John W. Kingdon of the University of Michigan who said, "Conditions become defined as problems when we come to believe that we should do something about them." Starling states that we are surrounded by conditions--bad weather, illnesses, pestilence, fanaticism, highway congestion, and dirty air. We may or may not choose to consider this set, or parts of it, a problem. This is the situation I believe we are currently faced with by the marine bacteria *Vibrio vulnificus*.

Infection by *Vibrio vulnificus* is no recent occurrence. Koeng, Iklueller, and Rose (1991), suggest that Hippocrates described what may be the first case in the medical literature. A patient named Criton from the island of Thasos presented with "violent pain in foot," fever, delirium, and black blisters of his shin. Despite state-of-the-art therapy, he died on the second day after the onset of symptoms. As Criton was a fisherman, it is likely that he was exposed to the *Vibrio vulnificus* organism in seawater. The first recent report of clinical infection was in 1970, with the case of a previously healthy man in whom leg gangrene, a generalized hemorrhagic rash, thrombocytopenia, hypotension, and vomiting and diarrhea developed two days after he bathed and clammed in the seawater of Narragansett Bay in Rhode Island.

The historic study of *Vibrio vulnificus* as a pathogen dates to the late 1970's when the organism was named by CDC scientists (Blake, Merson, Weaver, Hollis, and Heublin, 1979). In 1987 the shellfish specialists from the FDA Southeast Regional office identified *Vibrio vulnificus* as an emerging public health concern due to illness and death caused by the consumption of raw oysters (Casey, Omstead, and Herrington, 1987). This increased
Concern led to a workshop on *Vibrio vulnificus* in 1988. Recommendations from this workshop included educate the target at-risk population, educate the industry concerning good handling practices, collect illness data to determine the scope of the problem, conduct research to answer unknowns, and analyze the results of the data collection and research to determine reasonable controls (Richard Thompson, 1994). As we can see past actions concerning this organism centered on gathering information on the magnitude of the problem.

Actions by the Interstate Shellfish Sanitation Conference during the 1990s centered on the education of at-risk persons, ie., persons with liver disease, blood disorders, and immune compromised conditions to avoid consumption of raw oysters. Incremental education efforts were initiated by individual states through the adoption of consumer messages on oyster packages and at retail locations, in an effort to educate high risk consumers. Messages were adopted by Louisiana in 1990, California in 1991, and Florida in 1993 and 1994 (Louisiana Register, 1990, Richardson, 1991, F.A.C. 1993, 1994). In 1994 the FDA and ISSC again sponsored a workshop in Washington D.C. to discuss the latest findings on *Vibrio vulnificus*. From the findings of this workshop, FDA submitted an issue at the 1994 ISSC conference requesting the conference adopt harvest controls which would restrict the harvest of oysters from the Gulf of Mexico during the months April-October if the oysters were for sale as raw oysters (ISSC issue 94257, 1995). This issue was not adopted by the ISSC, however it was referred to a committee in order that manual language for adoption be drafted, and alternatives to this option be identified (Thompson, 1994). The Consumer Protection Committee met twice during 1994 to work
on its charges. As a result of deliberation at the committee level, regulatory officials and industry members in the states of Florida, Alabama, Mississippi, Louisiana, and Texas agreed to implement controls prior to action by the ISSC. Controls were initiated to voluntarily restricted harvest times during the summer of 1995 to 14 hours or less a day, place at-risk consumer information labeling on oysters, and require a SELL BY date on shellstock tags not to exceed 14 days post harvest. These common sense Good Manufacturing Practices reduced the time of harvest to refrigeration from 20 hours a day, initiated consumer information labeling on both finished products and endorsed labeling at retail for Gulf of Mexico oysters, and established for the first time a shelf life for oysters in the shell. The Consumer Protection Committee Report to the ISSC executive board included these same immediate actions as alternatives to the FDA proposal to restrict the raw oyster sales of Gulf states during April-October (ISSC Issue 94-257, 1995). Final action on this issue was addressed at the 1995 ISSC meeting.

At the 1995 ISSC meeting, held in Orlando, Florida, a total of ten separate issues dealing with Vibrio vulnificus were considered. An alternative method of control was approved by the voting delegates of the States. This proposal called for the use of a temperature matrix to establish harvest controls in states where Vibrio vulnificus has been implicated. The matrix would call for decreasing the harvest time to refrigeration as water temperatures warm. This matrix inherently recognizes that as water temperatures warm, Vibrio vulnificus levels increase in both waters and meats. It also recognizes that reducing the time to refrigeration reduces Vibrio vulnificus levels. Table one below outlines the Matrix as adopted by the ISSC.
Table One.

<table>
<thead>
<tr>
<th>ACTION LEVEL</th>
<th>WATER TEMPERATURE**</th>
<th>TIME TO REFRIGERATION*</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEL 1</td>
<td>November - December</td>
<td>Present manual requirements</td>
</tr>
<tr>
<td></td>
<td>January - February</td>
<td></td>
</tr>
<tr>
<td>LEVEL 2</td>
<td>65 - 74 degrees F</td>
<td>14 hours</td>
</tr>
<tr>
<td>LEVEL 3</td>
<td>75 - 84 degrees F</td>
<td>12 hours</td>
</tr>
<tr>
<td>LEVEL 4</td>
<td>&gt; 84 degrees F</td>
<td>6 hours</td>
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* Product must be under ambient refrigeration at 45 degrees F within the hours specified above based upon the first shellfish harvested. During action levels periods 2,3, and 4, the product shall be shaded.

