

Integrated Oyster

Market Research Product Development, Evaluation Promotion and Consumer Education for the *Gulf of Mexico's Oyster Industry*

Sea Grant Award No. NA16RG2195 (GSAFFI #88) Project R/LR-Q-23 Year 2

FINAL REPORT



September 2004

**Gulf & South
Atlantic
Fisheries
Foundation, Inc.**

**Sea Grant
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By

Dr. Tomas Vergel C. Jamir
Project Technical Consultant

Judy Jamison
Principal Investigator

Ruth Posadas
Ewell Smith
Tracy Mitchell
Joanne McNeely
Paul Balthrop
Co-Principal Investigators

September 2004

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Executive Summary

1. FINAL SYNOPSIS

2. DATE: September 30, 2004

3. INVESTIGATORS:

Principal Investigator **Ms. Judy Jamison, Executive Director**
Gulf & South Atlantic Fisheries Foundation, Inc.

Collaborators/Co-P.I. **Ms. Ruth Posadas, Director**
Seafood Technology Bureau
Mississippi Department of Marine Resources

Mr. Ewell Smith, Executive Director
Ms. Tracy Mitchell, Assistant Executive Director
Louisiana Seafood Promotion Board
Louisiana Oyster Task Force

Ms. Joanne MacNeely, Bureau Chief
Mr. Paul Balthrop, Development Representative
Florida Bureau of Seafood & Agriculture Marketing
Florida Dept. of Agriculture & Consumer Services

Technical Consultant **Dr. Tomas Vergel C. Jamir**

4. PROJECT NUMBER: R/LR-Q-23 Year II

5. INSTITUTIONS:

Gulf & South Atlantic Fisheries Foundation, Inc.
Mississippi Department of Marine Resources
Louisiana Seafood Promotion Board/Gulf Oyster Task Force
Florida Bureau of Seafood & Agricultural Marketing

6. DATES COVERED: October 1, 2002 to September 30, 2004

7. PROJECT TITLE:

Integrated Oyster Market Research, Product Development, Evaluation, Promotion and Consumer Education for the Gulf of Mexico's Oyster Industry

8. PROJECT RESULTS

A. Objectives

Objective 1. *To develop and evaluate the sensory characteristics of commercially available Post Harvest Processed (PHP) oyster products (heat pasteurized, individually quick frozen, high hydrostatic pressure treated) versus raw oysters and other value added product categories (e.g., oyster cheese ball).* Objective 1 has been achieved.

The MS-DMR Seafood Technology Bureau is the lead cooperator in-charge of the research and development aspects of the Gulf Oyster Project. MS-DMR Seafood Technology Bureau staff and scientists from the Mississippi State University completed the following research projects:

- "Sensory Differences of Gulf Post Harvest Processed Oysters" conducted by Dr. Patti Coggins
- "Consumer Acceptability of Post Harvest Processed and Value Added Oysters – Year 2" by Dr. Linda Andrews
- "Shelf Life of Post Harvest Processed Oysters" by Dr. Linda Andrews
- "Marketing Considerations for Post Harvest Processed and Value Added Oyster Products" by Dr. Benedict Posadas, Ruth Posadas, Dr. Linda Andrews, and Susan DeBlanc
- "Consumer Preferences for Post Harvest Processed Raw Oysters in Coastal Mississippi" by Dr. Benedict Posadas and Ruth Posadas
- "Bibliography on Oysters and Other Shellfish Post Harvest Processing Technologies" compiled and sorted by the MS-DMR Seafood Technology Bureau staff
- "Gulf Oyster Recipes" featuring new value added oyster products and recipe formulations derived from the Gulf Oyster Project; developed and published jointly by the MS-DMR Seafood Technology Bureau and Mississippi State University's Coastal Research and Extension Center.

Objective 2. *To educate wholesalers, retailers, processors, food service professionals, high-risk individuals and general consumers of the availability, safety and sensory characteristics of new, commercially available PHP and other value added oyster products.* Objective 2 has been achieved.

(1) Mississippi DMR Seafood Technology Bureau

Education and Promotional Events. The MS-DMR STB participated in numerous education and promotion events where PHP and VAP oyster products were highlighted, for example: the Louisiana Seafood Industry Convention and Field Day, Fish and Wildlife Show Extravaganza, Interstate Shellfish Sanitation Conference, Louisiana Restaurant Show, International West Coast Seafood Show, Jackson County Trade Show and Fair, Mississippi Business Expo, International Boston Seafood Show, and the Biloxi Cajun Crawfish Festival.

Public Conferences. As part of its mission, the MS-DMR STB staff also participated in various food technology, health and safety meetings and conferences like: International Food Technology Convention and Food Expo, Mississippi Food Safety Task Force Meeting, Oyster Forensic Science Workshop and Oyster Ecology and Management Workshop, and the World Aquaculture Society Convention.

Other Related Activities. The MS-DMR STB staff also distributed Gulf Oyster Project educational materials during the AFDO Basic HACCP and Sanitation Training Course, supplied the education materials to the Public Affairs Office of the MS Department of Marine Resources and all permitted members of the MS Seafood Industry, Mississippi State Research and Extension Center (MSU-CREC), Gulf and South Atlantic Fisheries Foundation, Florida Sea Grant College Program, Northeastern Regional Aquaculture Center, and the National Marine Fisheries Service among others. The bureau conducted semi-annual mail-outs to 91 newly certified Seafood Dealers (11 new dealers) on seafood safety including updated ISSC/NSSP regulations and education materials on Post Harvest Processing of Oysters to reduce *Vibrio vulnificus*-related illnesses. Aside from the above engagements, the bureau also offered technical assistance to two Mississippi seafood dealers who adopted PHP technologies.

(2) Louisiana Seafood Promotion and Marketing Board

Industry Promotion. The LSPMB promoted PHP and VAP oyster products and technologies at the National Restaurant Show in Chicago where Gulf Oyster Project developed brochures and informational materials were distributed to attendees visiting the seafood displays. While at the National

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Restaurant Show, the Louisiana project team conducted product comparison demonstration at the American Leadership Conference where approximately 200 Executive Chefs from around the country tasted PHP oysters that were harvested and processed in Louisiana.

Advertisement. Advertisements were placed in the Louisiana Cooking magazine (approximately 30,000 readers), Seafood Business magazine (advertised twice; approximately 45,000 readers), and Chain Leader magazine (approximately 50,000 readers) to promote the Gulf Oyster Project's Public Conference, held in conjunction with the First Gulf Coast Seafood Pavilion on July 31, 2004 to August 2, 2004, and to promote the three commercially available oyster PHP technologies.

Trade Shows. The LSPMB participated in the International Boston Seafood Show, the International Hotel/Motel and Restaurant Show, the Louisiana Restaurant Show, and the National Restaurant Show where about 500 brochures were distributed at each trade show.

Legislative Promotion. Louisiana held the Louisiana State Legislature and Washington, D.C. Mardi Gras/Louisiana Alive events to showcase Louisiana's seafood to the country's lawmakers. Other D.C. festivities included the Louisiana Oyster Task Force annual Legislative Appreciation Reception participated by the media, food service industries, and legislators. The event, held in honor of the Louisiana Legislature, was attended by approximately 3,000 people.

Media Promotion. In order to promote public awareness of oyster products, the LSPMB partnered with the ACME Oyster House and the International Federation of Competitive Eating to host the annual Louisiana Oyster Challenge held during the French Quarter Festival in New Orleans. As expected, there were extensive local and national media coverage of this event where 12 competitive eaters slurped-down dozens of Gulf oysters within 10 minutes.

Press Releases. Several articles were prepared by the LSPMB staff for submission to the North American Precip Syndicate (NAPS). This enables national newspapers and magazines to access the article for one year. Additional articles were submitted to Waterbottoms, an in-house quarterly publication of the Louisiana oyster industry.

Website. Aside from the Gulf Oyster Project's official website, the LSPMB complemented its widespread media exposure with its newly designed website at www.louisianaoysters.org. This is the official website of the Louisiana Oyster Task Force and features important industry events and information.

Billboard. Located at prime locations, the Louisiana Oyster Billboards affords great exposure for the oyster industry and receives a lot of positive feedback from various sectors.

Seafood Pavilion. The first annual Gulf Coast Seafood Pavilion was held on July 31, 2004 through August 2, 2004 in conjunction with the Louisiana Restaurant Show. Forty-eight exhibitors and 16,000 qualified buyers attended this debut event that featured locally grown and produced seafood products.

Public Conference. The LSPMB hosted the Year 2 Gulf Oyster Project's Public Conference held in New Orleans in conjunction with the Louisiana Restaurant Show.

(3) Florida Bureau of Seafood and Aquaculture Marketing

In order to promote VAP and PHP oysters to the general seafood consuming public, the Florida Bureau of Seafood and Aquaculture Marketing team brought product samples for display and promotion at various prestigious trade shows such as the International Boston Seafood Show (as part of the Florida Fresh Pavilion) and to chefs and restaurateurs at the International Hotel/Motel and Restaurant Show held in New York City.

Getting the word out to the *Vibrio vulnificus* at-risk population has been a major problem for most organizations trying to reach them. The perseverance of the Florida cooperators led to a major breakthrough – i.e., the active participation and direct support of the Winn Dixie Pharmacies in this effort. For their part, the Florida team coordinated the ordering and distribution of relevant educational materials with the Interstate Shellfish Sanitation Conference and the Winn Dixie Corporation. To date, Winn Dixie has distributed both English and Spanish versions of the ISSC's *Vibrio vulnificus* informational brochure at their 300 Florida pharmacies.

Objective 3. *To develop technology transfer (targeted at oyster processors), consumer education (aimed at the wholesale, retail and food service industry professionals), and general seafood consumer market promotion materials and strategies centered on commercially available PHP and value-added oyster products (VAP) and processing technologies.* Objective 3 has been achieved.

The lead cooperator for this aspect of the project is the Florida Bureau of Seafood and Aquaculture Marketing. Although most of the educational materials were already developed during Year 1 of the project, the Gulf Oyster Project cooperators developed additional promotional or educational materials as needed. A press release regarding the Gulf Oyster Project, PHP oysters and

the at-risk consumers was developed by the Florida project cooperators and distributed nationwide to all newspapers with a readership of over 50,000 as well as to all television stations and daily and weekly newspapers in Florida. Another press release highlighting the role of Winn Dixie Pharmacies in the Gulf Oyster Project's *Vibrio vulnificus* at-risk consumer education effort was made in the same manner by the Florida cooperators.

B. Problems Encountered

Most of the problems encountered during the implementation of the Gulf Oyster Project emanate from the multi-disciplinary and multi-institutional nature of this research, development and education project. The problems associated with the geographic separation of the three major project collaborators were real although most were adequately addressed by developments in computer and internet technologies. However, there is still no substitute to face-to-face meetings. In order to facilitate better coordination of Year 2 project activities, a planning meeting was held in Tampa, Florida prior to the commencement of Phase 2 project implementation.

Mother Nature was also a major factor that played some part in the delays encountered by the project, especially at the close-out portion of the project. The succession of strong hurricanes that hit the Florida and central Gulf of Mexico coasts in the summer of 2004 created some delay as coastal populations evacuated from affected regions.

C. New Research Directions

None resulting from Phases 1 and 2 of the project (final year).

9. ADVANCEMENT OF THE FIELD

A. Integrated Research and Development Model

While most academic research projects are narrowly focused based on the investigator's expertise and area of interest, the Gulf Oyster Project deliberately followed a different, albeit more difficult path. Essentially, the Gulf Oyster Project is a combination of three projects integrated together to form an abbreviated and highly inexpensive version of new product/technology research and development process commonly practiced by private corporations. Following a real-life "theory-to-practice" approach, the Gulf Oyster Project integrated laboratory research with industry prototype documentation, field validation, and development of

technology transfer materials and strategies designed to sell a product(s). Since the project needed to address industry problems and issues involving food, it was important to gather and incorporate consumer information in all phases of the program. Hence, the Gulf Oyster Project's main focus involving: (1) market and new product development and testing, (2) technology documentation and feasibility analysis, and (3) consumer education and outreach.

B. Research-Based Consumer Education/Technology Transfer Program

Following the above R & D model, the Gulf Oyster Project intentionally incorporated research-based approaches as part of the development of its consumer education and technology transfer materials and programs. This insures that the information being provided to the target audience is fact-based and current. This is a very important consideration for the Gulf Oyster Project collaborators since this project involves convincing potential seafood consumers to try and possibly adopt new VAP and PHP oyster products as part of their regular seafood orders/diets. In the case of potential investors, entrepreneurs or industry adopters, it is imperative that current and accurate information be made available for their review, especially those concerning potential market supply/demand conditions and the technical and economic performance of these new VAP/PHP products and technologies under commercial operations.

C. Market-Oriented vs. Production-Oriented Development

The underlying philosophy of the Gulf Oyster Project emanates from the belief in the primacy of the market as a major factor in the success or failure of innovations, whether it be the introduction of new PHP technologies or new VAP oyster products designed to expand the current market for Gulf oysters or significantly decrease the occurrence of *Vibrio vulnificus*-related illnesses. Working to address the critical issues on both sides of the demand (consumers) and supply (producers) side of the equation is needed if we are to achieve the long-term goals of this project. Hence, the reason why the consumer education and promotion efforts of the Gulf Oyster Project is being conducted in tandem with efforts to promote new PHP/VAP processing technologies to the Gulf oyster industry.

10. ACCOMPLISHMENTS

A. No Students Supported

B. Publications

Posadas, R.A. 2004. Mississippi Oyster Recipes. A publication of the Mississippi Department of Marine Resources with assistance from the Gulf & South Atlantic Fisheries Foundation, Inc. and Sea Grant Award No. NA16RG2195.

Davis, J.P. and R.A. Posadas. 2004. Bibliography on Post Harvest Processing Technologies for Oysters. A publication of the Mississippi Department of Marine Resources with assistance from the Gulf & South Atlantic Fisheries Foundation, Inc. and Sea Grant Award No. NA16RG2195.

Please see 'Technical Report' section below.

C. No Patent Applied For

D. Ancillary Research – none conducted outside of those proposed.

E. A Public Presentation entitled “Oyster Education Public Conference” was held at the Ernest Morial Convention Center in New Orleans, Louisiana on July 31, 2004. In this conference, the results of Year 2 Gulf Oyster Project were presented to the public. Participation by industry and interested organizations was high, especially since this public conference was done in conjunction with the “1st Gulf Coast Seafood Pavilion” and the “Louisiana Restaurant Show.”

A poster presentation of the results of the Gulf Oyster Project’s consumer acceptability/sensory studies were presented by Drs. Andrews and Coggins at the 2004 Institute of Food Technology (IFT) Convention held in Las Vegas, Nevada.

F. Technology and Information Transfer/Development of Consumer Education and Market Promotion Materials:

Most of the technology transfer and consumer education materials were developed and completed as part of the Gulf Oyster Project - Year 1 implementation. The activities during the second year of the project primarily centered on consumer education and outreach using the materials developed during Year 1. Additional education materials were also developed, mainly the Oyster Education Public Conference proceedings available in CD/DVD version, a web-based downloadable version of the “Available Oyster PHP Technologies” originally produced by the Mississippi project team, a Mississippi Oyster recipe book containing new value added products developed or tested by the project team, and technical manuals and power point presentation slides on the economics and marketability of PHP/VAP products and technology.

11. BENEFITS

- Industry guide to consumer market segments. The results of the Gulf Oyster Project's Consumer Acceptability Survey provides business decision makers with key segmentation variables that they can use to target their potential customer base. The Gulf Oyster Project identified key factors that influence oyster-buying behavior such as: degree of risk aversion, age, gender, and level of formal education.
- Facilitation of technology transfer. On the supply side of the equation, the Gulf Oyster Project focused on gathering factual technical, economic and marketing information about potential investment value of commercially available PHP technologies. The main reason for doing so is because the successful adoption of innovation not only depends on the technical feasibility but must also satisfy the economics of bringing the innovation or product into the market place. The ability of the Gulf Oyster Project to account for the dollars and cents involved with respect to the three commercially available PHP technologies (i.e., Heat-Cool Pasteurization, High Hydrostatic Pressure Treatment, and Individually Quick Frozen) will hasten the rate of adoption (i.e., from awareness to interest, evaluation, trial and adoption) of the new processes and PHP technologies by potential investors or entrepreneurs.
- Contribution to consumer's level of awareness of safer Gulf oyster products. Survey results point to a lack of awareness among respondents about the risks associated with eating raw oysters as well as the availability of equally tasty and safer PHP oyster product alternatives in the market. The extensive efforts made by the collaborating agencies to educate the general public, especially the *Vibrio vulnificus* at-risk segment of the population, helped address this dearth of public awareness. Through the Gulf Oyster Project's support, adequate consumer education and outreach materials are now available to help volunteer organizations, concerned state agencies and the region's oyster industry in their consumer education and seafood promotion efforts.
- Choice of information channel to reach seafood consumers. Survey results indicated that the most widely used means of delivery of information within the Gulf region are (in order of popularity): word of mouth ("somebody told me"), television, magazines, and newspapers. These are the same mass media that are being used by the Gulf Oyster Project to promote Gulf oysters to seafood consumers, e.g., Louisiana Seafood Promotion Board's participation and support of the widely televised and headlined, "Louisiana Oyster Challenge" co-sponsored with the ACME Oyster House and International Federation of Competitive Eating, industry trade shows (International Boston

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Seafood Show, American Culinary Federation, and International Hotel, Motel and Restaurant Show), and various local, state and regional fairs.

- Documentation of consumer acceptance and sales potential of Post Harvest Processed oyster products. Seafood processors and food service industries could now be assured of the market potential for PHP products as indicated by the following findings: (1) Survey results indicated that 77% of those surveyed would buy more oysters with perception of increased safety. The trend to “buy more” was for those with more education, (2) All Post Harvest Processed oysters scored “good” acceptability regardless of ethnic background, and (3) Processing treatments have not altered the perceived attributes of the Gulf oysters. It also did not change the consumer acceptability of Gulf oyster.
- Public health benefits: persistence pays off. The participation of Winn Dixie Pharmacies in the providing important point-of-sales consumer education materials to *Vibrio vulnificus* at-risk individuals could not have happened if Gulf Oyster Project did not exist. Prior to the Gulf Oyster Project, much of the frustration and difficulty encountered by similar consumer education programs centered on the ability to get the medical/health professionals to participate in notable public health awareness programs like this. With Winn Dixie Pharmacies’ long-term commitment and involvement in this endeavor, the ability of oyster industry and other public health agencies to actually reach most of the at-risk segment of the population is now a reality. Essentially, the Gulf Oyster Project, through the dogged persistence of the Florida Bureau of Seafood and Aquaculture Marketing team, provided other states and interested organizations with a workable model to follow.

12. OTHER DOCUMENTATION - NONE

13. OTHER ASSISTANCE

- A. Gulf Oyster Industry: Provided most of the oyster products that were used in the sensory evaluation, consumer education, market promotion, and new value added product development. Also provided collaborators and university researchers technical assistance and access to their facilities, especially for the economic studies and documentation of PHP technologies and plant operations.
 - Motivatit Seafoods, Inc.
 - Ameripure Processing Company
 - Louisiana Seafood Processors
 - Mississippi Seafood Dealers

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- Bradford's Oyster Company
- Crystal Seas Seafood
- Fourier and Sons
- Gulfstream Seafood
- J and W Seafood
- Terry's Seafood

B. Contributing Agencies:

- Gulf Oyster Industry Initiative
- NOAA/National Sea Grant Program
- Florida Sea Grant College Program
- Mississippi Sea Grant College Program
- Mississippi State University (MSU) Coastal Research & Extension Center
- MSU Department of Food Science, Nutrition and Health Promotion

Project Final Report

PROJECT TITLE:

Integrated Oyster Market Research, Product Development and Evaluation, Promotion and Consumer Education for the Gulf of Mexico's Oyster Industry

AMOUNT OF GRANT:

Federal:	\$ 200,000	Match:	\$ 100,000
Total:	\$ 300,000		

AWARD PERIOD:

From: October 1, 2002 To: September 30, 2004

GRANTEE:

Gulf & South Atlantic Fisheries Foundation, Inc.