** The state shellfish control authority shall establish Average Monthly Maximum (AMMWT) Water Temperature for each growing area by averaging the previous 5 years maximum monthly water temperature (ISSC Task Force Two Report, 1995). Evaluation of exact implementation strategies are still in development by Gulf states regulators (Personal Communication Heil, 1995).
Performance measures to judge the success of this matrix have yet to be determined. This step will be addressed in 1995/96 by a committee of state/federal/industry representatives in order that the matrix can be evaluated when it is adopted (Personal Communication Moore, 1995). This future control should be able to be implemented by Gulf states during 1996.

What can be seen from this short chronology of events is that health officials, and the shellfish industry have been struggling with *Vibrio vulnificus* and raw shellfish consumption for nearly a decade. Debate has raged on whether this condition is a public health problem or a personal health problem. This debate will continue. What becomes evident, as Eldein (1988) states, is "The choice confronting politician and policymakers is not 'What are the right things to do?' but rather 'What might serve as a basis for common action of people with widely differing goals, values, and perceptions?'" Eldein continues that "Despite the fact that information is always incomplete, bad, or just not available, decisions have to be made: problems have to be confronted even though knowledge is imperfect."

It remains a question, whether or not the consumers of this nation are demanding protection from oysters in the raw form. What does appear from testimony at the 1994 *Vibrio* workshop, is that consumer advocates wish that consumers are given the information to make informed decisions themselves (1994 *Vibrio vulnificus* workshop transcript, page 229). This can best be done through both directed and general education materials to consumers.
Current efforts in this regard include the education of over 700 health professionals in the Gulf states during 1994 through funding by the EPA Gulf of Mexico Project. This education project will continue in 1995 by researchers at the University of Florida and Florida State University (Personal Communication Tamplin, 1995). $500,900 was provided by the National Marine Fisheries Service in 1994 for use by the U.S. Food and Drug Administration in an effort to educate high risk consumers about their risk of raw oyster consumption. FDA with the help of the ISSC is developing messages for distribution (ISSC Vibrio vulnificus Information Sheet, 1995).

A balanced approach to this problem will call for regulators, industry, and the consumers of shellfish to each take increased responsibilities to find a solution. Regulators will have to implement and enforce regulations which are balanced, which provide for an safer raw shellfish product, yet does not prevent through regulatory burden the industry operation. Industry must increase its efforts to provide safe products to the marketplace, to develop innovative practices which provide for improved shellfish products, and strive to educate their customers. Consumers must accept responsibility for their own health conditions and make informed choices about the risks they take, realizing that eating is a risky business but that not eating is fatal.
REFERENCES CITED


USE OF “COOL PASTEURIZATION” TO CONTROL

*Vibrio vulnificus* IN RAW SHELL-STOCK OYSTERS

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*Vibrio vulnificus* is a natural inhabitant of estuarine environments and may be transmitted to humans by the ingestion of raw seafood. This bacterium has been recovered from natural waters in high numbers during the warmer months (Ruple and Cook, 1992). Oysters from these waters are often incriminated in human diseases since the oysters are commonly consumed raw. Several methods have been used to control *V. vulnificus* in oysters for raw consumption. Depuration has proven largely unsuccessful even though such treatment is effective in removing “indicator” bacteria. Ionizing radiation is very effective but requires an expensive facility and is not yet federally approved. The use of additives such as organic acids, BHA, or diacetyl, although effective in reducing the vibrios, produces unacceptable flavor changes. This study focused on the use of a mild heat treatment to reduce *V. vulnificus* while preserving the sensory characteristics desired in raw oysters.

**MATERIALS AND METHODS**

**Oyster Study. Artificial Inoculation:** During the spring (March, April, May 1995) live shell stock oysters were artificially inoculated with *V. vulnificus* by placing them into 2-20 gal aquariums containing the pathogen. Concentrations were of either $10^4$ or $10^6$ cfu *vibrio/ml* seawater. Oysters were held for 24 hr for self inoculation of the pathogen by filtration and concentration.

**Oysters Study. Environmental Contamination:** During the summer (June, July, Aug, Sept. 1995) the oysters harvested contained a naturally high level of *V. vulnificus* of approximately $10^6$ cfu/g oyster meat.

**Post Harvest Oyster Processing:** In-shell *oysters* were sorted into 3-sizes prior to heat treatment. Oysters, with shell clamped to stay closed, were submerged in a 55°C 50 gal water kettle and brought to an internal temperature of 48-50°C. Oysters in baskets were then transferred to a like kettle and held at 50°C for 0, 5, 10, 15 min. Oysters were then transferred to a cold water bath and cooled to 2-4°C. The oysters were then enumerated for *V. vulnificus* at 0, 4, 7, 10, and 14 days.