I. INTRODUCTION

Every year millions of Americans love to eat oysters, especially raw oysters on the half-shell. For a small segment of the population, however, eating raw or undercooked oysters could cause serious illness or even death from *Vibrio vulnificus*, a bacterium commonly found in warm waters, including approved oyster harvesting areas in the Gulf of Mexico. Infection can also occur when cuts, burns, or sores come in contact with seawater containing *V. vulnificus*. As a warm water species, the amount of *V. vulnificus* found in oysters tends to be higher during warm weather months of April through October. What makes it difficult for consumers to detect *V. vulnificus* is that it does not change the appearance, taste, or odor of oysters.

Although most healthy individuals are not at risk from *V. vulnificus* infections, those with any of the following conditions belong to the “high risk” category: liver disease; alcoholism; diabetes; AIDS or HIV infection; gastric disorders; inflammatory bowel disease; cancer (including lymphoma, leukemia, Hodgkin’s disease); hemochromatosis/hemosiderosis; steroid dependency (as used for conditions such as emphysema, chronic obstructive pulmonary disease, etc.); and any illness or medical treatment which results in a compromised immune system. While there is no shortage of quality medical/health care professionals in the U.S., the level of awareness among medical professionals regarding the at-risk population and how they communicate the risks to their patients is still inadequate.

Failure to educate and warn high-risk individuals of vibriosis could lead to an increase in vibrio-related illnesses. The economic impact of negative newspaper publicity on the Gulf’s oyster industry is enormous, causing as much as a 40% decline in dockside price of oysters and a net welfare loss of up to \$13 million to oyster growers and harvesters.

While the need to inform high-risk consumers of the dangers of eating raw oysters contaminated with *V. vulnificus* is paramount, it is equally important to educate the high-risk and general consumers of the availability of equally satisfying PHP oyster products with “safety added” features and other oyster value-added products (VAP) that everyone can enjoy. This win-win strategy requires an integrated R&D effort that combines consumer research, new product development and technological innovations with appropriate consumer education, market promotion and technology transfer programs.

The main activities of the Year 1 “Gulf Oyster Project” center primarily on the implementation of research and outreach projects aimed at (a) documenting the economic and operational characteristics of currently available commercial oyster post-harvest processing (PHP) technologies, (b) objective assessment of the sensory characteristics of various PHP and new oyster value-added products (VAP), and based on the results of these research projects, (c) develop and distribute factual consumer education and technology transfer materials for use by the region’s extension professionals, state seafood marketing boards, and the Gulf oyster industry.

Year 2 of the Gulf Oyster Project is essentially a continuation and expansion of Year 1 activities. Among the key activities conducted by various collaborating agencies and industry cooperators during the second phase of this project were: (a) exploratory analysis of the demographic characteristics of various oyster consumers who participated in the structured surveys and outreach programs, (b) studies on the marketability of VAP and PHP oyster products among Gulf states and California consumer groups, and (c) intensification of consumer education and outreach activities aimed at promoting greater awareness and interest on VAP and PHP oyster products among the general seafood consuming public.

II. PROJECT GOALS AND OBJECTIVES

The long-term goal of this program is to increase the overall consumption and sale of oyster products through

- Promotion of new oyster PHP and VAP processes and technologies,
- Development of acceptable and safer oyster product alternatives, especially for V.v. at-risk consumers, and
- Formulation of effective consumer and food service professional education and product promotion strategies.

More specifically, the objectives of this project are three-fold:

- To continue the development and evaluation of the sensory characteristics of commercially available PHP oyster products (heat-cold pasteurization, quick freezing, high hydrostatic pressure) versus raw oysters and other existing or new value-added product categories (oyster cheese ball).
- To continue educating wholesalers, retailers, processors, food service professionals, high-risk individuals and general seafood consumers on the availability, safety and sensory characteristics of new, commercially available PHP and other value added oyster products.
- To continue the development of technology transfer (targeted at oyster processors and extension professionals), consumer education (aimed at the wholesale, retail and food service industry professionals), and general seafood consumer market promotion materials and strategies centered on commercially available PHP and value-added oyster products (VAP) and processing technologies.

Sustained education and promotion effort by various collaborating agencies is essential throughout Year 2 of this project in order to continue building on the momentum resulting from Year 1 project activities. The ability to persuade seafood consumers, processors, and food service professionals to accept non-traditional oyster product forms and new oyster processing technologies depends to a large extent on the enthusiasm, level of support, unrelenting show of commitment, and vigorous effort of the cooperating agencies and Gulf oyster industry leaders in the pursuit of their long-term goals.

III. APPROACH

A. Theoretical Framework:

Maintaining the existing market share of traditional (raw) oysters requires an in-depth understanding of the industry's current and potential oyster consumer markets. Developing markets for new, post-harvest processed (PHP) products is even more complicated as it requires greater consumer education and product promotion effort. Significant amounts of capital investment, risk and commitment on the part of the oyster industry in the form of new processing methods, technologies and facilities are also expected.

The same hurdle is expected with respect to educating food service professionals and at-risk consumers about the dangers of eating raw oysters and the availability of safer alternatives. This is the reason why this project's educational and technology transfer programs extended to oyster harvesters, processors, restaurateurs and seafood retailers as well as to the at-risk market segment.

Furthermore, aside from the essential consumer understanding and new oyster product R&D components of this project, most of the project collaborator's time and resources were devoted towards developing and implementing appropriate consumer education and/or technology transfer programs. The principles of *diffusion theory* and the *individual adoption process* provided the theoretical framework that guided various participants of this project.

(1) Diffusion Theory and the Technology Adoption Life Cycle Model

Diffusion research emerged out of the troubles that change agents had in getting people to use innovations and information that had been developed specifically for them, usually at the public's expense (e.g., *V. vulnificus* education project aimed at preventing raw oyster consumption by high-risk individuals). *Diffusion* is the process by which an innovation is communicated through certain channels over time among the members of a social system.

The practical aspect of this theory is captured in the *Technology Adoption Life Cycle Model* that relates how communities respond to *discontinuous innovations*. An *innovation* is an idea, practice, or object perceived as new by an individual or other unit of adoption. Truly *discontinuous innovations* are new products or services that require the end users and the marketplace to dramatically change their behavior in exchange for promises of equally dramatic benefits.

Applied to marketing, the model postulates that when a marketplace is confronted with the opportunity to switch to a new infrastructure paradigm – e.g., new oyster product forms or processing technology – customers self-regulate along an axis of risk aversion, with the risk-immune innovators moving to the forefront while the risk-allergic laggards retreat to the rear of the line. In-between, the model identifies three additional communities, i.e., early adopters (visionaries), early majority (pragmatists), and later majority (conservatives).

(2) The Individual Adoption Process

The *innovation-decision process* is a mental process through which an individual (or other decision-making unit) passes from first knowledge of an innovation to forming an attitude towards an innovation, to a decision to adopt or reject, or to implementation of a new idea, and to confirmation of this decision. The five stages in the individual adoption process is as follows:

Awareness. This is the first stage in the process where a person becomes aware of a new idea, product, or practice for the first time and possess only general information about it. If his interest is kindled, he will try to learn more about it. At this stage, the adopter simply needs to be notified of the innovation's existence, e.g., through mass media channels, fellow oyster processors, government personnel, etc.

Interest. At this stage a person develops an interest in the new idea or practice. General information is not enough and the person actively seeks additional detailed information to know what the innovation really is, what it will do and how it will work for him. Since the adopter is basically interested in becoming informed, the preferred information sources are similar to those in the awareness stage.

Evaluation. As the prospective adopter accumulates information, he weighs the pros and cons of the new idea and mentally relates it to his own situation. The person determines whether (a) the idea is a good one and (b) if it is good for him. At this stage, the adopter needs trustworthy sources of information, which includes trusted fellow oystermen, observation of local results, and other trusted individuals in the community or industry.

Trial. At this stage a person tries the new idea or practice. After initial trial, he may adopt the innovation for sustained use or choose not to use it. At this stage the adopter goes beyond knowledge and into actual hands-on-experience. His information needs at this point are more pragmatic and would include "how-to" publications, instructions with the product, experienced oyster processor's assistance, government extension agents, etc.

Adoption. At this stage the individual decides that the new idea is good enough for full-scale use. It is reasoned that he is likely to continue full use until something new starts the cycle again. Therefore, what is more important here is the adopter's own experience and observations about the merits of the innovation as well as confirmation from his peers that his decision was the right one.

(NOTE: Due to significant reductions in the overall proposal's budget as well as other industry considerations, the technology transfer aspect of this project was limited to developing communication materials and implementation of technology transfer-related activities up to the "evaluation" step of the process only.)

B. Collaborators and Sub-Contracted Work:

This project required close cooperation with the Florida Department of Agriculture and Consumer Services (Bureau of Seafood and Aquaculture Marketing), Louisiana Seafood Promotion and Marketing Board/Oyster Task Force, the Mississippi Department of Marine Resources (Seafood Technology Bureau) as well as industry groups such as Motivait Seafood Company, Ameripure Oyster Company, etc. Because of this, close coordination and more involved project planning

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were emphasized. Periodic face-to-face and telephone meetings were conducted throughout the project to evaluate the progress of the different programmed activities and to plan necessary updates.

The second year of this two-year program has three major components corresponding to the three objectives of this project as outlined in Table 1 below (Gulf Oyster Project Schedule of Activities Matrix).

Table 1. Gulf Oyster Project Schedule of Activities Matrix (Year 2).

ACTIVITY DESCRIPTION	DURATION (Months)											
	Y1	October 2002 – September 2004										
Pre-Project Implementation:												
a. Program Planning & Preparation	Y1	x	x	x								
b. Contracts Processing	Y1	x	x	x								
Objective 1. New PHP/VAP Oyster Product Research & Development:												
a. Literature Review	Y1											
b. Consumer/Product Profiling	Y1											
c. Oyster Sensory Evaluation	Y1											
d. Plan/Dev. Tech. Transfer Materials	Y1											
e. Print Tech. Transfer Materials	Y1											
f. Industry Extension Activities	Y1											
g. Integration & Dissemination										x	x	x
h. New PHP Economic Study			x	x	x	x	x	x	x			
i. PHP Shelf-Life & Sensory Evaluation			x	x	x	x	x	x	x			
j. PHP/VAP Handbook Section Write-up			x	x	x	x	x	x				
Objective 2. Consumer/Food Service Professional Education:												
a. Restaurant/Chef Focus Group	Y1											
b. Dev. Video & PHP Processors Guide	Y1											
d. Print Education Materials	Y1											
e. Dev. PHP/VAP Oyster PR/Brochures			x	x	x	x	x	x	x			
f. Print PHP/VAP Promo. Materials						x	x	x	x			
g. LA Trade/Seafood Show Participation			x	x					x			
h. FL Trade/Seafood Show Participation					x				x	x		
i. Local Seafood Show Participation				x	x	x	x	x	x			
j. Gulf Oyster Handbook Write-up			x	x	x	x	x	x				
k. Oyster Handbook Editing/Integration								x	x	x	x	x
l. Handbook Printing/Dissemination										x	x	x
Objective 3. Technology Transfer												
a. Plan/Dev. Tech. Transfer Materials	Y1											
b. Print Tech. Transfer Materials	Y1											
c. Dev. PHP Processors Guide & Video	Y1											
d. Industry Extension Activities				x	x	x	x	x	x			
e. Integration & Dissem. of Proj. Output										x	x	x
Program Close-Out:												
a. Public Presentation	Y1											x
b. Final Report Preparation (last 3 mo)	Y1									*****		
c. Other Close-Out Activities (last 3 mo)	Y1									*****		

1. New Oyster Product Research/PHP Processing Technology Transfer:

New Oyster Product R&D

Reduction or elimination of adverse health risks or illnesses resulting from eating *Vibrio vulnificus* infected oysters requires proper communication of risks, adequate consumer education, and the availability of equally tasty and reasonably priced PHP oyster products with safety added features. Year 2 research projects continue and expand on Year 1 activities and findings to include: analysis of marketing considerations for PHP and VAP oyster products, consumer preferences for PHP raw oyster products in coastal Mississippi, sensory differences of Gulf PHP oysters, consumer acceptability of PHP and VAP oysters, and PHP oyster shelf-life studies. Food scientists and economists at Mississippi State University under the supervision of the Seafood Technology Bureau (STB) of the Mississippi Department of Marine Resources, the lead agency in-charge of this important Gulf Oyster Project component, conducted these studies.

Industry Technology Transfer

Based on the economic and production performance of commercially available PHP oyster processing facilities, supplemented by research findings from both Year 1 and Year 2 project, appropriate technology transfer strategies and extension materials aimed at promoting the benefits of new PHP technologies to other commercial oyster processors were developed and implemented. STB took the lead in the pilot implementation of this project component (i.e., Awareness, Interest, and Evaluation steps of the Individual Adoption Process).

2. Food Service Professionals and Consumer Education/Market Promotion:

Food Service Professionals and At-Risk Consumer Education

The insights gained from targeted focus group sessions as well as relevant research/surveys conducted during Year 1 project were used to develop appropriate consumer education materials and communication strategies targeted at food service professionals and the at-risk consumer segment of the population. Awareness of the risks involved in eating *Vibrio vulnificus* infected oysters and information on the availability of equally good tasting product alternatives with safety added features (i.e., PHP and VAP oysters) was the main focus of this project's consumer education program aimed at the *V. vulnificus* at-risk population. The ability of the Florida Department of Agriculture and Consumer Services to get the Florida Winn Dixie Pharmacies actively involved in the Gulf Oyster Project's consumer education effort gave tremendous boost to the effectiveness of Year 2 activities aimed at reaching the at-risk segment of the U.S. population.

Since restaurants contribute about 60% of the total seafood consumed in the United States, participation in national conventions of food service professionals (e.g., International Hotel, Motel and Restaurant Show; American Culinary Federation; and International Boston Seafood Show) was another approach used to effectively reach this key group of people. The Florida Department of Agriculture and

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Consumer Services was the lead agency that developed and implemented consumer education materials and strategies targeted at this group.

Gulf Oyster, Commercial PHP and Other Value-Added Oyster Product General Consumer Market Promotion

One way to effectively reduce the health risk associated with eating raw oysters as well as expand the market for oysters is by increasing the visibility and availability of safer but equally tasty product alternatives. This “demand-pull” strategy would also encourage seafood processors to consider the trial and adoption of oyster PHP technologies. This requires the development of appropriate commercial PHP oyster market promotion strategies and materials targeted at the general oyster consumers as well as new converts. Participation in local and national seafood/trade shows was effectively utilized to reach a large audience. The Oyster Task Force (OTF) of the Louisiana Seafood Promotion and Marketing Board was the lead agency in-charge of this project component. OTF was also the lead agency that planned and coordinated the Gulf Oyster Project Public Presentation aspect of this project.

IV. PROJECT ACCOMPLISHMENTS

A. Gulf Oyster Project Website (www.GulfOysters.Net)

1. Project Staff:

- Dr. Tomas Jamir, Project Coordinator
- Ms. Juliana Smith, Webmaster
- Ms. Karen Tavares, Associate

2. Goals/Objectives



As part of the two-year communication effort of the Gulf Oyster Project, the ultimate goal of the official project website was to provide cooperating agencies and the general public with an array of communication and information dissemination tools targeted at:

- a. General oyster consumer market with the message, “Eat PHP oysters – they’re tasty and also good for you.”
- b. *Vibrio vulnificus* at-risk population to convey the message, “Abstain from eating raw oysters or follow recommended oyster preparation procedures.”
- c. Commercial oyster processors with the message, “Adopt PHP technology designed to produce safer oysters and open up new market niches (= increased sales) for your company.”

3. Approach

a. Theoretical Framework:

Following the general principles of the Individual Adoption Process, the contents of the Gulf Oyster Website was designed and programmed to provide the appropriate information needed by the project’s target audience as they go through each of the five stages of the PHP oyster technology adoption process, i.e., Awareness, Interest, Evaluation, Trial and finally, either Adoption or Rejection of the new technology or innovation

b. Program Status:

Figure 1 shows the different phases of the PHP oyster technology adoption process from the perspective of an abbreviated three-year “accelerated” program. Phase 1 (Year 1) of the program concentrated mainly on the “Awareness” and “Interest” stages of the Individual Adoption Process. This coincided with the general information, market promotion and educational materials developed by the

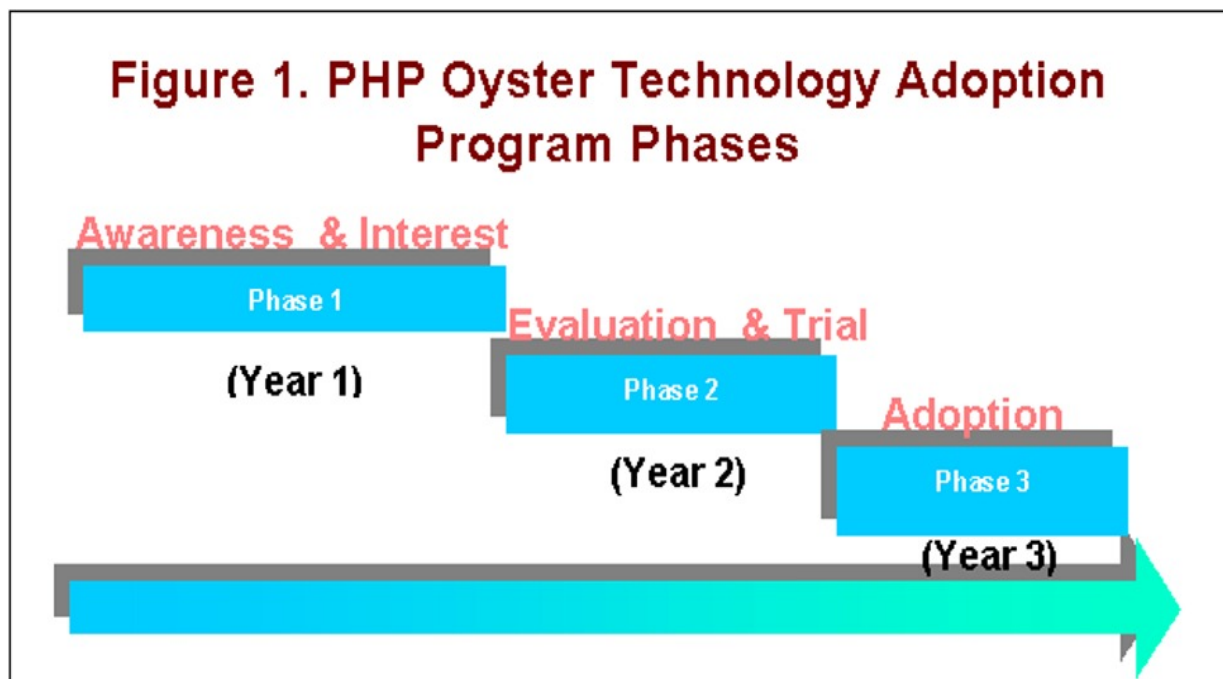
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project collaborators for various target audiences during Year 1 of the project aimed at commercial oyster processors, V.v. at-risk individuals, health providers and medical professionals, general seafood consumers, seafood chefs, restaurants and food service providers.

Year 2 of the abbreviated Gulf Oyster Project coincides with Phase 2 of the PHP Oyster Technology Transfer Program. During this stage in the process, the Gulf Oyster Website carried informational or educational materials designed to increase awareness and interest for PHP oyster products and technology, as well as deliver pertinent materials or links that would enable seafood processing businesses to evaluate, and possibly try for themselves, whether the commercial oyster PHP technology or new oyster value added products is for them or not.

Website informational materials developed during Phase 1 (Year 1) of the project were continued and expanded during Year 2 to include additional oyster recipes from various sources as well as links to cooperating agency websites and various links. Among the new entries included in the Gulf Oyster website are: a downloadable video showing the actual operation of various commercially available PHP technologies, oyster cookbook that features more than fifty delicious new value-added products developed by the Mississippi State University and the Seafood Technology Bureau of the Mississippi Department of Marine Resources.

Regular website updates and maintenance became the main pre-occupation of the Gulf Oyster Project's Website Design and Development Team. As part of the team's commitment to the project's goals, the Gulf Oyster website will be continually updated until the end of this year and will remain on-line for another six months on a *pro bono* basis.



B. Florida Bureau of Seafood and Aquaculture Marketing

1. Project Staff:

- Joanne McNeely, Bureau Chief
- Paul Balthrop, Development Representative

2. Introduction

The Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing participated in this multi-state collaborative oyster marketing research and consumer education grant with the long-term goal of increasing the overall sales and consumption of oyster products through the development and promotion of safer post-harvest processed (PHP) oyster products, processes and technologies. More specifically, the Florida Bureau of Seafood and Aquaculture Marketing was tasked as the project's lead collaborating agency in developing effective education and promotion strategies aimed at reaching the *Vibrio vulnificus* at-risk segment of the population.

Awareness of the risks involved in eating oysters and information on the availability of equally good tasting and safer product alternatives was the main focus of Florida's education program. In this regard, the Florida Department of Agriculture and Consumer Services helped develop and distribute appropriate consumer education materials and communication strategies targeted at food service professionals and the at-risk consumer segment of the population.

3. Goals/Objectives

Statistics show that millions of Americans love to eat oysters. For a small segment of the population, however, eating raw or undercooked oysters can cause serious illness or death from *Vibrio vulnificus* (V.v.), a naturally occurring bacterium found in warm coastal waters. Failure to educate and warn high-risk individuals could lead to increased vibrio-related fatalities. The resulting media coverage is estimated at costing the industry millions of dollars in lost sales. Without question, the need to inform high-risk consumers of the dangers of eating raw oysters is a high priority. However, it is equally important to educate the high-risk consumers, general consumers and the food service industry of the availability of equally satisfying post harvest processed (PHP) oysters.

The overall goal of this project is to increase sales and consumption of oyster products through a variety of methodologies. Florida's objective was to educate the at-risk consumer, general consumer and the food service industry on the availability and safety of new, commercially available PHP and other value added oyster products.

4. Approach and Highlights of Accomplishments

The Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing took a number of approaches to accomplishing the stated objectives.

- a. The *International Boston Seafood Show* (IBSS) is an annual exposition that is the premier seafood event in the country featuring over 750 exhibitors and over 23,000 qualified buyers. Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing staffed the “Fresh from Florida” Pavilion at the show. At the 2003 and 2004 IBSS, staff provided an overview of the grant and its focus to a cross section of the seafood industry, including wholesalers, distributors, foodservice, retail and international buyers. The grant overview piqued interest particularly among the attendees from the food service industry. It should be noted that because of Florida’s participation at IBSS for over a decade, the “Florida Pavilion” is a landmark and attendees tend to gravitate and revisit every year. The “Florida Pavilion” generates an immediate positive impression and always provided an opening to speak about the grant and its focus. At the 2004 IBSS, PHP oysters using a new patent pending process and a new “Apalachicola Oysters” brochure were highlighted. This new process will not be in full production until November 2004. However, the exhibitor displaying this new oyster product and brochure observed an unusually high interest in the product and visitors to the booth indicated that, had it been available several tractor trailer loads of this new product would have sold at the IBSS.
- b. In November of 2002, the Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing staffed a booth at the *International Hotel/Motel Restaurant Show* held at the Jacob Javits Center in New York City, New York. Information targeting the general and at-risk consumer was distributed. PHP and value-added oyster products, i.e., Oysters Rockefeller, were also displayed. PHP oysters were also highlighted at a culinary competition held at the show.
- c. The Florida Department of Agriculture and Consumer Services disseminated informational literature to over 400 attendees at the 2003 Boston Seafood Show. Department staff also spoke with many more attendees about post-harvest processed oyster packaging, price, availability and the at-risk population.
- d. The Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing wrote letters to the major pharmacy chains in Florida requesting, as a public service and in the interest of public safety, their affiliated pharmacies place a brochure about the risk of eating raw oysters in each prescription filled for individuals with a compromised immune system. *Winn Dixie Pharmacies* accepted our offer and in coordination with the *Interstate Shellfish Sanitation Conference*, the Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing launched a campaign to educate the at-risk consumer about the risks of eating raw oysters. As a public service, Winn Dixie agreed to place a brochure containing valuable information about the risks of eating raw oysters in each prescription filled for

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individuals with compromised immune systems. These brochures, in English and Spanish, all provided by the Interstate Shellfish Sanitation Conference, were distributed by Winn-Dixie at their 300 Florida pharmacies.

- e. Finally, A press release highlighting Winn Dixie Pharmacy's role in educating the at-risk consumer was distributed nationwide to all newspapers with a readership of over 50,000 as well as to all television stations and daily newspapers in Florida.

5. Evaluation

The intended goals of the Florida Department of Agriculture and Consumer Services, Bureau of Seafood and Aquaculture Marketing were accomplished following the outline and timeline set forth in the original project proposal. Specifically, Florida's designated responsibility as part of the Year two goals were also met with unexpected windfall. The project's ability to reach the V.v. at-risk consumers was significantly increased following the participation of Winn Dixie Pharmacies in the long-term information dissemination and consumer education program. The results of Year 2 activities and project updates were also reported at a public conference held in New Orleans, Louisiana, July 31, 2004.



C. Louisiana Seafood Promotion and Marketing Board

1. Project Staff:

- Ewell Smith, Executive Director
- Tracy Mitchell, Assistant Executive Director

2. Executive Summary

The Louisiana Seafood Promotion and Marketing Board has strengthened and expanded its traditional general consumer education efforts by expanding its programs to include information on the risks of eating raw oysters, as well as the availability of alternative PHP oyster products for the *Vibrio vulnificus* at-risk consumer segment of the population. The focus and contributions of the Louisiana group in the Gulf Oyster Project primarily involved the participation and dissemination of V.v. at-risk segment and PHP/VAP oyster informational materials at several trade shows and industry promotional venues, project website and newsletter assistance, and the organization and facilitation of the Gulf Oyster Project's Public Presentation Conference in New Orleans, Louisiana.

3. Goals/Objectives

The main objectives of the Louisiana Seafood Promotion Board with respect to the Gulf Oyster Project are two-fold. They were:

- a. To educate consumers and the food service industry of the health hazards of *Vibrio vulnificus* to the at-risk consumers, and
- b. To promote the availability of equally satisfying post harvest processed (PHP) and new value-added oyster products (VAP) with "added safety" features in the market.

4. Approach

Since the main task of the Louisiana Seafood Promotion Board with respect to this project was to raise the awareness and interest among the target audience (i.e., general seafood and V.v. at-risk consumers) with regards to the availability of post harvest processed oyster products, most of the efforts made by the project team revolved around the seafood industry and consumer outreach. The general message was, "as a safer and equally tasty substitute to raw oysters, these new VAP and PHP products provide the at-risk consumer segments with commercially available oysters that they can enjoy."

At trade shows, the Louisiana Seafood Promotion and Marketing Board was usually represented by two to three staff members and one fisheries specialists who are well trained to answer seafood related questions and place product orders from accredited buyers and distributors. During the project implementation period, the seafood promotion team set-up booth displays at the ***International Boston Seafood Show in Boston*** on March 14, 15, & 16, 2004; The ***International Hotel, Motel and Restaurant Show in Las Vegas*** on March 8, 9 & 10, 2004; The ***Louisiana Restaurant Show in New Orleans*** on July 31, August 1 & 2, 2004; and the ***National Restaurant***

Show in Chicago on May 22, 23, 24, & 25, 2004. Approximately 500 brochures were made available and distributed at each of these trade shows.

Advertisements were placed in several publications to promote the **Gulf and South Atlantic Fisheries Foundation's, Inc. Public Oyster Conference**, which was held in conjunction with the first **Gulf Coast Seafood Pavilion** on July 31, 2004- August 2, 2004. This advertisement also promoted Cryogenic Freezing, Low-Heat Pasteurization and Hydro-Static Pressure PHP technologies. The advertisements gave a full definition of each technology and offered oyster processing plant tours to interested people attending the Gulf Coast Seafood Pavilion. Advertisements were placed in **Louisiana Cooking** magazine (approximately 30,000 readers), **Seafood Business** Magazine (advertised twice; approximately 45,000 readers each advertisement), and **Chain Leader** Magazine (approximately 50,000 readers).

During the National Restaurant Show in Chicago, we conducted a product comparison demonstration at the **American Executive Leadership Conference**. Approximately 200 Executive Chef's from around the Country tasted PHP oysters harvested from and processed in Louisiana. Hydro-Static Pressure (Motivatit), Heat-Cool Pasteurization (Ameripure) and traditional raw Gulf oysters were available. Each Chef tasted the oyster and was educated on the individual PHP process. Our staff explained different post-harvest process technologies available and gave a comprehensive perspective of the *Vibrio vulnificus* bacteria and the choices that are available to V.v. at-risk consumers.

Finally, the Louisiana Seafood Team organized and hosted the **Gulf Oyster Project's Public Presentation** held on July 31, 2004 at the Ernest Morial Convention Center in New Orleans, Louisiana. The conference was well attended by project collaborators, oyster processors and the public.

5. Highlights of Accomplishments

a. Industry Promotion.

The Louisiana Seafood Promotion and Marketing Board promoted PHP and VAP oyster products and technologies at the National Restaurant Show in Chicago. Oyster Project brochures and informational materials were disseminated to attendees visiting the seafood display booth. During the National Restaurant Show, we conducted a product comparison demonstration at the American Executive Leadership Conference. Approximately 200 Executive Chef's from around the Country tasted PHP oysters harvested and processed in Louisiana.

b. Advertisement:

Advertisements were placed in several publications to promote the Gulf and South Atlantic Fisheries Foundation's, Inc. Public Conference held in conjunction with the first Gulf Coast Seafood Pavilion on July 31, 2004- August 2, 2004. This advertisement also promoted Cryogenic Freezing, Low-Heat Pasteurization and Hydro-Static Pressure PHP technologies. The advertisements gave a full definition of each technology and offered oyster processing plant tours to interested people attending the Gulf Coast Seafood Pavilion. Advertisements were placed in Louisiana Cooking magazine (approximately

30,000 readers), Seafood Business Magazine (advertised twice; approximately 45,000 readers each advertisement), and Chain Leader Magazine (approximately 50,000 readers).

c. Trade Shows

The Louisiana Seafood Promotion and Marketing Board is usually represented at trade shows by two to three staff members and one fisheries specialists who are well trained to answer seafood related questions and put in product orders from accredited buyers and distributors. During the project implementation period, the seafood promotion team set-up booth displays at the International Boston Seafood Show in Boston on March 14, 15, & 16, 2004; The International Hotel, Motel and Restaurant Show in Las Vegas on March 8, 9 & 10, 2004; The Louisiana Restaurant Show in New Orleans on July 31, August 1 & 2, 2004; and the National Restaurant Show in Chicago on May 22, 23, 24, & 25, 2004. About 500 brochures were made available and distributed at each trade show.

d. Legislative Promotion

Louisiana held two major events at both the Louisiana State Legislature and Washington, D.C. This included the Washington Mardi Gras/Louisiana Alive event in Washington, D.C. and Baton Rouge Legislative events.

Washington Mardi Gras was held in Washington, D.C. the week of January 23, 2004. The purpose of this event was to showcase Louisiana seafood commodities. In combination with the week-long festivities, the Gulf Oyster Industry Council developed and distributed a white paper (Gulf Oyster related issues) to Congressional Delegates. Other festivities included the Louisiana Oyster Task Force annual Legislative Appreciation Reception (held in Washington, D.C.) in which approximately 300 individuals from the media, food service industries and legislature are in attendance. Three Restaurants from Louisiana prepare and serve Louisiana Oyster dishes at this reception. The Louisiana Alive event is held in conjunction with the Legislative Appreciation Reception at the Hilton Hotel in Washington, D.C.; approximately 3,000 people were in attendance. At this event, the Louisiana Oyster Task Force distributed oyster promotional items such as: Blinky Buttons and Beads. The three restaurants also prepare and serve Louisiana Oyster dishes at this event.

The Louisiana Legislature Annual Appreciation Reception was convened during March 2004 at the State Capitol in Baton Rouge, Louisiana. The purpose of this event was to educate and show appreciation to the Louisiana Legislature for their support of the Louisiana Oyster Industry. Approximately 300 people attend this event every year and seven Louisiana restaurants prepare and serve Louisiana Oyster Dishes. Promotional items such as Golf Shirts, Beads and Cups are distributed.

e. Local Media Promotion

Another avenue used by the Louisiana Seafood Promotion and Marketing Board to increase awareness and interests among a broad spectrum of consumers within the region, is through participation or co-sponsorship of local oyster promotional events. The

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Louisiana Seafood Promotion and Marketing Board, together with Acme Oyster House and the International Federation of Competitive Eating, organized the Louisiana World Oyster Challenge held during the French Quarter Festival in New Orleans on April 17, 2004. Local and National Media coverage was present and 12 competitive eaters competed in this contest. This year's winner was 36 year old Sonya Thomas from Alexandria, Virginia. Weighing only 100 pounds, Sonya consumed 36 Dozen Oysters in 10 Minutes. That's 432 Oysters!

f. Press Releases

Several articles prepared by the Louisiana Seafood Promotion and Marketing Board staff have been submitted to the North American Precis Syndicate (NAPS). In return for a \$2,000 per article submission, NAPS enables national newspapers and magazines to access the article for a period of one year- a good PR return for a minimal investment. Additional articles were prepared and submitted to *Waterbottoms*, an in-house quarterly publication produced by, and for, the Louisiana oyster industry and updates industry on oyster related issues and events.



Louisiana Oyster Task Force
July 2004

produced by and for
the Louisiana oyster industry.

Sweet Sonya Devours 432 Oysters



Sonya Thomas slid 36 dozen ice-cold Louisiana oysters down her gullet, effortlessly. The Asian American, a slip of a woman, only 100 pounds, actually doubled last year's record at the **Acme World Oyster Eating Championship** in New Orleans on April 17, 2004.

At the table were notables including *Crawfish* Nick Stipelcovich of Metairie, Louisiana, *Crazy Legs* Conti of New York City, Ken *Tender Vittle* Tittle of Atlanta, Robert Passman of Magnolia, Mississippi, and Eric *Badlands* Booker of Long Island.

When the bell sounded, Sonya raised her slim arms in joy and Rich Shea of the International Federation of Competitive Eating awarded her the championship. Turner Broadcasting and the Associated Press along with local television stations eased in for close-ups and a few words. And the 2004 World Oyster Eating Champion was also featured in Time Magazine!

Louisiana Legislators' 2004 Oyster Reception

At dusk on April 21, 2004, the movers and shakers of the Louisiana oyster industry talked with Louisiana legislators at the Pentagon Barracks Courtyard. Information exchange at this well-attended annual event is always lively. For more, see the write up on the final 2004 legislation.

The oyster industry wishes to extend their gratitude to the following for their contribution to an elegant repast: Acme Oyster House, Avoyelles on the River, Drago's Seafood Restaurant & Oyster Bar, Galatoire's Restaurant, La Cote Brasserie, Marcello's Wine Market, Parrain's Seafood Restaurant, Pascale's Manale Restaurant, the Gulf Oyster Industry Council, Louisiana Seafood Promotion and Marketing Board, and the Louisiana Oyster Dealers and Growers Association.

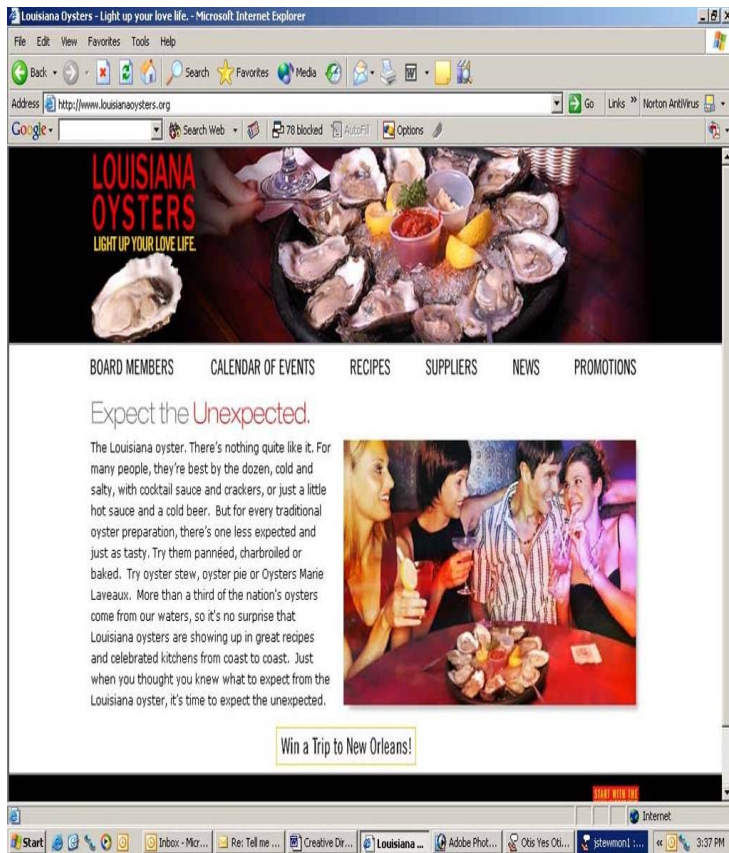


g. Website

Complementing the widespread media exposure of the Louisiana Oyster Task Force is the newly designed website at: www.louisianaoysters.org.

The web-site gives a description of the Louisiana Oyster Task Force, its Members, as well as the Associations they represent. A "Calendar of Events" page is incorporated into the web-site and displays upcoming events of the Louisiana Oyster Task Force. The "Recipe" and "New" pages showcase approximately 25 oyster recipe's and the latest issues of *Waterbottoms*, respectively. The "Promotion" page includes information on current oyster

promotional events that the Louisiana Oyster Task Force and Louisiana Seafood Promotion and Marketing Board are working on at the time. The current promotional campaign is a solicitation for the most unusual place a Louisiana oyster has been consumed, a photo and brief description are to be submitted. The winner will receive an all expense paid weekend trip to New Orleans, LA. The “Suppliers” page of the website catalogues every oyster supplier in the State of Louisiana and is accompanied by the companies name and point of contact.



h. Billboard

The Louisiana Oyster Billboard was purchased over a year ago and advertisements rotate every two-three months. The Billboard is situated at prime locations throughout Louisiana and affords great exposure for the oyster industry. Positive feedback has been received by the Louisiana Seafood Promotion and Marketing Board regarding the effectiveness of the Billboard.