**Microbial Analysis:** A combination of 3-tube MPN and mCPC (modified Colistin-Polymyxin B-Cellobiose) agar with EIA (enzyme immunoassay) was used for the isolation and enumeration of *Vibrio vulnificus* in raw shell stock oysters (FDA-BAM 1992).
RESULTS AND DISCUSSION

Survival rate of *V. vulnificus* in aquarium water

The percent growth and survival of *V. vulnificus* in aquariums rose by 15% to 36% during the 48 hours inoculation period and then began to drop (Fig. 1). The cell density of *V. vulnificus* in the aquariums showed a slight increase during the initial inoculation period (2 days) and was then followed by a decrease. Since the growth rate of *V. vulnificus* during the inoculation period was slow, the change of cell density was not significant.

Survival of *V. vulnificus* in heat treated oysters

The results of the 50°C water heat treatment of inoculated shellstock oysters are presented in Table 1 and Table 2. The treatment was very effective in the reduction of *V. vulnificus* in both 1.5 x 10⁵ MPN/g (high level) and 2.4 x 10³ MPN/g (low level). Time exposure of 5 min was sufficiently effective to reduce the numbers of the pathogen by 99.9% Preliminary work on shucked oysters, which lead to our study was reported by Cook and Ruple (1992). They reported death of *V. vulnificus* at temperature above 45°C and that 50°C was sufficient to reduce the bacterium to undetectable levels.

<table>
<thead>
<tr>
<th>Heating time</th>
<th><em>V. vulnificus</em> MPN/g of oyster meat from high concentration level</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td>1.5 x 10⁵</td>
<td>0%</td>
</tr>
<tr>
<td>5 min</td>
<td>93</td>
<td>99.9 %</td>
</tr>
<tr>
<td>10 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
<tr>
<td>15 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 2. Effect of 50°C internal temperature heat treatment on the survival of *V. vulnificus* in the shellstock oysters treated with low level of contamination

<table>
<thead>
<tr>
<th>Heating time</th>
<th><em>V. vulnificus</em> MPN/g of oyster meat from high concentration level</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td>2.4 x 10³</td>
<td>0%</td>
</tr>
<tr>
<td>5 min</td>
<td>&lt;3</td>
<td>99.9 %</td>
</tr>
<tr>
<td>10 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
<tr>
<td>15 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
</tbody>
</table>
Survival rate of *V. vulnificus* in oysters during storage

The survival of inoculated *V. vulnificus* in non-heated oysters stored on ice is presented in Fig. 2. The data demonstrates the sensitivity of this bacterium to temperatures below 5°C with a significant decrease in the number of *V. vulnificus* during the first 7 days and a further slow decrease in numbers from day 7 to 14. *Vibrio vulnificus* was not recovered from oysters stored at -20°C after 30 days.

Environmental Contamination

Naturally incurred *V. vulnificus* was found to exist in the shellstock oysters harvested from Adam bay, Louisiana from June through September. Results of heat treatment of these oysters gave similar results to the first experiment with no *V. vulnificus* detected after heat treatment (Table 3). The numbers of aerobic plate count of heat treated shellstock oysters were also significantly reduced (Table 4).

<table>
<thead>
<tr>
<th>Heating time</th>
<th><em>V. vulnificus</em> MPN/g of oyster meat</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td>$8.9 \times 10^4$</td>
<td>0%</td>
</tr>
<tr>
<td>3 min</td>
<td>9</td>
<td>99.9%</td>
</tr>
<tr>
<td>5 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
<tr>
<td>10 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
<tr>
<td>15 min</td>
<td>&lt;3</td>
<td>100%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heating time</th>
<th>CFU/g of oyster meat</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 min</td>
<td>$3.5 \times 10^5$</td>
<td>0%</td>
</tr>
<tr>
<td>3 min</td>
<td>$2.7 \times 10^3$</td>
<td>99.2%</td>
</tr>
<tr>
<td>5 min</td>
<td>$6.6 \times 10^2$</td>
<td>99.99%</td>
</tr>
<tr>
<td>10min</td>
<td>$6.0 \times 10^2$</td>
<td>99.99%</td>
</tr>
<tr>
<td>15 min</td>
<td>$4.6 \times 10^2$</td>
<td>99.99%</td>
</tr>
</tbody>
</table>

Effect of ice storage on the survival of naturally contaminated *V. vulnificus* in shellstock oysters: The numbers of naturally occurring *V. vulnificus* in shellstock oysters dropped dramatically during the first 4 days of ice storage before stabilizing. No *V. vulnificus* were detected in heat treated samples.
throughout the iced storage. (Table 5.) Cook and Ruple (1992) reported a reduction of *V. vulnificus* during iced storage of shucked oysters but at a slower rate than with the shellstock and/or heat treated oysters analyzed in this study.

Table 5. Survival numbers (MPN/g) of *V. vulnificus* in mild heat treated and non-treated shellstock oysters during ice storage

<table>
<thead>
<tr>
<th>Storage time</th>
<th>Control</th>
<th>3 min</th>
<th>5 min</th>
<th>10 min</th>
<th>1.5 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 0</td>
<td>8.9 x 10^4</td>
<td>9</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Day 4</td>
<td>1,100</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Day 7</td>
<td>460</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Day 10</td>
<td>240</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
<tr>
<td>Day 14</td>
<td>240</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
<td>&lt;3</td>
</tr>
</tbody>
</table>

Effect of ice storage on the aerobic plate counts and psychrotroph counts

Aerobic plate counts of shellstock oysters showed a significant drop during the first 7 days of iced storage before beginning to show recovery (Fig. 3). Cold storage has proved effective in reducing numbers of viable bacteria cells. In this study, about 80% of the living cells presented in shellstock oysters were killed or inactivated when the temperature was lowered to about 0°C during the ice storage. It was believed that the later rise of aerobic plate counts were due to the growth of psychrotrophs (Fig. 4). As shown in Fig. 3 and Fig. 4, both aerobic plate count numbers and psychrotrophic numbers of mild heat treated oysters remained low and stable, which suggested that the mild heat treatment effectively inactivated most of the bacterial cells, preventing the growth of psychrotrophs even after 7 day of storage on ice.