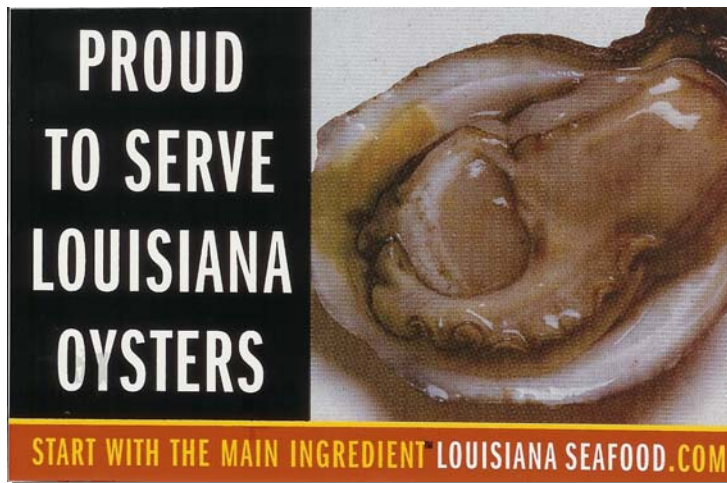
i. Seafood Pavilion

The first annual Gulf Coast Seafood Pavilion was held July 31 through August 2, 2004 in conjunction with the Louisiana Restaurant show. This Pavilion was the first of its kind and highlighted only domestic seafood products harvested from the Gulf of Mexico. Forty-eight exhibitors participated in the Pavilion and 16,000 qualified buyers were in attendance.



j. Proud to serve Louisiana Oyster Campaign

Campaign targeting Restaurants that serve Louisiana Oysters. Custom Decals were developed and distributed to hundreds of seafood restaurants in the Louisiana area and vicinity.



k. Public Conference

The Public Oyster Presentation was coordinated, hosted and convened by the Louisiana Seafood Promotion and Marketing Board staff. The conference was held in New Orleans on July 31, 2004 and moderated by Ms. Tracy Mitchell, Assistant Executive Director of the Louisiana Seafood promotion and Marketing Board. Presentations were videotaped and copied to CD/DVD; copies are available from the Louisiana Seafood Promotion and Marketing Board or the Gulf and South Atlantic Fisheries Foundation, Inc. The presentation topics and presenters at the Gulf Oyster Project's Year 2 Public Presentation were as follows:

- **Paul Balthrop (Florida Department of Agriculture)**
Presentation Topic:
“Program Update - Florida”
- **Tracy Mitchell (Louisiana Seafood promotion Board)**
Presentation Topic:
“Program Update - Louisiana”
- **Ruth Posadas (Mississippi Department of Marine Resources)**
Presentation Topic:
“Program Update - Mississippi”
- **Dr. Tomas Vergel Jamir**
Presentation Topic:
“The Gulf Oyster Project: Marketing of Seafood Products and the Internet”
- **Dr. Patti Coggins (Mississippi State University)**
Presentation Topic:
“Sensory Differences in Mississippi Gulf Oysters Processed by High Heat Pasteurization, High Pressure Treatment, and Individual Quick Freezing”
- **Dr. Linda Andrews (Mississippi State University)**
Presentation Topics:
“Consumer Acceptability of Post Harvest Processed and Value Added Oysters” and
“Consumer Acceptance of Value Added Product”
- **Dr. Benedict Posadas (Mississippi State University)**
Presentation Topic:
“Marketing Considerations for Value Added Product Oysters”
- **Ken Moore (ISSC) and Dot Leonard**
Presentation Topic:
“Summary of ISSC Oyster Education Efforts”

6. Evaluation

The ability of the Louisiana Seafood Promotion Board to aggressively promote the merits of eating safer but equally tasty VAP and PHP oysters have been significantly boosted by the Gulf Oyster Project. Due to the congruence of goals between the Board and the Project, it was relatively easy to meld the two together to form a synergistic and well-integrated consumer education and promotion effort despite the limited resources available. Overall, the project objectives were more than adequately met and Louisiana's oyster industry needs were well served.

A. Mississippi Department of Marine Resources – Seafood Technology Bureau

1. Project Staff:

Mississippi DMR Seafood Technology Bureau

- Ruth Posadas, Bureau Director and Project Coordinator
- Members: Jeff Davis Rod Jordan Jan Welker Clay Boulet
 Linda Bullard Irvin Jackson Lauren Thompson
- Adviser: William “Corky” Perret

Mississippi State University-Coastal Research and Extension Center

- Dr. David Veal, Director
Experimental Seafood Processing Laboratory
Patrick Broussard Tommy Schultz Susan DeBlanc Dr. Linda Andrews
Natural Resource Economics Program
Dr. Benedict C. Posadas
- Department of Food Science and Technology
Garrison Sensory Evaluation Laboratory
Dr. Patti Coggins

2. Executive Summary

The Seafood Technology Bureau of the Mississippi Department of Marine Resources was given the task of conducting *Vibrio vulnificus* education for the state of Mississippi. In the state of Mississippi, V.v. education is a voluntary effort whereas it is mandatory among all the other Gulf States. Being a member of the Gulf States, however, Mississippi has always been a team player and remains so especially in the field of V.v. education. As a result of the research and outreach efforts made through the Gulf Oyster Project, Mississippi’s goals to achieve significant reduction in V.v. illnesses are now more reachable through pro-active consumer education. The level of interest and active involvement of various state oyster producers and processors in promoting VAP and PHP oysters provides additional support and credibility to the whole program.

The Seafood Technology Bureau primarily serves the Mississippi seafood industry in a regulatory capacity. But under the leadership of Ruth Posadas and with the full support of her supervisors, the Bureau is actively pursuing technical assistance and public outreach as a means to assist and be of service to the state’s seafood industry. By actively participating in the research and documentation of the different oyster post-harvest processing technologies, sensory surveys, feasibility studies and marketing analysis, the Bureau had expanded its strength to better serve the seafood industry.

The three researchers of the Mississippi State University’s Coastal Research and Extension Center completed most of Mississippi DMR - Seafood Technology Bureau’s applied research and

development component of the Gulf Oyster Project. The research team includes Dr. Linda Andrews, Dr. Patti Coggins and Dr. Benedict Posadas under the leadership of Dr. David Veal. The MSU Department of Food and Science Technology team of Dr. Andrews and Dr. Coggins conducted the descriptive survey and sensory analysis as well as the development of the value added oyster products, which resulted in 59 new oyster recipes. These new recipes are included in the entries that are going to be published in Volume I of the forthcoming Mississippi Oyster Recipe Book. The Seafood Experimental Laboratory team conducted the research on the shelf life of oysters processed by the three commercially available post-harvest processing (PHP) technologies. They also completed the consumer acceptability survey and analysis of PHP and value added oysters. Sensory and consumer acceptance survey of the differences among Gulf processed oysters and value added oyster products were also conducted. Consumer preferences survey for PHP raw oyster products among coastal Mississippi respondents were conducted by Dr. Posadas. These surveys were designed to determine the important factors needed for the effective marketing of these three commercially available PHP technologies. The insights resulting from these surveys were also used to determine the parameters needed in developing a practical economic model for the Gulf's seafood industry.

This project is a collaborative project being undertaken by various Gulf State seafood agencies and oyster industry leaders as part of the Gulf Oyster Industry Program. Federal funding for this program was provided by the NOAA Sea Grant Program to the Gulf and South Atlantic Fisheries Foundation, Inc. and administered by the Florida Sea Grant College Program. The collaborating agencies involved in this project include the states of Florida (Florida Department of Agriculture and Consumer Services), Louisiana (Louisiana Seafood Promotion and Marketing Board) and Mississippi (Mississippi Department of Marine Resources).

3. Goals/Objectives

Millions of Americans love to eat oysters, especially raw oysters on the shell, however, a very small segment of the population, who eat raw or undercooked oysters could succumb to a serious illness or even death from *Vibrio vulnificus*, a naturally occurring organism in the warm waters of the Gulf. This is one of the main reasons why sales of raw oysters have declined over the last 15 years. The Gulf Coast seafood industry through the Gulf Oyster Industry Council recognized this problem and supported this project to promote the sales and consumption of oysters. This was a necessary step to help revive the oyster industry. Support for new technologies has been tremendous. Few entrepreneurs of the oyster industry for safer oyster product alternatives today are adapting the three PHP available in the market slowly.

During the Year I of this project, capturing the technology and making them available to the seafood industry was one of the project's key objectives. This was accomplished by documenting and producing various technical, promotional, educational and scientific materials based on solid research findings. They were then transformed into useful information and outreach products such as posters, videos, fact sheets, brochures and other educational and promotional materials.

For Year II, the primary objective of the Mississippi component of the project was to promote VAP and PHP technologies and products to the seafood industry as well as to the general seafood consuming public, especially the V.v. at-risk segment of the population. The consumer education and industry technology transfer materials that were developed under Year 1 project were used to educate the industry and consumers about the availability of PHP technologies for producing safer oyster products. Other activities, like surveys, were completed to document possible product and marketing strategies of the available post-harvest processing technologies, the industry can adapt. Surveys were also

conducted among the Asian and Hispanic population to determine sensory and consumer preferences. Economic modeling was established to help business people have an additional tool in evaluating their resources and capabilities before adapting such technologies. Value added product research and analysis were specifically geared towards providing the industry with alternative products they develop to market oysters and increase the per capita oyster consumption of the public.

4. Approach

Given the limited resources, facilities and expertise available for conducting sensory evaluation, economics and consumer surveys at the Mississippi DMR's Seafood Technology Bureau, a number of scientists and extension personnel from the Mississippi State University were subcontracted for this part of the project. The following were the types of research done under this project:

- a. Descriptive Sensory Evaluation Study: Developed descriptive sensory characteristics for Gulf Oysters using focus groups. The trained panel developed the sensory profile of the Gulf Oyster for comparative purposes and product improvement efforts. Sensory evaluation studies on Post Harvest Processed Mississippi oysters were performed through surveys and analyses utilizing Descriptive Analysis techniques. On the choices of Descriptive Analysis techniques, the Spectrum® method was selected based on ease of use and flexibility of scale development and usage by panelists.
- b. Product Development and Consumer Sensory Survey Study: Consumer evaluation of value-added oyster product (smoked oyster and oyster cheese spread) was conducted at the Wildlife Extravaganza on August 1-3, 2003 in Jackson, Mississippi. Approximately 400 consumer volunteers participated in this 3-day event. Both products received very favorable ratings. Evaluation of PHP oysters was conducted at the West Coast Seafood Show from October 12-14, 2003 in Long Beach, California. Approximately 225 volunteers participated. Most were from Asian or Hispanic cultures. These surveys were conducted to understand how different formulations or processing changes affect product acceptability.
- c. PHP Oyster Shelf Life Studies: PHP oyster shelf-life studies were started on October 8, 2003. Oysters that were processed using 3 PHP and control oysters (raw) were stored under appropriate cooling or freezing conditions. Oysters stored under refrigeration were evaluated after 0, 7, 14, 21 days; those stored under freezing conditions were evaluated after 0, 1, 2, 3, 4, 5, 6 months. These studies were made to assess how storage conditions and duration affect product quality.
- d. Development of Economic Feasibility and Marketing Plan Studies: Development of marketing plans for three-post harvest processing (PHP) technologies and value added products for oysters; Individually Quick Frozen (IQF), Heat-Cool Pasteurization (HCP), and High-Hydrostatic Pressure (HHP). These studies looked at various marketing considerations for post-harvest processed and value added oyster products like the consumers' willingness to buy or the processing costs of the three different PHP technologies considered for this study. This information will help the industry make decisions based on consumer perceptions and inferences about the different products and PHPs under consideration. Carefully managed, the findings can give the Gulf seafood industry a significant competitive edge over other products and in a variety of regions.

- e. Education and Promotion of PHP Technologies: Various public outreach efforts were conducted to help in the education and promotion of the three PHP technologies as part of the V.v. illness reduction efforts being implemented among oyster producing states. Included were participation in different trade shows, public meetings, festivals and conferences, and solicitation of feedback from people and institutions that have used the distributed materials.
- f. Bibliographic documentation of Post Harvest Process Technology on Shellfish: Collection of different bibliographic entries, research materials, scientific journal articles, and other published materials on post-harvest processing technologies for oysters and other shellfish were conducted as part of the research and information dissemination component of the Gulf Oyster Project.

5. Accomplishments

This section enumerates the results of various research activities as well as accomplishments made by the Mississippi DMR's Seafood Technology Bureau in its year-long consumer education and technology transfer efforts. Detailed technical reports by various researchers are included in the Technical Report section of this document.

a. Research and Development:

- "The Consumer Acceptability of Post Harvest Treated Oysters" by Dr. Linda Andrews and Dr. Patti Coggins.
- "Consumer Acceptability of Post Harvest Processed and Value Added Oysters Year 2" by Dr. Linda Andrews.
- "Sensory Differences of Gulf Post Harvest Processed Oysters" by Dr. Patti Coggins.
- "Consumer Preferences for Post Harvest Processed Raw Oyster Products in Coastal Mississippi" by Dr. Benedict Posadas and Ms. Ruth Posadas.
- "Marketing Considerations for Post Harvest Processed and Value Added Oyster Products" by Dr. Benedict Posadas, Ms. Ruth Posadas, Dr. Linda Andrews and Ms. Susan DeBlanc.
- Bibliography of Oyster and other Shellfish Post-Harvest Processing Technologies.

b. Education and Promotional Events:

- Louisiana Seafood Industry Convention and Field Day on July 30, 2003 at Grand Isle, LA.
- Fish and Wildlife Show Extravaganza on July 31- August 3, 2003 at Jackson, MS.
- Interstate Shellfish Sanitation Conference in Portland, OR on August 2-7, 2003.
- Louisiana Restaurant Show on August 8-10, 2003 in New Orleans, LA.
- Men's Thursday Club on Sept.4, 2003 at Jackson County, MS.
- Emergency HACCP and Sanitation Training on Sept.11-12, 2003 at Biloxi, MS.
- Biloxi Seafood Festival on Sept. 12-14, 2003 and September 11-12, 2004 at Point Cadet, Biloxi, MS.

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- Celebrate the Gulf on Sept. 27, 2003 and September 25, 2004 at Pass Christian, MS.
 - International West Coast Seafood Show on October 10-15, 2003 at Long Beach, CA.
 - Jackson County Trade Show and Fair on October 18-25, 2003 at Pascagoula, Mississippi
 - Coastal Research and Extension Service Open House on December 5, 2003 at the National Estuarine Research Reserve System conference center at Pascagoula, MS.
 - Mississippi Business Expo Week at Jackson, MS on January 2004.
 - Participation at the Legislative Luncheon at Jackson, MS on January 7, 2004.
 - Participation at MS Governor's Inaugural Ball on January 12, 2004.
 - Conducted Basic HACCP and Sanitation Training at Pascagoula, MS by the Mississippi State University Experimental Seafood Laboratory on Feb.3-6, 2004.
 - Participated at the International Boston Seafood Show on March 12-16, 2004.
 - FDA Training on Shellfish Growing Waters on March 14-16, 2003 at Biloxi, MS.
 - Participation at the Biloxi Cajun Crawfish Festival on April 16-18, 2004 at Biloxi, MS.
- c. Public Conference Activities:
- The International Food Technology Annual Meeting and Food Expo on July 12-16, 2003 at Chicago, IL.
 - Participation at the Food Safety Task Force Meeting at Jackson, MS on July 23, 2003.
 - Participation at the Oyster Forensic Science Workshop and the Oyster Ecology and Management Workshop on July 28-29, 2003.
 - Presented Year I Accomplishment Report of the PHP Research project to the Mississippi Commission on Marine Resources during the July 2003 monthly meeting.
 - Participation at the Interstate Shellfish Sanitation Conference in Portland, Oregon on August 2-7, 2003.
 - Presentation of *Vibrio vulnificus* and PHP educational materials on all the Intrastate Interim Basic HACCP and Sanitation Training Course in Biloxi, MS.
 - Presentations of scientific papers on PHP during the International Food Technology Annual Meeting and Food Expo on July 12-16, 2003 at Chicago, Illinois.
 - Participation at the Food Safety Task Force Meeting at Jackson, MS on July 23, 2003.
 - Presentations of scientific papers on PHP during the 27th annual Conference of the Seafood Science and Technology Society on Nov. 3-6, 2003 at Biloxi, MS.
 - Presentation and participation at the Mississippi Department of Health Environmentalists Training Workshop at Canton MS on Nov. 13, 2003.
 - Mississippi Academy of Sciences meeting on February 2004 at Biloxi, MS.
 - Participated at the *Vibrio vulnificus* Train-the-Trainer workshop at New Orleans, LA on April 12- 14, 2004.

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- Sensory Evaluation for oyster value added products on April 16-18, 2004.
- World Aquaculture Society Conference on March 1-5, 2004 at Honolulu, HI.
- Institute of Food Technologists Annual Meeting on July 2004.

d. Others:

- Distribution of DMR packets during AFDO Basic HACCP and Sanitation Training Course at Pascagoula, MS on February 2-5, 2004.
- Distributed educational and promotional materials through the Public Affairs Office of the MS Department of Marine Resources, to all permitted members of the MS Seafood Industry and to Mississippi State Research and Extension Center (MSU-CREC) Seafood Experimental Laboratory.
- Provided PHP educational and promotional materials to the Gulf and South Atlantic Fisheries Foundation, Inc., Florida Sea Grant College; Northeastern Regional Aquaculture Center (University of Massachusetts Dartmouth) and to the National Marine Fisheries Service/ National Oceanographic Atmospheric administration office at Pascagoula, MS for their own distribution and dissemination to their constituency.
- Provided PHP educational and promotional materials to the Gulf Coast Community College West Harrison Vocational and Technical School.
- Semi-annual mail-outs to 91 newly certified Seafood Dealers (11 new dealers) on seafood safety articles including updated ISSC/NSSP regulations and educational materials on Post Harvest Processing of Oysters and *Vibrio vulnificus*.
- Assisting MS seafood dealers who are adapting PHP technology (2 dealers).

e. Educational and Promotional Materials Developed or Utilized:

- CD/DVD (DMR's "*Available technologies for Post Harvest Processing of Oysters?*")
- Video (DMR's "*Available technologies for Post Harvest Processing of Oysters?*" and 2001 "*Vibrio vulnificus Training video?*")
- Poster (DMR's "*Post-harvest Processing Technologies for Oysters?*")
- Brochure (DMR's "*Available Technologies for Post Harvest Processing of Oysters?*;" ISSC's "*The Risk of Eating Raw Oysters or Clams?*" Brochure; FDA's "*Fight Bac! Four Simple Steps to Food Safety?*" Brochure) NFI's "*Food Safety: Fish and Shellfish Raw Seafood?*;" ISSC's "*A Call to Action: Illegal Shellfish Harvesting, Legal Intervention?*;" ISSC's "*Don't Dump...Pump?*;" DMR's "*Mississippi Oyster Seafood Safety?*" Slides)
- Training Kit (ISSC's *Vibrio vulnificus Training Kit*)
- Books (DMR "*Seafood Recipes - South Mississippi Style?*" Volumes 1 and 2)
- Fact Sheets (ISSC's "*Vibrio vulnificus Fact Sheet for Health Care Providers?*;" DMR's "*Post-harvest Oyster Processing Technologies?*")
- PowerPoint Presentation ("*Available Technologies for Post Harvest Processing of Oysters?*")

6. Evaluation

The over-all goals and objectives of the different studies originally planned for the project were accomplished. However, due to the amount of research data that accumulated as a result of this project, their processing, analysis, and integration into final research reports could not possibly be done within the short time frame and budget allocated for this two-year project. These include an expanded analysis of the market factors for inclusion into the marketing plan, additional promotion and consumer education materials that are still on the drawing board, and technology transfer materials that still need to be sorted and integrated into ready-to-use investment packages. As a result of this project, however, the Mississippi DMR's Seafood Technology Bureau have accumulated enough factual research-based information on VAP and PHP oyster from various sensory evaluations, consumer surveys, and analysis of commercial PHP processing plant operations on which to base future business feasibility studies, targeted marketing research, consumer outreach and industry technical assistance programs.

As part of Mississippi DMR's long-term commitment to assist the Gulf seafood industry and look after the welfare of the consumers, the results of this project will be posted on the web and hard copies produced and distributed among the different cooperators, interested member states of the ISSC, and the Gulf seafood industry. Additional effort will be made to send these materials to different seafood institutions, cause-oriented organizations and government agencies that have a use and need for the data and information generated by this project.

7. Acknowledgements

Funding and Collaborating Agencies

- Gulf Oyster Industry Program, NOAA/National Sea Grant Program
- Florida Sea Grant College Program
- Gulf & South Atlantic Fisheries Foundation, Inc.
- Seafood Technology Bureau, Mississippi Department of Marine Resources
- Coastal Research & Extension Center (CREC), Mississippi State University
- Bureau of Seafood and Aquaculture Marketing, Florida Department of Agriculture and Consumer Services
- Louisiana Seafood Promotion and Marketing Board

Seafood Processing Industry Cooperators

- Ameripure Processing Company
- Motivatit Seafood, Inc.

Mississippi Seafood Dealers

- Bradford's Oyster Company
- Carmel Seafood
- Crystal Seas Seafood
- Gulfstream Seafood
- Jerry Forte Seafood
- Kimball Seafood
- Pass Purchasing Seafood

Thanks to Mr. John Tesvich and Mr. Pat Fahey of Ameripure Processing Company for allowing the team to document the patented process (Heat-Cool Pasteurization) as part of their help to the industry. Special thanks are also extended to Mr. Ernie Voisin, Mr. Mike Voisin and Family for the accommodation and hospitality of the Motivatit Seafood, Inc. oyster company have afforded the research team

The whole oyster operation of the Motivatit Seafood, inc. was opened for the documentation of the post-harvest processes namely, the High Pressure Process and the Individually Quick Frozen. Without their help, none would have been documented. The processing of samples for the different surveys, the interviews with employees and the whole workforce of both companies were at the team's disposal during the two trips made to each of their facilities this year.

This Year II report was based on the work conducted by several people and cooperators sub-contracted to do the different aspects of the project. This project was granted to the Seafood Technology Bureau of the Marine Fisheries Office, Mississippi Department of Marine Resources who supplied the matching funds. The work under this project was subdivided and sub-contracted to the Mississippi State University through Dr. David Veal of the Mississippi State University Coastal Research and Extension Center with researchers Dr. Linda Andrews, Dr. Patti Coggins and Dr. Benedict Posadas. Dr. Andrews worked on the post harvest process (PHP) product profile and sensory surveys, collaborating with Dr. Patti Coggins the PHP descriptive and sensory surveys and product development of the value added product (VAP) of oysters, descriptive and sensory surveys. Dr. Posadas worked on the economic benchmarking of the three PHP technologies and the analysis of the consumer product profile survey of Mississippi Gulf Coast.

V. PROGRAM EVALUATION



All of the major project deliverables and activities planned for Year 2 (Phase 2) of the Gulf Oyster Project have been achieved despite some delays at the start (contract negotiation period) and end of the project (due to hurricane that passed through Florida and the Northern Gulf of Mexico).

Pre-planning activities by all project team members were conducted in Tampa, Florida to review Year 1 accomplishment and to identify, coordinate and allocate Year 2 research, education and outreach activities. Year 2 project activities were concentrated on three key result areas: (1) continuation of more targeted product and consumer marketing research, (2) implementation of *Vibrio vulnificus* at-risk consumer education initiatives, and (3) promotion of VAP and PHP oyster products to seafood consumers and PHP oyster processing technologies to the Gulf oyster industry.

Planning for Year 2 activities, especially with respect to the allocation of lead responsibilities among the cooperating agencies, were greatly facilitated by knowledge gained during the implementation of the Year 1 project as well as the trust developed among various implementation teams. Understanding the core competencies of each collaborating agency and the strengths of each project team members enabled the Gulf and South Atlantic Fisheries Foundation, Inc. to better assign tasks and control the quality of expected project deliverables.

Given the prior experience, university collaboration, staff capabilities, project team's competency and strategic congruency of Mississippi DMR-STB's program goals with those of the Gulf Oyster Project, much of Year 2 research and development subcontracts were awarded to this group for implementation. The close working relationship among the project staff of MS-DMR Seafood Technology Bureau and the subcontracted scientists and extension professionals of Mississippi State University's Sensory Science Laboratory and MSU Coastal Research and Extension Center enabled the smooth implementation of various Year 2 research projects. These include (a) Consumer Acceptability of Post Harvest Process and Value Added Oyster Products, (b) Economic Analysis of Commercial PHP Oyster Processing Plants, (c) Sensory Differences of Gulf Raw, VAP and PHP Oyster Products, (d) Shelf Life Studies and Acceptability of Various PHP Oyster Products, and (e) Analysis of Consumer Preferences for Post Harvest Processed Raw Oyster Products in Coastal Mississippi.

The long-standing interest, industry contacts, and prior work by the Florida Bureau of Seafood and Aquaculture Marketing staff made them the ideal lead agency tasked with the development and implementation of consumer education efforts targeting the at-risk *Vibrio vulnificus* population. The impact of the Gulf Oyster Project in addressing the major health concerns of this segment of the population has been made more apparent with Florida's signing-on of the senior officers of Winn Dixie Pharmacies into the program. Finally, the difficulty of identifying and involving influential people in the communication chain has been addressed, thereby enabling the Gulf Oyster Project to reach the target population with relative ease and certainty.

Among the collaborating agencies, the Louisiana Seafood Promotion Board is perhaps the most experienced, focused and effective team with it comes to the promotion of seafood products to the general consumers and the political arena. As such, they were assigned the lead role with respect to this component of the Gulf Oyster Project. By participating in tandem with the major seafood promotion program and activities planned by the Louisiana Seafood Promotion Board throughout the year, the Gulf Oyster Project was able to maximize its VAP and PHP oyster product promotion efforts beyond what the meager project budget could hope to achieve. Because of this, the project was able to reach not only local and regional seafood consumers, traders, processors, restaurateurs, and chefs but also national and international contacts as well (e.g., through the International Boston Seafood Show, the American Culinary Federation, the

International Hotel, Motel and Restaurant Show, and the ACME Oyster House and the International Federation of Competitive Eating).

Aside from their main project responsibilities, it should also be noted that all of the collaborating agencies were also very active in V.v. consumer education, general seafood promotion and VAP/PHP oyster technology outreach at the various county, state, and regional mass gatherings.

VI. CONCLUSION/RECOMMENDATION

After working for two years on the Gulf Oyster Project, a number of important lessons and research findings were learned by the project team that is worth sharing. First of all, what started as an experimental organization to enable a motley crew of geographically dispersed institutions run a complex and somewhat ambitious research and outreach project, later became a model of what could be done with only a limited amount of resources, but with ample technical guidance and a clear vision of where one needs to go. The key factors that pulled the project team together and deliver a credible product can be summed up in the following:

- (a) Commonality of vision and program goals,
- (b) Strategic fit among various collaborating agency programs and the Gulf Oyster Project,
- (c) Ability of the Gulf and South Atlantic Fisheries Foundation, Inc. to match the strengths and core competency of individuals and organizations with the requirements of the job,
- (d) Early industry buy-in and support,
- (e) Professionalism and competence of project personnel, and
- (f) Commitment of all involved with the long-term goals of the project.

Reaching out to the *Vibrio vulnificus* at-risk segment of the population through the traditional network of medical/health care professionals has proven to be a very difficult and expensive proposition for similar programs and institutions prior to the breakthrough achieved by the Gulf Oyster Project. In reality, the Gulf Oyster Project's ability to enlist the participation of Winn Dixie Pharmacies in this important consumer education effort was a combination of dogged persistence, years of preparation, and pure luck on the part of the dedicated staff of the Florida Bureau of Seafood and Aquaculture Marketing. This communication link needs to be explored at other states and regions as it may well be the most effective and economical way of reaching a relatively small segment of the population most affected by V.v. infections.

Should the above scenario turn out to be true, then a dedicated institution like the Interstate Shellfish Sanitation Conference may be enough to deal with the problem. As the health issues pertaining to the V.v. at-risk segment of the population gets adequately and effectively addressed in the future, the Gulf oyster industry needs to face up to its real problem – the bigger issue relating to the safety of eating raw oyster products in general. Dr. Linda Andrews framed it well when she noted that the food safety aspects surrounding the consumption of raw oysters parallels consumer resistance to accepting pasteurized milk. By comparison, the Gulf oyster industry situation is much better than that of the dairy industry. For example, the Gulf Oyster Project's sensory evaluation studies concluded that PHP oyster products were not perceived

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to be different from raw oyster products. Furthermore, the project's consumer acceptability studies also indicated that oyster consumption levels would increase if taste and food safety issues would be adequately addressed. Pasteurized milk, on the other hand, has its own distinctive flavor that is different from raw milk. Yet, through aggressive consumer education and promotion, pasteurized milk eventually became highly acceptable and safer particularly for children and pregnant women. The last point leads to a need to focus our future research and consumer education efforts on marketing and the economics of PHP/VAP oyster production systems.

Although research results indicate parity of PHP oysters with raw oyster products, the current commercial methods and technologies to produce safer, PHP oyster products are still in the infancy stage. As such, PHP oysters cannot hope to compete in the market on the basis of price alone. A more viable positioning strategy would be to emphasize the perceived and real benefits that consumers could derive from eating oysters with added safety features. Fear detracts a large segment of the population from eating raw oysters, but the comforting element of product safety and quality branding sells products.

For the majority of the oyster lovers, the issue of product safety is not a major selling point. Also price is not a motivating factor to buy given that the demographic characteristics of the population belonging to this category include older men with higher levels of formal education. Rather, perceptions of high product quality associated with delicate gourmet taste and social status should be explored. Such characteristics are particularly appealing to the development of appropriate oyster-based value added products.

In closing, it is recommended that future research, development and consumer education efforts should focus more on targeted oyster marketing research, new oyster VAP product development and testing, PHP technologies and process improvements, and consumer education aimed at enhancing the perception and acceptability of safer VAP/PHP oyster products to the general public.

Ms. Judy L. Jamison, Executive Director
Principal Investigator

September 30, 2004
Date

Dr. Tomas Vergel C. Jamir
Project Technical Consultant

September 30, 2004
Date

Technical Reports

ECONOMIC BENCHMARKS FOR POSTHARVEST PROCESSING SYSTEMS FOR RAW OYSTERS IN THE GULF OF MEXICO

Benedict C. Posadas

Associate Professor of Economics
Coastal Research and Extension Center
Mississippi State University
Mississippi-Alabama Sea Grant Extension Program
2710 Beach Blvd., Suite 1-E, Biloxi, MS 39531

Ruth A. Posadas

Bureau Director
Bureau of Seafood Technology
Mississippi Department of Marine Resources
1141 Bayview Avenue, Suite 101, Biloxi MS 39530

Introduction

During the last three decades, the per capita oyster consumption in the U.S. declined from about 0.35 pounds per year in 1971-1989 to about 0.25 pounds per year in 1980-2001 (Posadas and Posadas, 2004). Respondents of consumer surveys conducted recently revealed several reasons for not eating oyster products or not eating more frequently. Using the results of a national survey, Hanson et al. (2003) reported that for nonconsumers, taste, texture and smell were the top three reasons for not consuming oyster products. Respondents who ate oyster products considered price, product safety concerns and unavailability of fresh products were the top three reasons for not eating more frequently.

Respondents from Coastal Mississippi who did not consume raw oysters cited several reasons which influenced their consumption decisions (Posadas and Posadas, 2004). The most frequently cited reason by 42% of the Coastal Mississippi nonconsumers was that “oysters are slimy”. About 36% of nonconsumers from Coastal Mississippi considered the “appearance of oysters” as a limiting factor to raw oyster consumption. Having a “smell” was mentioned by 27% of the Coastal Mississippi nonconsumers as a negative characteristic of raw oysters. Personal safety and concerns or illness (other than allergies)

was also considered by 25% of nonconsumers as a constraint to raw oyster consumption. The other reasons cited by nonconsumers ranged from “think oysters would taste bad” to “do not know what to do with them.”

In a survey conducted in Houston (TX), Baltimore (MD), Boston (MA) and Gulfport (MS), respondents who did not eat raw oysters, cited several determining factors which influenced their consumption decisions (Posadas and Andrews, in review). The reason most commonly cited by 34% of the nonconsumers was “they think oysters would taste bad”. About 29% of the nonconsumers considered the “appearance of oysters” as a limiting factor to raw oyster consumption. Being “slimy” was selected by 22% of the nonconsumers as a negative characteristic of raw oysters. The other reasons cited by nonconsumers included “do not like new things - no specific reason”, “smell”, “personal safety concerns - illness”, “color”, “think grit/internal waste is bad”.

The question of ‘what can change their minds to try and eat PHP raw oysters’ was addressed by the Coastal Mississippi respondents in several ways (Posadas and Posadas, 2004). The guarantee of a safe product was the most frequently considered type of inducement to consume PHP raw oysters by 17% of the respondents. ‘Education on health benefits’ and ‘good presentation’ were cited by at least 12% of all the respondents. About 11% of Coastal Mississippi residents would consider eating PHP raw oysters if they get paid for doing it. Hanson et al. (2003) also concluded that respondents will increase oyster consumption if sold at a lower price, guarantee of safe product and become more wide available.

Federal regulatory mandates and market constraints set up by individual states would eventually require that a significant portion of raw oyster production undergo postharvest processing. The state of California imposed a ban on the sale of untreated raw oysters from the Gulf of Mexico during summer months starting spring 2003. Federal mandates require that individual oyster producing states establish postharvest processing capacity in relation to reported *Vibrio*-related cases. As of summer 2004, four of the five commercial raw oyster postharvest processing plants operating in the United States are located in the Gulf of Mexico.

The overall goal of this study is to provide economic benchmarks for commercially viable postharvest processing (PHP) systems for raw oysters in the Gulf of Mexico. The three PHP systems included in this study were heat-cool pasteurization (HCP), high hydrostatic pressure (HHP) and individually quick frozen (IQF).

Specifically, it aims to achieve the following objectives:

- (1) To develop hypothetical commercial postharvest processing systems for raw oysters (CPHPS) in the Gulf of Mexico;
- (2) To estimate annual costs and returns of CPHPS at different levels of PHP capacity use;
- (3) To evaluate the economic feasibility of CPHPS under different plant management systems and marketing opportunities.

Benchmark Modeling

Spreadsheet economic benchmark models were developed for heat-cool pasteurization (HCP), high hydrostatic pressure (HHP) and individually quick frozen (IQF) postharvest processing (PHP) for raw halfshell oysters in the Gulf of Mexico. The hypothetical CPHPS model using the HCP postharvest processing system was developed based on observations made during two visits at the AmeriPure Processing Company, Inc. (<http://www.ameripure.com>) in Franklin, Louisiana, earlier models developed by Muth et al. (2000) on oyster postharvest processing, and Tesvich and Fahey (2003).

The HHP model was constructed based on observations made during two visits at Motivait Seafoods, Inc. (<http://motivait.com/index.cfm>) in Houma, Louisiana, and Muth et al. (2000). The IQF model was developed from observations made during two visits at the Motivait Seafoods (<http://www.motivatit.com>) in Houmma, Louisiana, visit with Hillman Oyster Company (<http://www.hillmanoysters.com>), visit with Crystal Seas Seafood in Pass Christian, Mississippi, and Muth et al. (2000). These CPHPS models were developed with the initial assumption that an oyster processor will design, build and operate a new PHP plant for the purpose of producing only one product line, i.e., raw halfshell oyster.

Space and Building Requirements

It was assumed that the three models are operated as a single plant, single location, one product line commercial post-harvest processing production system. The space requirements and building specifications are listed in Table 1. The processing building space would require 2,000 sq ft with different specifications for the ceiling height. Multipurpose, refrigeration and administrative building spaces were assumed at 1200, 1000 and 800 sq ft, respectively. The assumed technical parameters of the CPHPS processing facilities for the three PHP systems were based on observed processing production conducted at the different processing plants visited (Table 2). Detailed descriptions of the postharvest processing production processes observed during visits with processing plants were described in posters, leaflets, videotapes and CDs published by the Seafood Technology Bureau of the Mississippi Department of Marine Resources (DMR-STB) (<http://www.dmr.state.ms.us/>) and the Gulf Oyster Project (GOP) (<http://www.gulfoysters.net/index.html>).

Processing Capacity

A single HCP processing line consisting of a 5000-gal warm-water tank and a 3,500-gal ice-water tank could process 8 batches per hour or a total of 64 batches per 8-hour-day processing schedules (Table 2). In order to operate the HCP processing plant at full capacity, it would require 384 sacks of suitable single oysters per day, 8,160 sacks per month, or 97,920 sacks per year (Table 3). In terms of the size of oyster lease or public reef, at least 196 acres of productive oyster growing area producing at least 500 sacks per acre would be required to supply this processing facility with suitable oysters year-round.

Table 1. Space requirements and building specifications for postharvest processing plants for raw oysters in the Gulf of Mexico. Based on specifications provided by (Muth et al., 2000).

HCP System	Unit	Quantity
No. of processing plants	plant	1
Processing building space: 12' ceiling height, concrete floor	sq ft	2,000
Multipurpose building space	sq ft	1,200
Refrigeration building space	sq ft	1,000
Administration building space	sq ft	800
HHP System		
No. of processing units	plant	1
Processing building space: 16' ceiling, 6' below enclosure, concrete floor	sq ft	2,000
Multipurpose building space	sq ft	1,200
Refrigeration building space	sq ft	1,000
Administrative building space	sq ft	800
IQF System		
No. of processing plants	plant	1
Processing building space: 9-10' ceiling height, concrete floor	sq ft	1,200
Multipurpose building space	sq ft	1,200
Refrigeration building space	sq ft	1,000
Administrative building space	sq ft	800

With a single 210 liter high hydrostatic pressure processor, a HHP processing facility could process 8 batches per hour or 144 batches per 18-hour-day processing schedules (Table 2). At full capacity, the HHP processing plant would need 432 sacks of single oysters per day, 9,180 sacks per month, or 110,160 sacks per year (Table 3). About 220 acres of oyster growing area producing at least 500 sacks per acre would be required to supply the HHP processing facility with oysters for 12 months each year.

It was assumed that a single freezer tunnel could process 12 batches per hour or 192 batches per 16-hour-day processing schedules (Table 2). About 614 sacks per day of winter oysters, 13,056 sacks per month or 78,336 sacks per 6-month processing period would be required to operate the IQF facility at full capacity. A minimum of 157 acres of productive oyster growing area would be necessary to supply the winter oysters needed to run the IQF facility for the specified 6-month processing period (Table 3).

Table 2a. Technical parameters used in developing processing facilities for Heat-Cool Pasteurization (HCP) post-harvest processing plants for raw oysters in the Gulf of Mexico.

HCP Processing Facility		
Parameter	Unit	Quantity
Number of boiler	Unit/plant	1.00
Number of 5,000-gal warm water tank	Tank/plant	1.00
Number of chilling and condensing unit	Unit/plant	1.00
Number of 3,500-gal ice-water tank	Tank/plant	1.00
Number of sacks of oysters per batch	Sack/batch	6.00
Length of processing:		
Heating process	Minute/batch	24.00
Cooling process	Minute/batch	15.00
Loading and unloading process	Minute/batch	5.00
Total processing time	Minute/batch	44.00
Number of batches per hour	Batch/hour	8.00
Number of processing hours per shift	Hour/shift	8.00
Number of processing shifts per day	Shift/day	1.00
Number of processing hours per day	Hour/day	8.00
Number of operating days per week	Day/week	5.00
Number of operating weeks per month	Week/month	4.25
Number of operating months per year	Month/year	12.00
Dozen of half shell oysters per case	Oyster/case	8.33

Table 2b. Technical parameters used in developing processing facilities for High Hydrostatic Pressure (HHP) post-harvest processing plants for raw oysters in the Gulf of Mexico.

HHP Processing Facility		
Parameter	Unit	Quantity
Number of 215-L high hydrostatic pressure processor	Unit/plant	1.00
Number of pounds of oyster shell stock per sack	Pound/batch	100.00
Number of pounds of shell stock per batch	Pound/batch	300.00
Number of sacks of oyster shell stock per batch	Sack/batch	3.00
Length of processing:		
Pressurized process	Minute/batch	5.00
Loading and unloading process	Minute/batch	2.50
Total processing time	Minute/batch	7.50
Number of batches per hour	Batch/hour	8.00
Number of processing hours per day	Hour/day	18.00
Number of operating days per week	Day/week	5.00
Number of operating weeks per month	Week/month	4.25
Number of operating months per year	Month/year	12.00
Dozen of half shell oysters per case	Oyster/case	8.33

Table 2c. Technical parameters used in developing processing facilities for Individually Quick Frozen (IQF) post-harvest processing plants for raw oysters in the Gulf of Mexico.