CONCLUSION

The use of mild heat treatment (50°C for 5 min) was very effective in eliminating the pathogen *V. vulnificus* while not eliminating all microorganisms. Therefore it is appropriate for this treatment to be classified as a “cool pasteurization” method. This treatment is currently under review by the U.S.F.D.A for approval. With approval and use, the Gulf Coast Oyster Industry should be able to continue harvesting and selling raw in-shell oysters year round. Early sensory testing of the treated oysters have indicated that panelists detect no noticeable adverse effects of the treatment. Results of sensory studies will be reported in the future. Further work on the effect of the treatment on other microbial pathogens continues.
REFERENCES


SATISFYING PUERTO RICO DEMAND FOR SEAFOOD
WITH A VISION TO THE FUTURE USING FOOD SCIENCES AND
RELATED TECHNOLOGY: UNIVERSITY OF PUERTO RICO INITIATIVES

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Coordinator of Food Science
and Technology Program
University of Puerto Rico
Mayagüez Campus
Mayagiiez, Puerto Rico 00680

Puerto Rico is the smallest of the islands that comprise the Greater Antilles. It has a tropical climate and ubiquitous water supply providing an adequate environment for aquaculture production. The University of Puerto Rico, Mayagüez Campus has a long history of commitment to support the different programs involved in Seafood through the activities of the Marine Science Department, Sea Grant Program, the Cooperative extension Programs and the Aquaculture Research in the Experimental Station and the recently established, Food Science and Technology Graduate Program.

The Food Science and Technology Multidisciplinary Graduate Program was established in March 8,1991, by the Council of Higher Education Certification 91-118. This program was the first one of its kind in the University system due to the multidisciplinary approach. This multidisciplinary program is part of the College of Agricultural Sciences but involves the coordination of the activities of three additional colleges: College of Arts and Sciences, College of Engineering, and College of Business Administration. It also involves seven departments: Agricultural Engineering, Animal Industries, Biology, Chemistry, Chemical Engineering, Horticulture, Marine Sciences, and Marketing.

The Mission of the Program is to gather and coordinate already existing activities in the Food Science and Technology Area in Campus to offer a Master Degree in Food Science and Technology. The goals are:

- To develop the professional resources that Puerto Rico needs to ensure a diverse, safe and nutritious food supply for our society.

- To contribute to the development of the scientific and technological knowledge needed for the growth and improvement of the food industry.

- To promote the research and development of processed food products to help local agriculture by adding value to its production and the possible opening of new markets for such commodities.
To promote the cooperation and a productive coordinated effort among the Departments involved in the Program, required for a successful Multidisciplinary Graduate Program.

To provide a contact and forum for the efficient exchange of information and utilization of expertise between university, government agencies and the food sector,

The Food Science and Technology Program created in 1991 had been since involved in seafood science and related technology through the research and extension activities in the processing of seafood and seafood products. There are 10 faculty members and 27 graduate students in the program of which 6 of them are working in seafood products research. In addition, graduate students had been participating in Cooperative training and research with the largest Tuna Processing Industry, Star-Kist Caribe at Mayagüez, PR.

After looking through the goals established by the faculty members and students involved in the program, it is not surprising that it plays an important role in the development of seafood research. Last May of 1995, a research grant was approved by the Science and Technology Board of the Economic Development Administration (best known as Fomento) to establish and Aquaculture Institute to promote the development of commercial technologies needed for aquaculture. A total of 2.5 million dollars was approved, for a three years period, of which 33% of the money are matching funds from the University. However, the expansion of the aquaculture industry cannot stand alone in its development without the involvement of the safety, shelf life, new products development research activities. The Food Science and Technology Program provides the multidisciplinary approach for the development of new seafood products as well as safety and shelf life studies.

There are research projects in the several seafood products: surimi, smoked tilapia, shrimps, mackerel, canned tilapia and fish fillets. The research projects are:

A. Development of commercial scale procedure for the small size Tilapia or the stunt ones.

B. Determination of shelf life of smoked tilapia packed under modified atmosphere and stored under refrigeration.

C. Development of traditional sausages’ recipes made out of minced tilapia meat.

D. Study of the effect of antioxidants in the shelf life of frozen tilapia fillets.

E. Determination of histamine level in Mackerel.

F. Development of a database for the presence/absence of metals in the aquaculture farms around the island.
Domestic aquaculture production of tilapia increased from twelve and onehalf million pounds in the eighty’s to thirteen million pounds in 1994 and further expansion is expected. Imports increased from 32 million pounds in 1993 to forty nine- million pounds in 1994. The Food Science and Technology Program provides the scientific staff and students needed to coordinate the research required for the development of new and innovative products using the underutilized products as well as the safety, chemical and microbiological studies needed to support these activities.
SAFETY CONCERN IN THE USE OF MODIFIED ATMOSPHERE PACKAGING IN SEAFOOD PRODUCTS: A REVIEW

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INTRODUCTION

Modified atmosphere packaging (MAP) is a food packaging technique in which the air in a package or container is replaced by one or more gases, in various concentrations, before sealing. During storage, the initial atmosphere of the product, will be modified as a result of metabolic, chemical and microbiological activity and by the package’s permeability. The choice of gas mixture used is influenced by the microbiological flora capable of grow on the product, the product’s sensitivity to \(O_2\) and \(CO_2\), and color stabilizing requirements.