IQF Processing Facility		
Parameter	Unit	Quantity
Number of freezer tunnel	Unit/plant	1.00
Number of half-shell oysters per batch	Tank/plant	960.00
Length of processing:		
Freezing process	Minute/batch	5.00
Glazing process	Minute/batch	1.00
Loading and unloading process	Minute/batch	3.00
Total processing time	Minute/batch	9.00
Number of batches per hour	Batch/hour	12.00
Number of processing hours per shift	Hour/shift	8.00
Number of processing shifts per day	Shift/day	2.00
Number of processing hours per day	Hour/day	16.00
Number of operating days per week	Day/week	5.00
Number of operating weeks per month	Week/month	4.25
Number of operating months per year	Month/year	6.00
Dozen of half shell oysters per case	Oyster/case	12.00

Table 3. Oyster shellstock requirements for post-harvest processing plants for raw oysters in the Gulf of Mexico.

Raw Oysters	Unit	HCP	HHP	IQF
Number of halfshell oysters per sack	Oyster/sack	300	300	300
Sack of oyster shellstock per case of halfshell oyster	Sack/case	0.33	0.33	0.48
Sack of oyster shellstock per day	Sack/day	384	432	614
Sack of oyster shellstock per month	Sack/month	8,160	9,180	13,056
Sack of oyster shellstock per year	Sack/year	97,920	110,160	78,336
Acre of oyster lease or public reef	Acre	196	220	157
Sack of oyster shellstock per acre	Sack/acre	500	500	500

Results and Discussion

Investment Requirements

The three hypothetical CPHPS models developed for the Gulf of Mexico PHP raw oysters proved to be economically viable processing systems given the technical parameters assumed and prevailing market conditions. The rate of utilization of production capacity (RUPC) was assumed to start at 20% during the first year and would reach full capacity during the fifth year.

Initial fixed investment required (IFIR) to establish an HCP processing system would be \$0.91M (Table 4). With the assumed input usage and cost structures, annual operating capital required (AOCR) to operate the HCP system at full capacity during the fifth year would be \$4.34M. At prevailing market conditions, the HCP system could generate annual gross sales during the fifth year (AGS5) amounting to \$7.34M. Annual production at full capacity (APFC) would be 293,760 cases of HCP processed halfshell raw oysters. Discounted investment indicators showed that HCP processing system had an internal rate of return (IRR = 67.54%) greater than the required rate of return (RRR= arbitrarily set at 35%). At a discount rate of 10%, the net present value of the HCP system (NPV = \$5.96M) is positive, indicating an economically viable investment alternative.

Establishing an HHP processing system for raw oysters could be considered an economically viable alternative. The HHP processing system would require IFIR = \$2.55M and AOCR = \$4.66M (Table 4). With APFC = 330,480 cases of HHP processed halfshell raw oysters, AGS5 were projected to reach \$8.26 M. At these assumed technical parameters and market conditions, the HHP processing system could be considered an economically viable alternative since it had an IRR = 35.69%, which is slightly higher than RRR = 35% and a positive NPV = \$5.45M.

The IQF processing system proved to be an economically viable raw oyster processing system. It has the potential to produce 163,200 cases of frozen halfshell oysters per six-month processing period. It would require IFIR = \$0.76M to establish the processing system, and AOCR = \$3.10M to operate the

system. With an expected AGS5 reaching \$5.88M, the IQF system would be a viable processing system with NPV = \$5.64M and IRR = 70.40%.

Table 4. Model results and investment analysis of post-harvest processing production systems for raw oysters in the Gulf of Mexico.

Model Results	Unit	HCP	HHP	IQF
Number of halfshell oysters processed per day	Oyster/day	115,200	129,600	184,320
Number of cases of halfshell oysters processed per day	Case/day	1,152	1,296	1,280
Number of halfshell oysters processed per month	Oyster/month	2,448,000	2,754,000	3,196,800
Number of cases of halfshell oysters frozen per month	Case/month	24,480	27,540	27,200
Number of halfshell oysters processed per year	Oyster/year	29,376,000	33,048,000	23,500,800
Number of cases of halfshell oyster frozen per year	Case/year	293,760	330,480	163,200
Investment Analysis				
Initial fixed investment requirement	\$M	0.91	2.55	0.76
Annual gross receipts at full capacity	\$M/yr	7.34	8.26	5.88
Annual operating capital requirements at full capacity	\$M/yr	4.34	4.66	3.10
Discount rate	%	10.00	10.00	10.00
Net present value	\$M	5.96	5.45	5.64
Internal rate of return	%	67.54	35.69	70.40

Average Production Costs

The total annual costs of the CPHPS models were estimated as a function of RUPC or annual processed raw oyster production (APROP). Total processing costs (TC) consisted of total fixed or ownership costs (TFC) and total variable or operating costs (TVC). For the HCP processing system described in Tables 1 and 2, the average total cost ($AC = TC \div APROP$) would range from \$0.25/halfshell to \$0.17/halfshell (Figure 1). At the current wholesale price (CWP = \$0.25/halfshell), the HCP plant would break-even at more than 50,000 cases of processed raw halfshell oysters.

For the HHP processing system described earlier, \$0.30 = ATC = \$0.17 per processed halfshell raw oyster (Figure 2). The HHP system would attain break-even position at $APROP > 100,000$ cases of processed raw oysters. The estimated ATC for the IQF system would range from \$0.27 to \$0.16 per processed halfshell raw oyster (Figure 3). The break-even point for the IQF system would occur at $APROP < 50,000$ cases of processed raw halfshell oysters.

The majority of total processing costs for the three PHP systems were incurred in the purchase of single oysters (31.3%-34.1%), hiring of hourly workers (13.2%-17.6%), cost of operating capital (8.3%-8.7%), purchase of banding materials (4.4%-5.9%), royalty fees for HCP and HHP (5.9%), packaging materials (2.7%-5.9%), cost of natural gas for HCP and IQF (5.9%-14.7%), and electric consumption (3.6%-4.7%).

Table 5. Percent distribution of annual processing costs of PHP systems for raw oysters in the Gulf of Mexico.

Cost Items	HCP	HHP	IQF
Variable Costs:			
Oyster shellstock	31.3%	31.4%	34.1%
Wage Labor	17.6%	17.7%	13.3%
Operating interest	8.7%	8.3%	8.4%
Banding materials	5.9%	5.9%	4.4%
Royalty fees	5.9%	5.9%	0.0%
Packaging materials	5.9%	5.9%	2.7%
Natural gas	5.9%	0.0%	14.7%
Electricity	4.7%	4.7%	3.6%
Salary Labor	3.0%	2.7%	4.1%
Liability insurance	2.4%	2.1%	3.3%
Fuel and oil	1.9%	1.9%	1.4%
Repair and maintenance	1.4%	4.3%	2.0%
Water	0.6%	0.3%	0.4%
Communication and internet	0.2%	0.2%	0.3%
Total Variable Costs	95.4%	91.2%	92.9%
Fixed Costs:			
Plant management	1.7%	2.2%	3.4%
Depreciation	1.6%	3.4%	2.3%
Interest on investment	0.9%	2.3%	1.0%
Insurance for building and equipment	0.4%	0.9%	0.4%
Total Fixed Costs	4.6%	8.8%	7.1%
TOTAL COSTS	100.00%	100.00%	100.00%

Figure 1. Estimated average costs of Heat-Cool Pasteurization (HCP) post-harvest processing system for raw oysters.

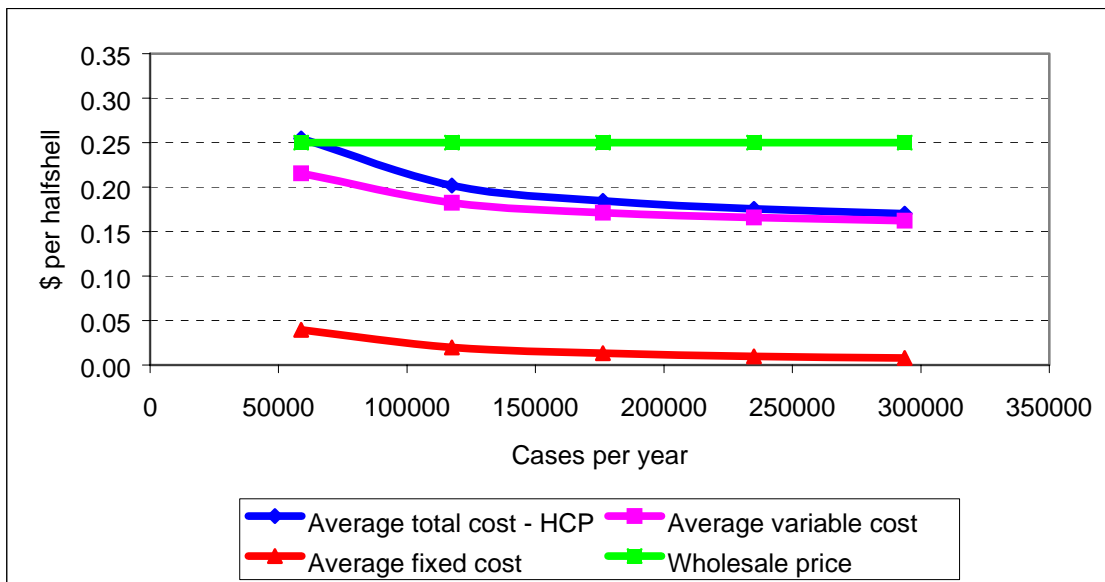


Figure 2. Estimated average costs of High Hydrostatic Pressure (HHP) post-harvest processing system for raw oysters.

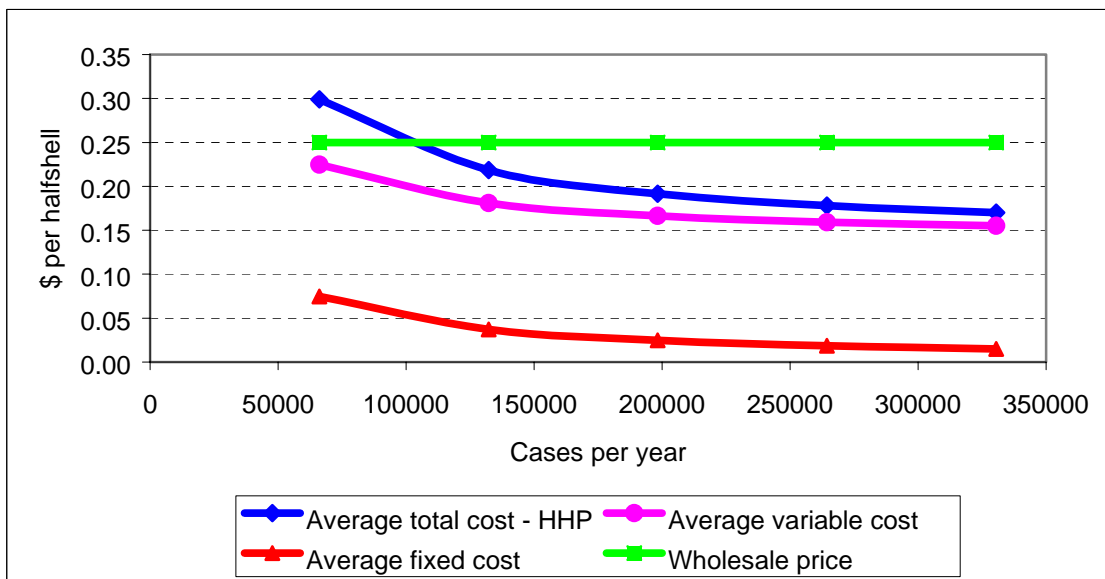
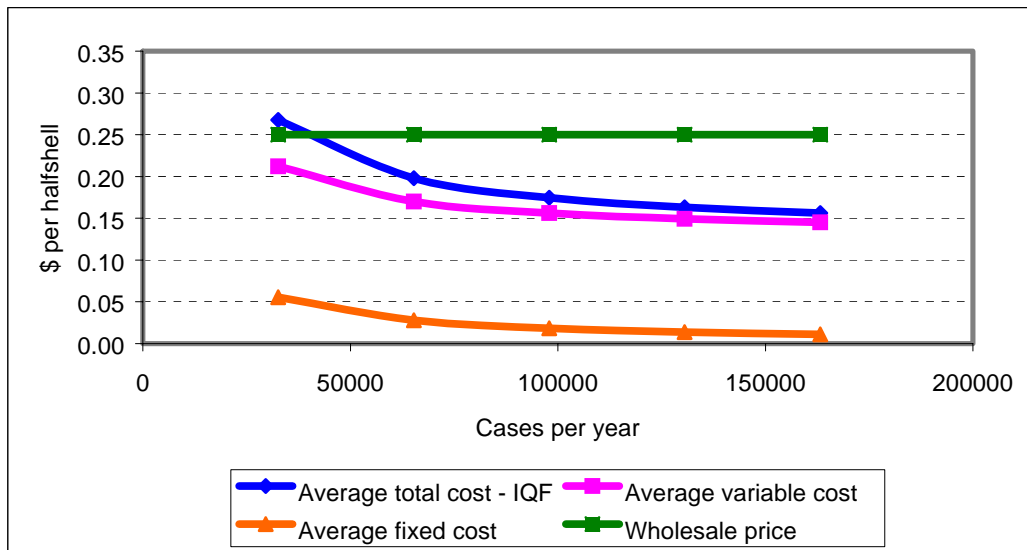


Figure 3. Estimated average costs of Individually Quick Frozen (IQF) post-harvest processing system for raw oysters.



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CONSUMER PREFERENCES FOR POSTHARVEST PROCESSED RAW OYSTER PRODUCTS IN COASTAL MISSISSIPPI¹

Benedict C. Posadas² and Ruth A. Posadas³

Introduction

U.S. per capita oyster consumption has declined from about 0.35 pound in 1971-1989 to less than 0.25 pound starting in 1989 (Figure 1). Oyster consumption may be affected by many determinants varying across regions, ethnicity, income levels, age groups, gender and awareness of potential risks. Results of recently conducted surveys revealed several reasons for not eating oyster products or not eating more frequently. Hanson et al. (2002) reported that taste, texture and smell were the most widely cited reasons for not consuming oyster products. Respondents who ate oyster products considered price, product safety concerns and unavailability of fresh products were the top three reasons for not eating more frequently.

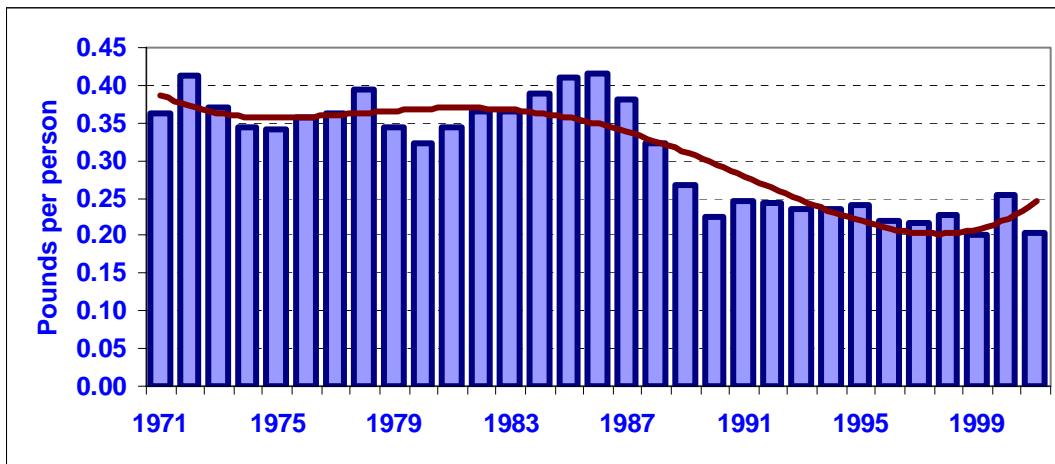
In a survey conducted in Houston (TX), Baltimore (MD), Boston (MA) and Gulfport (MS), respondents who did not eat raw oysters, cited several determining factors which influenced their consumption decisions (Posadas and Andrews, in review). The reason most commonly cited by 34% of the non-consumers was “they think oysters would taste bad”. About 29% of the non-consumers considered the “appearance of oysters” as a limiting factor to raw oyster consumption. Being “slimy” was selected by 22% of the non-consumers as a negative characteristic of raw oysters. The other reasons cited by non-consumers included “don’t like new things-no specific reason”, “smell”, “personal safety concerns-illness”, “color”, “think grit/internal waste is bad”. Hanson et al (2000) also concluded that respondents will increase oyster consumption if sold at a lower price, guarantee of safe product and become more wide available.

1- Final Report Submitted to the Mississippi Department of Marine Resources. July 2004.

2- Associate Professor of Economics, Mississippi State University, Coastal Research and Extension Center, Mississippi-Alabama Sea Grant Extension Program, 2710 Beach Blvd., Ste. 1-E, Biloxi, MS 39531, E-mail: benp@ext.msstate.edu

3- Bureau Director, Mississippi Department of Marine Resources, Bureau of Seafood Technology, 1141 Bayview Avenue, Suite 101, Biloxi MS 39530

Figure 1. U.S. per capita oyster consumption.



The overall goal of the consumer survey was to evaluate consumer preferences for postharvest processed (PHP) raw oyster products. Specifically, it aimed to achieve the following objectives:

- (1) Compare the socio-economic characteristics of consumers and non-consumers of raw oyster products;
- (2) Determine reasons for not eating and food safety concerns about eating raw oysters;
- (3) Evaluate consumption patterns for PHP and non-PHP products of consumers and non-consumers of raw oyster products;
- (4) Evaluate consumer interest and willingness to pay for PHP products by consumers and non-consumers of raw oyster products;
- (5) Evaluate packaging preferences for PHP products of consumers and non-consumers of raw oyster products;

Methods

Consumer preferences for PHP raw oyster products were evaluated from results of a consumer survey conducted at the Jackson County Fair in Pascagoula, Mississippi on October 21-25, 2002. Respondents were asked to specify their socio-economic characteristics including sex, marital status, age, household income, and educational attainment.

They were asked whether they eat raw oysters or not, and indicate the main reasons for eating or not eating raw oysters. They were also asked about their primary food safety bacteriological concerns about raw oysters, frequency of eating raw oysters, and source of raw oysters. A series of questions was asked regarding their awareness, sources of information, level of interest, willingness to pay, and packaging preferences for PHP raw oysters.

The results of the consumer survey were categorized into consumers and non-consumers of raw oysters. Analysis of variance (ANOVA) or chi-square analysis was used to compare differences among responses.

Results and Discussion

Socio-Economic Characteristics

The raw oyster consumption behavior displayed by Coastal Mississippi residents was strongly influenced by the gender, age and formal education completed by respondents. Marital status, race and household income did not have significant influences on raw oyster consumption. Differences existed in the consumption of raw oysters between male and female respondents. More of the male respondents consumed raw oysters than female respondents. Among male respondents 56% ate raw oysters while 25% of female respondents reported eating raw oysters (Table 1).

Table 1. Distribution of respondents by gender and raw oyster consumption						
Gender	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Female	193	75%	66	25%	259	100%
Male	111	44%	141	56%	252	100%
Total	304	59%	207	41%	511	100%
Chi-square value = 49.206 ***						

In Coastal Mississippi, the age of respondents showed to have very strong influence on raw oyster consumption. The percent of respondents eating raw oysters was higher among older respondents. The highest reported raw oyster consumption was observed among the 40-49 age group, followed by the 50-59 and 60 & above age groups (Table 2).