The use of MAP system has numerous advantages such as: extends product shelf life and quality, reduces economic loss, and allows the product to be transported longer distances for distribution and marketing. However, MAP also has some problems that also must be considered, since the technique needs strict temperature control, costs twice as much as vacuum packaging, and the container and packaging vary from product to product. Also, it may retard or inhibit spoilage microorganisms that might warn the consumers of problems, while allowing the growth of pathogens (Farber, 1991, and Reddy et al., 1992). But the major concern related to MAP is the growth and potential production of \textit{Clostridium botulinum} type E in MAP fresh fish. The concern is well founded because of the pathogenesis significance of these organisms (Bristor and Hotchkiss, 1986, Farber, 1991, and Church, 1994).

LITERATURE REVIEW

The gases normally used in MAP are those found in the atmosphere: \(O_2\), \(CO_2\), and \(N_2\) (Church, 1994). Each of these gases plays a specific role in extending the shelf life of fresh seafood. Oxygen \((O_2)\) generally stimulates the growth of aerobic bacteria while inhibiting the growth of the strictly anaerobic, although there is a very wide variation in the sensitivity of anaerobes to \(O_2\) (Church, 1994). Nitrogen \((N_2)\) is an inert, tasteless gas with low solubility in both water and lipids. \(N_2\) displays little or no antimicrobial activity on its own. Usually \(N_2\) is used to balance a gas mixture or reduce the concentration of other gases in a mixture, to displace \(O_2\) in packaging, delay oxidative rancidity and inhibit the growth of aerobic microorganisms. Also it is used as a filler to prevent pack collapse (snuffing), which can be a problem in atmospheres containing a high \(CO_2\) concentration (Farber, 1991, and Church, 1994). Carbon dioxide \((CO_2)\) is both water and lipid soluble and is
mainly responsible for the bacteriostatic effect on microorganisms in modified atmosphere. CO₂ inhibit aerobic bacterial, yeast and mold activity in foods. The overall effect on microorganisms is an extension of the lag phase and a decrease in the growth rate during the logarithmic phase.

This bacteriostatic effect is influenced by the CO₂ concentration, volume of headspace gas, acidity, water activity, the type of microorganisms, the growth phase and load of the initial bacterial population, the storage temperature and the type of product being packaged (Farber, 1991, Church, 1994 and Reddy, et al. 1992). Although the bacteriostatic effect of CO₂ has been known for many years, the precise mechanism of its action is still a subject of much scientific interest. Since the bactericidal and bacteriostatic effects of CO₂ are temperature dependent, lack of refrigeration at any time during a product’s life could allow the growth of organisms that had been inhibited by CO₂ during storage at a lower temperature. Pathogens that are resistant to the antimicrobial effects of CO₂ that cannot grow at low temperatures might grow during temperature abuse. MAP products do not represent a new or unique situation in that temperature abuse after processing and packaging is of serious concern. Under conditions of product temperature abuse, pathogens will grow in almost any atmosphere including air. Any atmosphere, then, must be considered as potentially dangerous (Bristor and Hotchkiss, 1986).

The incidence of *C. botulinum* in foods, although very serious, is low. *C. botulinum* type E has been isolated almost exclusively from aquatic sources. Fish may present a more significant problem because of the occurrence of *C. botulinum* type E in their natural habitat (Bristor and Hotchkiss, 1986). In order for foodborne botulism to occur, the following conditions must be met: **First**, the food must be contaminated with the spores or cells of toxigenic *C. botulinum*. Usually, contamination is due to the presence of *C. botulinum* in the environment where the food is produced, harvested, processed or stored. **Second**, the cells or spores must resist the food processing treatment. Alternatively, postprocessing contamination must occur. **Next**, the organism must multiply and produce toxin in the food. For this, the food must have an environment or microenvironment favorable for germination and outgrowth of the spores, and for growth and toxin production of the vegetative cells. **Finally**, the food must be consumed without sufficient cooking to destroy the heat labile toxin (Eklund, 1992).

Commercial use of modified atmosphere to extend the shelf life of fishery products has been limited by the potential of *C. botulinum* growth and toxin production in refrigerated, modified atmosphere packed fish. Despite these concerns, fillets of fresh fish packaged under modified atmospheres and stored continuously at temperatures below 3 °C have appeared in European supermarkets. No cases of botulism have been associated with the consumption of such products thus far MAP shows great promise for the extension of shelf life and control of the growth of food pathogens at refrigerated temperature. It is not, however, a substitute for refrigeration (Bristor and Hotchkiss, 1986). Overall, the majority of the studies reported in the literature indicate that the risks from foodborne pathogens in MAP are no greater and are frequently less than those from aerobically stored foods. These findings are substantiated by the excellent safety record, to date of MAP (Church, 1994).
CONCLUSION

According to some researchers the success of MAP depends on: 1) good initial quality, 2) good hygiene from slaughter on, 3) maintenance of controlled temperature, 4) correct packaging material selection, 5) reliable packaging equipment, and 6) appropriate gas mixture. Also we have to keep in mind that there are some causes of concerns and that we have to take care of them such as: 1) under-processing, 2) post-process contamination, 3) temperature abuse, and 4) prolonged refrigerated storage.

RECOMMENDATIONS

1) To establish a Hazard Analysis of Critical Control Points (HACCP) that may include, among others’ things, prevention of under-processed or postprocess contamination products and temperature abuse. 2) Educate the consumer. 3) Keep product below 3 °C at all times. 4) Factors that contributes to the incidence of botulism are often related to improper refrigeration, so the recommendation is that to prevent outgrowth, the fish must be heated sufficiently (SO-82 °C) to destroy spores of non proteolytic strains and refrigerated sufficiently (10 °C) to prevent the growth of proteolytic strains of C. botulinum (Sperber, 1982). 5) In the future, the addition of lactic acid starter cultures. 6) The product should be placed in modified atmosphere immediately after harvesting and processing. 7) Most expert feel, that at this time, consumer sized packages of MAP fish should not be available for sale retail level. 8) If for some reason the product is for sale at a retail level, the addition of a time-temperature indicator (TTI) should be useful on each package. These indicators would provide warnings and messages to the consumer if the product was improperly handled at some point. 9) For products in which the removal of oxygen could permit the growth of anaerobic pathogens, it is recommended that one or more of the following criteria should be met: a) water activity < 0.92, b) pH < 4.5, and c) addition of sodium nitrite. 10) Use a pretreatment step such as radiation or antimicrobial treatment before storage.

REFERENCES


UTILIZATION OF WASTE TILAPIA IN THE PRODUCTION OF A SARDINE SUBSTITUTE

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*2 Professor and Director of Department of Marine Sciences
*3 Associate Professor and Coordinator of Food Science and Technology program

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Tilapia nilotica, a fish native to Africa and the Levant, recently reclassified in the genus Oreochromis, is one of the most cultivated species in aquaculture systems in the world1. This is due in part, to its easy adaptability to tropical and subtropical areas, than are able to grow in waters that would kill many fishes, are able to utilize a wide variety of nutrient inputs for growth, are disease resistant, and are appetizing food items. 2 Tilapias have a firm, semi-moist, delicately flavored flesh with no intramuscular bones which, in part, explains why in 1994 Tilapia was named as the restauranteurs fish of the year in the United States, in Latin America the development of Tilapia culture has begun as a mean of satisfying local markets for high protein foods and as an export product to satisfy the growing demand in the United States3. However, a major problem in tilapia culture has been that its proclivity for early reproduction, at just 3 months of age, which often leads to a stunted population. 4 Due to this, a large part of the harvest in mixed stocked systems are fishes too small to sell, resulting in a loss for the producer. 5 One viable solution to this problem, which can also help in feeding the world’s expanding population, is to develop canning methods6,7,8 that would permit small tilapia to be utilized as a substitute for sardines or other similar size products.

Puerto Rico’s fishery resources have shown indications of overfishing. One indication is that landings of fish and shellfish have shown a consistent decline since 1979, when decrease in production from 7.2 millions of pounds, to 5.4 million pounds in 1982. this is equivalent to a 25% reduction in the total fisheries production for the island over this time period and when in 1987 while fishing effort did not decrease, only 2.1 millions of pounds were reported9. Another indication of overfishing is that fish species that in the past did not have commercial value (e.g. Holocentrus ascensionis and Acanthurus spp.) are now easily being sold. Biostatistical data collected have also provided indications of overfishing. For example some important commercial species (e.g. panulirus argus, Lutianus vivanus, Epinephelus quattatus and Ocyurus chrysurus) were caught in large percentages before reaching minimum size of sexual maturation10. The total estimated value of reported landings for the years 1992-93 by 42 municipality and coast, are 2.5 pounds.
MATERIAL AND METHODS

Product Preparation. Live commercially harvested tilapia were obtained from the Aquacultural Experimental Station of in Lajas, P. R. Their body weight and length was 90 - 100 g (average 92 g) and 17 - 18 cm long for tilapia. After the fish were chillkilled and rinsed with water, the scales, head, tail, viscera and backbone were discarded. The remaining was precooked in a conventional oven at 350°F, precooking times were 0, 10, 20, or 30 min. The precooked tilapia were cooled and packed in 30l x 41l cans with sufficient patching to give a net weight of 535 ± 5 g, with 230 ± 5 milliliter portions of canned tomatoe juice seasoning, vegetable broth, or distilled water were then placed on top of the meat, leaving a headspace of about 10 mm. All cans were sealed (Dixie model 24 eletric set to close cans), immediately after being exhausted for 15 min. (Fisher scientific model 139, serial 115). The cans were then steam-retorted at 100°C for 87 min, allowed to cool under running water, and stored at room temperature for subsequent analysis. According to the food and Drug Agency, a manufacturer must thermally process acidified foods sufficiently to destroy all vegetative cells of microorganisms of public health concern11.