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Table 2. Distribution of respondents by age group and raw oyster consumption

Age group	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
18-29	186	62%	112	38%	298	100%
30-39	43	66%	22	34%	65	100%
40-49	26	43%	34	57%	60	100%
50-59	26	54%	22	46%	48	100%
60 & above	19	54%	16	46%	35	100%
Total	300	59%	206	41%	506	100%

Chi-square value = 9.690*.

The level of formal education completed had very strong influence on raw oyster consumption among Coastal Mississippi residents. The percent of respondents eating raw oysters rose as the level of education of respondents increased. About 13% of respondents with elementary education reported eating raw oysters. Among those who completed at least some college education, 46% reported consuming raw oysters.

Table 3. Distribution of respondents by education and raw oyster consumption

Education	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Elementary	14	88%	2	13%	16	100%
High School	115	65%	62	35%	177	100%
Some college	106	54%	91	46%	197	100%
Completed college	40	54%	34	46%	74	100%
Advanced degree	20	56%	16	44%	36	100%
Total	295	59%	205	41%	500	100%

Chi-square value = 11.103*.

Reasons for Not Eating Raw Oysters

Respondents from the Mississippi Gulf Coast who did not eat raw oysters, cited several reasons which influenced their consumption decisions. The most frequently cited reason by 42% of the non-consumers was that **“oysters are slimy”** (Table 4). About 36% of non-consumers considered the **“appearance of oysters”** as a limiting factor to raw oyster consumption. Having a **“smell”** was mentioned by 27% of the non-consumers as a negative characteristic of raw oysters. **Personal safety and concerns or illness (other than allergies)** was also considered by 25% of non-consumers as a constraint to raw oyster consumption. The other reasons cited by non-consumers ranged from “think oysters would taste bad” to “don’t know what to do with them.”

Reason for not eating raw oysters	Number	Percent
Slimy	128	42%
Appearance	110	36%
Smell	82	27%
Personal safety and concerns/illness, not allergies	75	25%
Think would taste bad	68	22%
Color	47	15%
Think grit, sandy/internal waste is bad	44	14%
Allergies (Doctor’s advice/Personal experience)	14	5%
Doctor’s advice due to illness	13	4%
Not sure where to get them	10	3%
Aversion to new things (No specific reasons)	7	2%
Don’t know what to do with them	7	2%

Bacterial and Viral Food Safety Concerns

Respondents from Coastal Mississippi strongly indicated their primary food safety concerns about eating raw oysters. The most commonly mentioned concerns were Hepatitis virus (55%) and *Escherichia coli* (42%), with more among the non-consumers voicing their concerns than the consumers (Table 5). About 18% of the respondents were concerned with Salmonella, 13% were concerned with *Vibrio*

vulnificus, and 10% mentioned Norwalk virus. Less than 10% of the respondents cited *Vibrio cholera* and *parahaemolyticus* and *Listeria monocytogenes*.

Table 5. Distribution of respondents by food safety bacterial and viral concerns

Concern	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Hepatitis virus	159	31%	122	24%	281	55%
<i>Escherichia coli</i>	133	26%	82	16%	215	42%
Salmonella	59	12%	33	6%	92	18%
<i>Vibrio vulnificus</i>	29	6%	39	8%	68	13%
Norwalk virus	37	7%	16	3%	53	10%
<i>Vibrio cholera</i>	23	5%	17	3%	40	8%
<i>Vibrio parahaemolyticus</i>	20	4%	14	3%	34	7%
<i>Listeria monocytogenes</i>	17	3%	14	3%	31	6%

Reasons for Eating Raw Oysters

Coastal Mississippi residents cited two major reasons for liking to eat raw oysters. Three-fourths of the consumers stated that they ate raw oysters because **“oysters taste good”** (Table 6). About 38% of the consumers mentioned that **“oysters are fun to eat”**. Other reasons for liking raw oysters included nutritional benefits (15%), habit (13%), believed to be aphrodisiac (5%), and image (2%).

Frequency of Eating Raw Oysters

Coastal Mississippi residents ate raw oysters about 4.77 times last year (standard deviation, SD = 24.15). There were no significant differences in frequency of raw oyster consumption last year among respondents of different socio-economic backgrounds. More than half (52%) of the respondents reported not eating raw oysters last year (Table 7). Those who ate raw oysters once a year consisted of 11%, three times a year - 17%, six times a year - 11%, and twelve times or more a year - 10%.

Table 6. Distribution of consumers by reason for eating raw oysters

Reason for eating raw oysters	Number	Percent
Tastes good	156	75%
Fun to eat	79	38%
Nutritional benefits	32	15%
Habit (Become use to eating oysters)	26	13%
Believe to be an aphrodisiac	11	5%
Image (Peer pressure)	4	2%

Table 7. Distribution of respondents by frequency of eating raw oysters last year

Eating frequency	Number	Percent
Never	265	52%
Once a year	56	11%
Three times a year	87	17%
Six times a year	54	11%
Twelve times a year	35	7%
Weekly	11	2%
Daily	3	1%
Total	511	100%

Potential Risks of Eating Raw Oysters

Majority of the Coastal Mississippi respondents (73%) were aware of the potential risks with eating raw oysters (Table 8). Awareness of the potential risks with eating raw oysters (risks) tended to enhance raw oyster consumption. Consumers of raw oysters were more aware of the risks than those who did not consume raw oysters. Awareness of the risks enables consumers to make consumption decisions regarding raw oysters.

Table 8. Distribution of respondents by awareness of potentials risks associated with eating raw oysters

Awareness of potential risks	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Not aware	56	18%	23	11%	79	15%
Aware	205	67%	170	82%	375	73%
Don't know/not sure	43	14%	14	7%	57	11%
Total	304	100%	207	100%	511	100%

Chi-square value = 13.894 **.

Coastal Mississippi respondents would tend to eat more raw oysters if health and safety concerns are reduced or eliminated. More than three-fourths (76%) of the consumers will eat more raw oysters if the concerns are reduced or eliminated. Over half of the non-consumers (57%) were not interested in changing their preferences with raw oysters. Changes in the perceptions of the Risks associated with raw oysters would alter consumers' preferences with regards to raw oyster consumption.

Table 9. Distribution of respondents who would eat more raw oysters if health and safety concerns were reduced or eliminated

Decision	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Will not eat more	174	57%	34	16%	208	41%
Will eat more	81	27%	158	76%	239	47%
Don't know/not sure	49	16%	15	7%	64	13%
Total	304	100%	207	100%	511	100%

Chi-square value = 123.124 **.

Sources of Raw Oysters for Consumption

Respondents from Coastal Mississippi preferred to buy most of their raw oysters for consumption from restaurants (27%) and seafood markets (21%). Some of them bought raw oysters directly from the dock (15%) and from oyster bars (15%). The other sources of raw oysters were recreational catch (7%)

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and retail grocery store (4%, Table 10). More than half (51%) of the respondents indicated that they consumed Gulf Coast raw oysters while 41% were not sure or did not know the regional source of the raw oysters they ate.

Sources of raw oysters	Number	Percent
Restaurant	137	27%
Seafood market	109	21%
Direct from the dock	77	15%
Oyster bar	78	15%
Recreational catch	35	7%
Retail grocery store	19	4%

Improvements in the availability of raw oysters would alter Mississippi Gulf Coast consumers' preferences with regards to raw oyster consumption. Three-fourths of the those who did not consume raw oysters would prefer not to eat more if they become more widely available. However, two-thirds of those who consume raw oysters would tend to eat more if raw oysters become available year round.

Decision	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Will not eat more	227	75%	45	22%	272	53%
Will eat more	27	9%	136	66%	163	32%
Don't know/not sure	50	16%	26	13%	76	15%
Total	304	100%	207	100%	511	100%

Chi-square value = 190.707 **.

Consumer Awareness of Postharvest Processed Raw Oysters

About 47% of all respondents believed that there are methods that render raw oysters safe and leaves no detectable levels of harmful bacteria. More raw oyster consumers (63%) believed that there were available methods than non-consumers (36%).

Coastal Mississippi residents were not widely aware of the availability of postharvest processed (PHP) raw oysters. About one-fifth of the respondents were familiar with whole, shucked, or half-shell raw oysters which have been processed with a high pressure method (Table 12). Pasteurized, in-shell or shucked raw oysters were known to 14% of the respondents. One out of ten of the respondents said that they knew of individually quick frozen (IQF) half-shell or whole shell raw oysters. Less than one-tenth of the respondents stated that they were aware of heat shocked in-shell or shucked raw oysters. The levels of awareness about PHP raw oysters were generally higher among consumers of raw oysters.

Table 12. Distribution of respondents by awareness of postharvest processed raw oysters

Oyster products	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Pressurized (HPP)	49	16%	50	24%	99	19%
Pasteurized (HCP)	40	13%	34	16%	74	14%
Individually quick frozen (IQF)	24	8%	26	13%	50	10%
Heat shocked (HS)	28	9%	20	10%	48	9%

Coastal Mississippi residents received information about methods of PHP of raw oysters through a wide variety of delivery methods. The most widely used means of delivery were **“somebody told me”** (19%), television (14%), magazines (12%) and newspapers (12%, Table 13). The other delivery methods used by less than 5% of the respondents were radio, trade shows, brochures, scientific journals, conferences and symposia. Consumers (22%) tended to believe **“somebody telling them”** about PHP raw oysters than non-consumers (16%).

Consumer Interest and Willingness to Pay for Postharvest Processed Raw Oysters

Less than 30% of Coastal Mississippi respondents stated that they will buy PHP raw oysters. About 19% of all respondents were interested in buying PHP full and half shell raw oysters, while 29% said they will buy PHP shucked raw oysters (Table 14). For PHP full-shell raw oysters, about 14 of non-consumers and 25% of consumers indicated that they will buy them. For PHP half-shell raw oysters, 10 and 31% of non-consumers and consumers stated that they will purchase this product, respectively. More non-consumers (24%) and consumers (36%) reported that they will buy PHP shucked raw oysters.

Table 13. Distribution of respondents by source of information about postharvest processed raw oysters

Information source	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Somebody told me	50	16%	45	22%	95	19%
Television	44	14%	30	14%	74	14%
Magazines	41	13%	20	10%	61	12%
Newspapers	32	11%	28	14%	60	12%
Radio	12	4%	13	6%	25	5%
Trade shows	10	3%	9	4%	19	4%
Brochures	9	3%	10	5%	19	4%
Scientific journals	7	2%	10	5%	17	3%
Conferences	1	0%	4	2%	5	1%
Symposia	1	0%	1	0%	2	0%

Table 14. Distribution of respondents who will purchase postharvest processed raw oysters

Product form	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Full-shell	43	14%	52	25%	95	19%
Half-shell	30	10%	65	31%	95	19%
Shucked	73	24%	74	36%	147	29%

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The current interest for PHP raw oysters among Coastal Mississippi residents was low. However, statistically significant differences were observed between consumers and non-consumers in each of the five PHP raw oyster products. For pasteurized PHP raw oysters, the average level of interest was 0.82 with 0.48 for non-consumers and 1.32 for consumers (Table 15). Pasteurized PHP raw oysters also attracted similar level of interest (0.84) from all the respondents, non-consumers (0.47) and consumers (1.37). The level of interest for heat shocked PHP raw oysters averaged 0.65 with 0.48 among non-consumers and 0.90 among consumers. Individually quick frozen (IQF) PHP raw oysters received a rating of 0.58 from all the respondents and 0.34 and 0.94 from non-consumers and consumers, respectively.

Item	Non-consumer (N = 304)	Consumer (N = 207)	Total (N = 511)
Pressurized (HPP) ***	0.48 ± 1.31	1.32 ± 1.89	0.82 ± 1.62
Pasteurized (HCP) ***	0.47 ± 1.26	1.37 ± 1.94	0.84 ± 1.63
Heat shocked (HS) ***	0.48 ± 1.34	0.90 ± 1.57	0.65 ± 1.45
Individually quick frozen (IQF) ***	0.34 ± 1.07	0.94 ± 1.66	0.58 ± 1.37

1 - level of interest = {0, 1, 2, 3, 4, 5} where 0 = not interested, 5 = very interested.

*** - statistically significant between consumers and non-consumers at 0.001.

The willingness to pay (WTP) for five PHP raw oyster products by Coastal Mississippi residents did not significantly vary between consumers and non-consumers of raw oysters. Consumers stated that they were willing to pay \$4.44/dozen of pressurized PHP raw half shell oysters from a supermarket (Table 16). Pasteurized and individually quick frozen PHP half shell raw oysters were valued at the retail level at \$3.89 and \$3.97/dozen, respectively. Consumers' willingness to pay for heat shocked and irradiated PHP half shell raw oysters were \$3.42 and \$3.11/dozen, respectively.

Consumer Packaging Preferences for Postharvest Processed Raw Oysters

Packaging of PHP raw oysters varies when sold at different market outlets. They are differentiated from the traditional or non-PHP raw oysters by way of the products are labeled and tagged. When asked about their preferences for the type of packaging for whole or full shell PHP raw oysters when buying at supermarkets or seafood stores, 31% of the Coastal Mississippi respondents preferred the traditional method of packaging them in sacks. The other preferred type of packaging whole or full shell

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PHP raw oysters selected by Coastal Mississippi respondents included ‘packaged loose in plastic containers’ (15.7%), ‘vacuum packed’ (13.3%), ‘clean plastic tubes’ (7.2%) and ‘packed in solid boxes’ (6.5%).

When solicited about preferred types of packaging for half shell PHP raw oysters when buying at supermarkets or seafood stores, Coastal Mississippi respondents revealed a certain mix of preferences. ‘Vacuum packed in solid cardboard box with a window’ was the leading preference selected by 15.1% of Coastal Mississippi residents. The second packaging method for half shell PHP raw oysters preferred by 14.7% of the respondents was ‘shrink wrapped trays in solid boxes’. ‘Shrink wrapped trays in solid boxes with a window’ was opted for by 13.5% of the respondents. The final preferred packaging method cited by 9.8% of the respondents was ‘vacuum packed in solid cardboard box’.

Item	Non-consumer	Consumer	Total
Pressurized (HPP)	4.43 (5.52) N=52	4.45 (4.21) N=58	4.44 (4.85) N=110
Pasteurized (HCP)	3.78 (5.13) N=47	4.00 (2.66) N=48	3.89 (4.05) N=95
Heat shocked (HS)	3.59 (5.21) N=46	3.22 (2.42) N=39	3.42 (4.15) N=85
Individually quick frozen (IQF)	3.80 (7.15) N=42	4.14 (4.31) N=44	3.97 (5.84) N=86
Irradiated (IRR)	2.51 (4.14) N=41	3.72 (3.46) N=41	3.11 (3.84) N=82

More than one-quarter (21.4%) of the Coastal Mississippi residents selected the traditional method of ‘packaging in plastic containers’ as their preferred method for PHP shucked raw oysters when buying at supermarkets or seafood stores. In terms of sizes of the plastic containers, the most preferred size by 30.5% (???) of the respondents was ‘quarts plastic container’, followed by ‘pint plastic container’ - 18.4%, ‘gallon plastic container’ - 13.7%, and ‘half gallon plastic container’ - 9.6%.

Consumption of Postharvest Processed Raw Oysters

The actual consumption of individual PHP raw oysters reported by Coastal Mississippi residents during the past year was limited. Pressurized PHP raw oysters were consumed by 7.5% of the respondents. About 4.1% of the respondents reported consuming pasteurized PHP raw oysters last year. Heat shocked, individually quick frozen, and irradiated PHP raw oysters were consumed by 2.3, 2.2 and 2.9% of the Coastal Mississippi respondents, respectively.

When viewed collectively, about 15.9% of the Coastal Mississippi respondents reported consuming PHP raw oysters during the past year. About 13.3% consumed only one type of PHP raw oyster product, 2% consumed two types of PHP raw oyster products, and 0.6% consumed three types of PHP raw oyster products. The remaining 84.1% of Coastal Mississippi respondents did not consume any PHP raw oysters last year.

The question of ‘what can change their minds to try and eat PHP raw oysters’ was addressed by the Coastal Mississippi respondents in several ways. The guarantee of a safe product was the most frequently considered type of inducement to consume PHP raw oysters by 17% of the respondents (Table 17). ‘Education on health benefits’ and ‘good presentation’ were cited by at least 12% of all the respondents. About 11% of Coastal Mississippi residents would consider eating PHP raw oysters if they get paid for doing it. The other selected types of inducements to eat PHP raw oysters are listed in Table 17.

Table 17. Distribution of respondents by type of inducement to consume postharvest processed raw oysters

Type of inducement	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Guarantee of a safe product	64	13%	21	4%	85	17%
Education on health benefits	46	9%	21	4%	67	13%
Good presentation	38	7%	21	4%	59	12%
Get paid to try eating	53	10%	4	1%	57	11%
Product should be labeled as treated	35	7%	13	3%	48	9%
Recommended by a friend or family member	23	5%	22	4%	45	9%

Table 17. Distribution of respondents by type of inducement to consume postharvest processed raw oysters

Type of inducement	Non-consumer		Consumer		Total	
	Number	Percent	Number	Percent	Number	Percent
Good advertising on nutritional values	22	4%	8	2%	30	6%
Knowledge where to get or buy	18	4%	10	2%	28	5%
Use of winter oysters	8	2%	15	3%	23	5%

Summary and Implications

Oyster consumption in Coastal Mississippi was strongly influenced by the gender, age and formal education while marital status, race and household income did not have significant influence. More of the male respondents consumed raw oysters than female respondents. The percent of respondents eating raw oysters was higher among older respondents with the highest observed among 40-49 age group. The level of formal education completed had strong positive influence on raw oyster consumption.

The most frequently cited reason by 42% of those who did not eat raw oysters was that “oysters are slimy”. More than one-third of non-consumers considered the “appearance of oysters” as a limiting factor to raw oyster consumption. Having a “smell” was blamed by more than one-fourth of non-consumers for their negative attitude toward raw oysters. Personal safety and concerns or illness was also revealed by one-fourth of non-consumers as a constraint to raw oyster consumption.

Coastal Mississippi residents ate raw oysters about 4.77 times last year. Due to large variations, however, no significant differences in frequency of raw oyster consumption were observed among different socio-economic groups. Three-fourths of the those who did not consume raw oysters would prefer not to eat more if they become more widely available. However, two-thirds of those who consume raw oysters would tend to eat more if raw oysters become available year round.

Awareness of the availability of postharvest processed raw oysters was very limited. About one-fifth of the respondents were familiar with raw oysters which have been processed with a high pressure method. Pasteurized raw oysters were known to 14% of the respondents. About 11% of the respondents reported that they were aware of a method of irradiating raw oysters. One out of ten of the respondents

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said that they knew of individually quick frozen raw oysters. Less than one-tenth of the respondents stated that they were aware of heat shocked raw oysters.

Coastal Mississippi residents received information about methods of PHP of raw oysters through a wide variety of delivery methods. The most widely used means of delivery were “somebody told me” (19%), television (14%), magazines (12%) and newspapers (12%). The other delivery methods used by less than 5% of the respondents were radio, trade shows, brochures, scientific journals, conferences and symposia. Consumers (22%) tended to believe “somebody telling them” about PHP raw oysters than non-consumers (16%).

Less than 30% of Coastal Mississippi respondents stated that they will buy PHP raw oysters. Although their current interest for PHP raw oysters was low, significant differences were observed between consumers and non-consumers in each of the five PHP raw oyster products. The willingness to pay for five PHP raw oyster products did not significantly vary between consumers and non-consumers of raw oysters. Consumers stated that they were willing to pay \$4.44/dozen of pressurized PHP raw half shell oysters from a supermarket. Pasteurized and individually quick frozen PHP half shell raw oysters were valued at the retail level at \$3.89 and \$3.97/dozen, respectively. Consumers’ willingness to pay for heat shocked and irradiated PHP half shell raw oysters were \$3.42 and \$3.11/dozen, respectively.