CONCLUSION

Fisheries statistics indicate that the Puerto Rico fisheries resources are declining. Evidence of this are: a) decrease in number of pounds landed; b) the selling of species, that in the past did not have commercial value; c) large percentages of individuals of commercially important species being caught prior to obtaining minimum size of sexual maturation. Puerto Rico with its tropical climate has the advantage that it could develop aquaculture systems that produce the year round, that could satisfy part of the demand of the consumption of the fish to local level. Besides the fish that are highles marketable the possibility of being able to turn small, unsellable fish into a product that would generate additional revenues for the producer would only improve the economic viability of tilapia production in Puerto Rico. By determinig consumer acceptabel and sensory characteristics of stunted and non-stunted tilapia it should be possible to determine the commercial valve of this unutilized resource.

REFERENCES


FLOWCHART DIAGRAM FOR THE CANNING PROCESS OF THE TILAPIA

1. Fingerlings
   - Production
   - Harvest
   - Sizes
   - Weighed

2. Removal of the Head
   - Scaled
   - Gutted
   - Cleaned
   - Weighted

3. Spices and other ingredients
   - Sauce preparation
   - Pre-cooking
   - Canning
   - Sealing
   - Retort
   - Cooling

4. Inoculation
   - Can selection
   - Installation of thermocouples

5. Microbiological analysis
FDA’S SEAFOOD HACCP INITIATIVE

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Program and Enforcement Branch
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U.S. Food and Drug Administration

Good morning! Thank you. I appreciate the opportunity to talk to you today about FDA’s Seafood HACCP Initiative. This is a time of great change in the world of seafood in the United States. It is a time of changes in how we regulate seafood domestically and internationally, as well as changes in how we participate in international trade. It is also an exciting time for the U.S. Food and Drug Administration, for consumers and for the seafood industry. I want to talk about these changes and explore further with you the impact they will have on us.

Side 1: Why HACCP (Environmental, Species)
Wild Caught, Natural Hazards, Most Perishable

First and foremost, seafood is unique - for a several reasons. Most of it is still predominantly wild-caught and therefore potentially exposed to a wide range of natural hazards, as well as hazards from human pollution. We must cope with a multitude of diverse environmental hazards, industrial pollutants near shore, and whatever problems or hazards may occur in the open ocean.

Seafood is the most perishable of all flesh foods; often resulting in decomposition, and occasionally illness from scombroid poisoning.

Consumed Raw, Many Species, Varied Regulatory Control
Seafood is consumed raw much more than any terrestrial flesh food.

Seafood consists of literally hundreds of species from all over the globe, many having little in common other than an aquatic origin.

No other flesh food is imported into the U.S. in such quantity (53% of the supply) or from so many places - over 135 countries. Some of these countries have advanced regulatory structures for seafood safety, but many do not.

Widely distributed, Recreational to Commercial, Seasonal
The distribution system for seafood is so extensive that both safety and shelf life can be adversely affected.
Americans consume almost four pounds per capita of recreationally caught fish and shellfish. Some of the recreational harvest finds its way into commercial channels, which raises concerns about where it was harvested and how it was handled.

The seasonal nature of the business, sometimes at very remote locations, presents the industry with special challenges in terms of employee training, facility upkeep, etc.

**New Stresses and Challenges**

Besides the intrinsic characteristics of seafood, other aspects of the world of food production and consumption have changed drastically in the last decade. These include:

- New ways of processing and packaging food
- Our food is more widely distributed affecting safety and shelf life.
- Different consumption patterns - more food is eaten outside the home
- New pathogens affecting food safety, new concerns about chemical contaminants, new concerns about the health impact on small population groups
- HACCP is being adopted internationally, therefore the U.S. must adopt it we want to maintain our place in international trade.

**Slides 2: Roles and Responsibilities**

One of the greatest benefits of HACCP is its effect on the respective roles of government and industry.

- Under HACCP the food industry is responsible for ensuring the safety of the food it produces.
- Under HACCP the government is responsible for verifying that the industry is meeting its responsibility.

**Slide 3: What is HACCP?**

Now, I want to talk a little about what HACCP means to us in FDA.

HACCP is an internationally recognized, state-of-the-art system that was first used by the food industry in the production of safe food for the U.S. astronauts. It was adopted for and has been very successfully used by the canning industry for over 20 years.

HACCP has gained recognition throughout the developed world as the best safety assurance system developed to date. It has been recommended by the National Academy of Sciences (NAS) and by the CODEX. In addition, the European Community (EC) and many developed nations that export seafood have adopted HACCP for their seafood products or are in the process of doing so.
Under our HACCP system, U.S. processors will develop plans for their operations. These plans will anticipate likely food safety hazards. These may be environmental hazards from the water, or processing hazards, such as cooking temperatures that are too low, or refrigeration temperatures that are too high. Each processor will then identify points where a hazard could be introduced or where a hazard already present may be eliminated. After identifying all the critical control points in a processing operation, the processor must then know how to measure whether these critical control points are operating the way they should. The first step is to establish critical limits for each CCP. A critical limit can be a cooking or refrigeration temperature. It can be the amount of detectable decomposition in a lot of fish.

Each individual HACCP plan will reflect the uniqueness of the seafood being produced, its method of processing and the facility in which it is prepared.

Under our proposal, all U.S. commercial processors of seafood products will be required to develop and operate under a HACCP plan. This includes packers, repackers and warehouses. We will not be requiring HACCP plans from retail stores, restaurants, common carriers and vessels that only harvest seafood. The HACCP plans must identify likely hazards, critical control points and critical limits, and indicate the monitoring procedures that will be employed at the critical control points and the records that will be maintained. These records and the HACCP plan itself will be available for review by our investigators.

I would like to point out that sanitation is a controlled prerequisite program to HACCP and that it is unlikely that HACCP will be effective if sanitation is not controlled.

The hazards that we are requiring processors to control through HACCP are safety hazards. Poor quality and economic fraud will continue to be violations of the FD&C Act, of course, and we will continue to look for them and apply our traditional controls and remedies when we find them, but HACCP will be required only for safety.

Because 53 percent of the seafood consumed in the United States is imported, foreign processors also fall under this new regulation. That is, all foreign processors shipping product to the U.S. will have to meet all the requirements I have just described for U.S. processors. In addition, all U.S. importers will be required to ensure that foreign processors have met their obligations. There are a number of ways that an importer could do this. The easiest way will be to import products from a country with which the U.S. has entered into an agreement establishing that our regulatory systems are equivalent. We are aggressively
pursuing such agreements and expect to enter into several of them within the next few years. Other means include auditing foreign processors or maintaining copies of their HACCP plan.

Slide 8: Molluscan Shellfish

Finally, the molluscan shellfish industry which supplies clams, oysters and mussels, will be required to process only product that originates from growing waters approved for harvesting by a shellfish control authority. This means that processors can only receive and process shellstock that is appropriately tagged or labeled and sold by a licensed harvester or processor, licensed by a shellfish control authority. In the U.S., this means the producer is in full compliance with the requirements of the National Shellfish Sanitation Program. For foreign imports, the same requirements must be met under the auspices of a Memorandum of Understanding.

In addition, all records must be maintained for shell stock that document the date and location of harvest, the quantity and type of shellfish, the date of receipt by the processor, and the name and identification number of the harvester.

Slide 9: HAZARDS AND CONTROLS GUIDE

To help the industry prepare for HACCP we have developed an unprecedented package of guidelines - the FDA Fish and Fishery Products Hazards and Controls Guide - that, for virtually every species and commercial process, identifies hazards and the types of controls that should be in place to keep those hazards from actually occurring.

There is a safety hazards listed for tuna, as per example - histamine. Histamine is produced in specific fish as a result of temperature abuse. The hazard statement describes how temperature control, especially on the harvest vessel is critical to controlling the hazard.

The critical control point for this hazard is receiving.

There are two options for control provided in the guide. One applies to the first processor, the other to subsequent processors. We will use the first processor as an example - this is option 1 which recommends, among other things that processors determine the temperature history of the fish on the vessel.

The control measure which is to determine the on-board temperature history of the fish should be done on every lot.

One of the critical control limits that applies to this control measure is that the internal fish temperature should be reduced to 40°F as soon as possible after capture. Other critical limits are also provided. (that pertain to iced fish, levels of histamine and decomposition.)
An example of a record that would be necessary to document that the fish temperature was dropped rapidly might be on-board refrigerated sea water temperature records, if refrigerated seawater is used to cool the fish upon capture. In other circumstances, other records may be appropriate. The guide addresses this (i.e., the results of histamine testing, calibration of thermometers and sufficiency of ice).

If the critical limit is not met the records would show that the temperature of the fish was not dropped as rapidly as necessary to prevent the development of histamine. The lot should be sampled and analyzed for histamine. If the results are high, the product must be frozen or cooked. If the results are very high, the product must be destroyed.

**Slide 10: International**

And finally, as I mentioned earlier, HACCP is the key to maintaining our position in world trade. HACCP will serve as the basis for bilateral agreements, since most of our key trading partners have switched to HACCP already or are planning to do so. Agreements based on HACCP will ensure that foreign processors are applying systems of preventive controls equivalent to those being required of domestic processors. We have already met with the EC and with Australia and New Zealand to discuss such agreements. Of course, in the case of Canada, the North American Free Trade Agreement (NAFTA) provides the framework for establishing equivalency and, therefore, a mutual agreement.

**Slide 11: Training**

I would like to say that training is critical to the successful implementation of HACCP systems in the seafood industry. Certain key functions such as reviewing monitoring records, developing and modifying HACCP plans which will require training in HACCP. The need for training exists not just for industry. Both state and local regulators, as well as FDA employees will need to be trained on how to evaluate HACCP plans and conduct HACCP inspections. For training, FDA is working closely with the Seafood Alliance to develop a HACCP training curriculum.

**Slide 11: Final Rule**

As you know, on January 28, 1994, we published in the Federal Register, the proposed regulation. During the comment period, the Agency received approximately 260 submissions each containing many comments on every part of the proposal. After each of those comments were reviewed, the Agency developed a final rule that accommodated as many of the comments with merit as possible. The FDA Commissioner Dr. David Kessler and the Honorable Secretary of Health and Human Service Ms. Donna Shalala and the have signed the final rule. At this moment, the final rule is being reviewed for final approval by the Office of Management Branch (OMB). After OMB signs off on the final rule, it will be published in the Federal Register. We are quite confident that by January 1996 the final rule will be published in the Federal Register.

Thank you