When asked about their preferences for the type of packaging for whole or full shell PHP raw oysters when buying at supermarkets or seafood stores, 31% of the respondents preferred the traditional method of packaging them in sacks. The other preferred type of packaging whole or full shell PHP raw oysters included ‘packaged loose in plastic containers’ (15.7%), ‘vacuum packed’ (13.3%), ‘clean plastic tubes’ (7.2%) and ‘packed in solid boxes’ (6.5%).

‘Vacuum packed in solid cardboard box with a window’ was the most preferred packaging method for halfshell PHP raw oysters. The second packaging method for half shell PHP raw oysters was ‘shrink wrapped trays in solid boxes’. ‘Shrink wrapped trays in solid boxes with a window’ was ranked third by the respondents. The final preferred packaging method cited by the respondents was ‘vacuum packed in solid cardboard box’.

More than one-quarter of the Coastal Mississippi residents selected the traditional method of ‘packaging in plastic containers’ as their preferred method for PHP shucked raw oysters when buying at supermarkets or seafood stores. In terms of sizes of the plastic containers, the most preferred size by 30.5% of the respondents was ‘quarts plastic container’, followed by ‘pint plastic container’ - 18.4%, ‘gallon plastic container’ - 13.7%, and ‘half gallon plastic container’ - 9.6%.

The actual consumption of individual PHP raw oysters reported by Coastal Mississippi residents during the past year was limited. Pressurized PHP raw oysters were consumed by 7.5% of the respondents. About 4.1% of the respondents reported consuming pasteurized PHP raw oysters last year. Heat shocked, individually quick frozen, and irradiated PHP raw oysters were consumed by 2.3, 2.2 and 2.9% of the Coastal Mississippi respondents, respectively. When viewed collectively, about 15.9% of the Coastal Mississippi respondents reported consuming PHP raw oysters during the past year. About 13.3% consumed only one type of PHP raw oyster product, 2% consumed two types of PHP raw oyster

products, and 0.6% consumed three types of PHP raw oyster products. The remaining 84.1% of Coastal Mississippi respondents did not consume any PHP raw oysters last year.

The guarantee of a safe product was the most frequently considered type of inducement to consume PHP raw oysters by 17% of the respondents. ‘Education on health benefits’ and ‘good presentation’ were cited by at least 12% of all the respondents. About 11% of Coastal Mississippi residents would consider eating PHP raw oysters if they get paid for doing it.

Acknowledgement

The authors wish to express sincere appreciation to all who contributed to the completion of this research undertaking. First, sincere appreciation is due to the participants of the Jackson County Fair in Pascagoula, Mississippi for providing the data used in this study. Second, this project would not have been feasible without the support of the staff of the Seafood Technology Bureau of the Mississippi Department of Marine Resources (DMR) for the conduct of the interviews at the Jackson County Fair in Pascagoula, Mississippi. Finally, to the reviewers for their comments and suggestions which tremendously improved the presentation of the survey results.

References

- Andrews, L.S., D.L. Park, and Y-P Chen. 2000. Low temperature pasteurization to reduce the risk of vibrio infections from raw shell-stock oysters. *Journal of Food Additives and Contaminants*, 19 (7):78-79.
- Andrews, L. S., B. Posadas, D. Burrage and M. Jahncke. 2002. Oyster Irradiation: Pathogenic Vibrio Response and Consumer Difference Testing. Paper presented at the 6th Joint Meeting of the Seafood Science and Technology Society and the Atlantic Fisheries Technology Society on October 9-11, Coronado Springs Resort, Orlando, Florida.
- Cook, D.W. 1997. Refrigeration of oyster shellstock: Conditions which minimize the outgrowth of *Vibrio vulnificus*. *Journal of Food Protection*, 60(4):349-352.
- Cook, D.W. and A.D. Ruple. 1992. Cold storage and mild heat treatment as processing aids to reduce the numbers of *Vibrio vulnificus* in raw oysters. *Journal of Food Protection*, 55(12):985-989.
- Cragg, J. 1971. “Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods”. *Econometrica*, 39: 829-844.
- Dillon, D. 1978. *Mail and Telephone Surveys – The Total Design Method*. John Wiley & Sons: New York, New York.

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- Hanson, T., L. House, S. Sureshwaran, B. Posadas and A. Liu. 2002. Opinions of U.S. Consumers toward Oysters: Results of a 2000-2001 Survey. Research Report 2002-005, Mississippi State University Department of Agricultural Economics, Mississippi State, Mississippi.
- Lin, C.T, J. W. Milon, and E. Babb. 1991. "Determinants of Subjective Food Safety Perceptions: A Case Study of Oysters in the Southeast." *Journal of Agribusiness*, Spring, 71-96.
- McDonald, J. and R. Moffit. 1980. "The Use of Tobit Analysis." *Review of Economics and Statistics*, 62: 318-321.
- Mitchell, R. and R. Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future: Washington, D.C.
- Muth, M.K., D. W. Anderson, S. A. Karns, B. C. Murray, and J. L. Domanico. 2000. Economic Impacts of Requiring Post-Harvest Treatment of Oysters. Final Report prepared for Interstate Shellfish Sanitation Conference. Research triangle Institute, Center for Economics Research, Research Triangle Park, North Carolina.
- Posadas, B. C., L. S. Andrews, and D.D. Burrage. 2002. Consumer Preferences and Attitudes Toward Irradiated Oysters at the 2002 Boston International Seafood Show. Paper presented at the 6th Joint Meeting of the Seafood Science and Technology Society and the Atlantic Fisheries Technology Society on October 9-11, Coronado Springs Resort, Orlando, Florida
- Tesvich, J. A. and P. Fahey. 2003. Snapshot of AmeriPure Oyster Company. Paper presented at the National Shellfisheries Association Annual Conference held in New Orleans, Louisiana on April 15, 2003. AmeriPure Oysters, Franklin, Louisiana.
- Wessells, C. and J. Anderson. 1995. "Consumer Willingness to Pay for Seafood Safety Assurances," *The Journal of Consumer Affairs*, 29(1): 85-107.

CONSUMER ACCEPTABILITY OF POST HARVEST PROCESSED AND VALUE ADDED OYSTERS – YEAR 2

Dr. Linda S. Andrews

Extension Specialist and
Assistant Research Professor of Food Science
Coastal Research and Extension Center
Mississippi State University

Dr. Patti Coggins

Assistant Research Professor of Food Science and Technology
Garrison Sensory Evaluation Laboratory
Department of Food Science, Nutrition and Health Promotion
Mississippi State University

Introduction

Problem: Traditional raw oyster consumption, with its mystic of romanticism and burliness, assumes the oyster must be eaten alive and still “kicking”. Most oyster lovers assume that eating dead processed oysters must not be safe or tasty. These ideas are similar to consumer resistance to accepting pasteurized milk. Pasteurized milk has its own distinctive flavor, different from raw milk, but still highly acceptable and safer particularly for children and pregnant women. In order to overcome consumers preconceived ideas regarding the tastiness of post harvest processed oysters, they must be educated about the improved safety of PHP oysters and introduced to the products themselves for their own sensory evaluation and degree of acceptability.

Impediments: The second year of this project focused on trying to provide consumer evaluation opportunities for minority groups including Asians, Blacks, and Hispanics. This required special effort on the part of the researchers to take the survey to work place situations and to the California “West Coast Seafood Show”.

Objectives:

- (1) Determine consumer acceptability of three PHP products.
- (2) Statistically determine if consumer panelist demographics influenced the acceptability of the PHP products.
- (3) Determine if consumers would purchase more oysters based on their perception of safety.
- (4) Determine consumer acceptability of oyster value-added products (Linda and Patti), and willingness to purchase these products and at what price.
- (5) Determine the shelf life of the PHP products.

Approach

Description of work performed:



Objective No. 1.

Mississippi oysters were harvested in October 2003 for the West Coast Seafood Show and in April 2004 for survey of Pass Christian Oyster Workers and the general public at the Biloxi Crawfish Festival. On the day of harvest, the oysters were transported by refrigerated truck to Houma, Louisiana. The next day the oysters were split into three lots, with each lot receiving one of three post harvest processes [Individually quick frozen (IQF), pasteurized (PST), or high hydrostatic pressure (HPP)]. That day, the oysters were transported back to Pascagoula, MS and placed under appropriate storage, either frozen or refrigeration.

Samples were then analyzed for microbial safety prior to presentation to the consumer panel volunteers. Samples from each of the three post harvest processes were also shipped to the Sensory Laboratory in Starkville for descriptive analysis and value added product development. Within five days of processing, consumer panels were conducted in Long Beach, California and in Pass Christian and Biloxi, MS.

Survey samples are listed below in both English and Spanish.

English Version of the Survey Questionnaire

OYSTER ACCEPTABILITY SURVEY

Please rate this oyster according to the level of acceptability: Number _____
 Bad poor fair good excellent
 0 _____ 5 _____ 10

Please rate this oyster according to the level of acceptability: Number _____
 Bad poor fair good excellent
 0 _____ 5 _____ 10

Please rate this oyster according to the level of acceptability: Number _____
 Bad poor fair good excellent
 0 _____ 5 _____ 10

Respondent's characteristics (Please check the most appropriate answer)

Gender: Male ___1 Female _____2

What is your race?

White ___1 Black or African American _____2 Hispanic _____3
 Asian or Pacific Islander _____4 American Indian _____5 Other _____6

Please indicate your age: ____ years old

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18-29 _____ 1 30-39 _____ 2 40-49 _____ 3 50-59 _____ 4 60 & older _____ 5

Please indicate your household's annual income:

<=20,000 _____ 1 20,000-40,000 _____ 2 40,000-60,000 _____ 3
60,000-80,000 _____ 4 >80,000 _____ 5

What is your educational attainment? (check one)

Did not complete high school _____ 1 Completed high school _____ 2
Some College _____ 3 Completed College _____ 4
Completed Advanced or Professional Degree _____ 5

Where did you attend high school?

NE _____ Midwest _____ Mid Atlantic _____ Southwest _____
SE (Gulf Coast) _____ Northwest _____ Outside US (please list) _____

Place of Birth _____

How often do you eat raw oysters?

Once a month _____ Less than once a month _____ More than once a month _____

Would you eat more raw oysters if they were free of bacterial pathogens?

Yes _____ No _____ Don't know/not sure _____

Spanish Version of the Survey Questionnaire

ENCUESTA SOBRE LA ACEPTACION DE OSTRAS

Por favor marque en la linea de acuerdo con la aceptabilidad de las ostras:

Malo pobre regular bueno excelente
0 _____ 5 _____ 10

Numero _____

Por favor marque en la linea de acuerdo con la aceptabilidad de las ostras:

Malo pobre regular bueno excelente
0 _____ 5 _____ 10

Numero _____

Por favor marque en la linea de acuerdo con la aceptabilidad de las ostras:

Malo pobre regular bueno excelente
0 _____ 5 _____ 10

Numero _____

Informacion general acerca de el participante (Por favor marque la respuesta mas apropiada)

Sexo: Masculino ___1 Femenino _____2

¿Cual es su raza?

Blanco ___1 Negro _____2 Hispano _____3
Asiatico _____4 Aborigen _____5 Otra _____6

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Por favor indique su edad: ____ años de edad

18-29 ____ 1 30-39 ____ 2 40-49 ____ 3 50-59 ____ 4 60 & older ____ 5

Por favor indique su ingreso anual:

<=20,000 ____ 1 20,000-40,000 ____ 2 40,000-60,000 ____ 3
60,000-80,000 ____ 4 >80,000 ____ 5

¿Cual es su nivel de educacion? (chequee el mayor nivel)

No termine bachillerato ____ 1 Soy bachiller (secundaria) ____ 2
Parte de carrera Universitaria ____ 3 Complete carrera universitaria ____ 4
Complete una carrera avanzada ____ 5

Pais de Origen: _____

Con que frecuencia consume otras crudas?

Una vezalmes ____ Menos de una vezalmes ____ Mas de una vezalmez ____

Comeria mas otras crudas si supiese que estan libres de bacterias patogenicas?

Si ____ No ____ No se ____

Objective 2: Numerical scores and demographic information were tabulated and analyzed using ANOVA by the Experimental Statistics Department, MAFES on MSU main campus.

Objective 3: As part of the questionnaire, consumers were asked if they would consume more oysters if they thought the oysters were free of bacterial pathogens. Responses were tallied and statistically analyzed.

Objective 4: Value added products. Recipes were published and professional pictures were submitted to the DMR. Oyster product survey were conducted at the Mississippi Wildlife Extravaganza in Jackson, MS August 2003. The surveys for VAP oysters are listed below:

OYSTER PRODUCT ACCEPTABILITY SURVEY

Please rate **THIS OYSTER PRODUCT: SMOKED OYSTER**, according to the level of acceptability:

Make a mark on the line for your response.

Do not like like a little like a lot like extremely
0 _____ 5 _____ 10

Would you be willing to purchase this product, especially if produced by a local processor?

Yes _____ No _____ Don't know, not sure _____

If yes, how much would you be will to pay for a can of smoked oysters like the one demonstrated?

\$.50 to \$1.00 ____ \$1.01 to \$1.50 ____ \$1.51 to \$2.00 ____

OYSTER PRODUCT ACCEPTABILITY SURVEY

Please rate THIS OYSTER PRODUCT: SMOKED OYSTER CHEESE SPREAD (VERY LOW FAT), according to the level of acceptability:

Make a mark on the line for your response.

Do not like like a little like a lot like extremely
0 _____ 5 _____ 10 _____

Would you be willing to purchase this product, especially if produced by a local processor?

Yes _____ No _____ Don't know, not sure _____

If yes, how much would you be will to pay for An 8 oz package of "low fat smoked oyster cheese spread?"

\$ 1.50 to \$2.00 _____ \$2.01 to \$2.50 _____ \$2.51 to \$3.00 _____

Product composition

Smoked Oysters:

Oysters were shucked the day after harvesting and smoked with pecan wood. (195⁰ F for 3.5 – 4.0 hr.) After smoking the oysters were packed in 10ppt salt water and frozen 20⁰ F. For consumer study, oysters were thawed at ambient temperature and held on ice until consumption.

Smoked Oyster Cheese Spread/Btch:

1- cup finely chopped smoked oysters
1- 8 oz pkg. cream cheese (regular, low-fat or fat free)
1 – Tbl fresh lemon juice
2 – Tbl grated onion
1 tsp prepared horseradish
1/4 tsp salt
2 – Tbl chopped cilantro

Blend together, shape into desired shape (log, ball) roll in chopped pecans (1 cup) and cilantro (1 tbl) blended. Serve on crackers or celery.

Objective 5: Determine the shelf life of the three post harvest processed products. Post harvest processed oysters from two harvest dates, October 2003 and March 2004, were stored appropriately for the product samples. Each harvest date, two cases of 100 oysters each pasteurized and hydrostatic pressure processed oysters were stored at 3-4°C for up to 21 days. Two cases of 120 frozen, IQF, oysters were stored for up to six months at -20°C.

Project Management

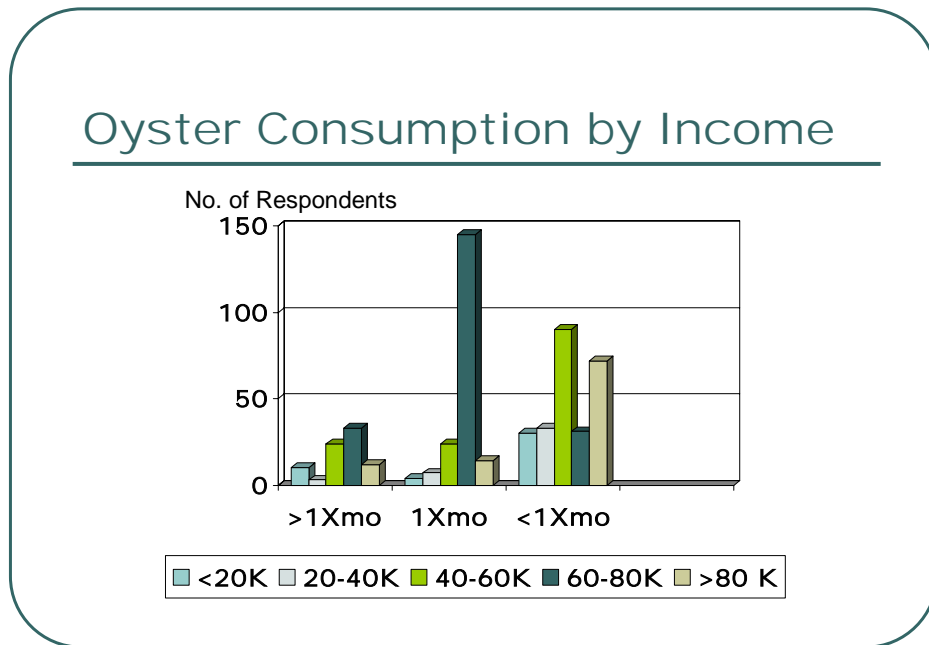
Dr. Linda Andrews, PHP consumer panel, VAP development and sensory panel.

Accomplishments (Findings)

Objective 1: The consumer panel, over 2 years of this project, was comprised of 528 people:

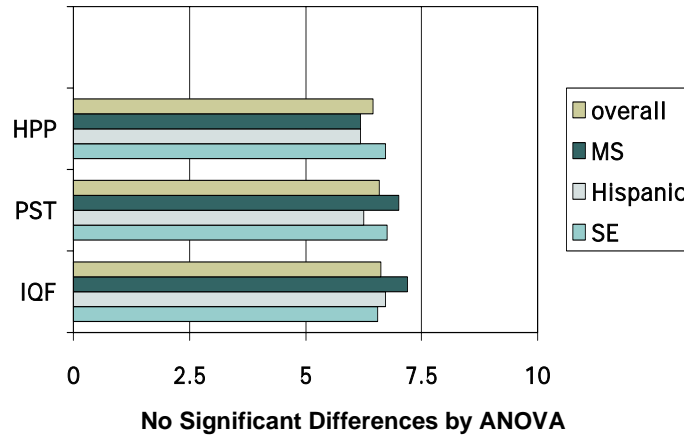
- Male 408; Female 120
- 73 % White, 4% Black, 9% Hispanic, and 14 % Asian
- Income level split about equal from \$20 to >\$80 K/year
- Panelist’s ages were between 18 and over 60, fairly evenly split.
- Most had attended some college, 40% had BA or BS.

Figure 1 shows oyster consumption by income. Nearly 15% of those surveyed consume oysters more than once a month; 36% once a month; and 49% less than once a month.



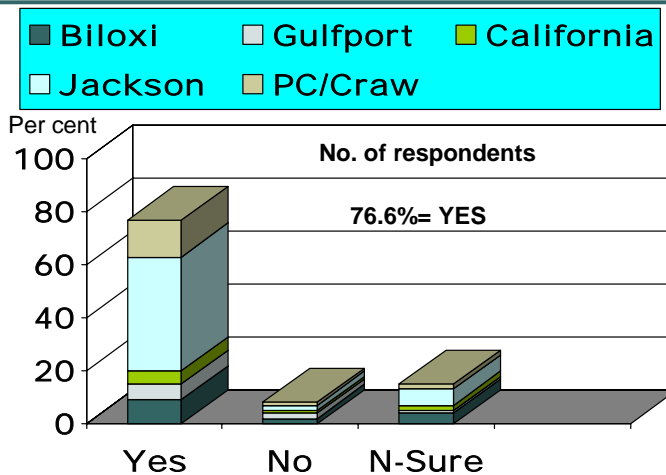
The overall acceptability mean scores were not shown to be significantly different, Figure 2. However, the Hispanic population scored higher acceptability for IQF oysters and Mississippi residents scored the highest acceptability for the pasteurized and IQF oysters. All three were in the acceptable to highly acceptable range. No significant differences were found based on age, income, education, or gender.

Figure 2: PHT Overall Acceptability Mean Sensory Scores



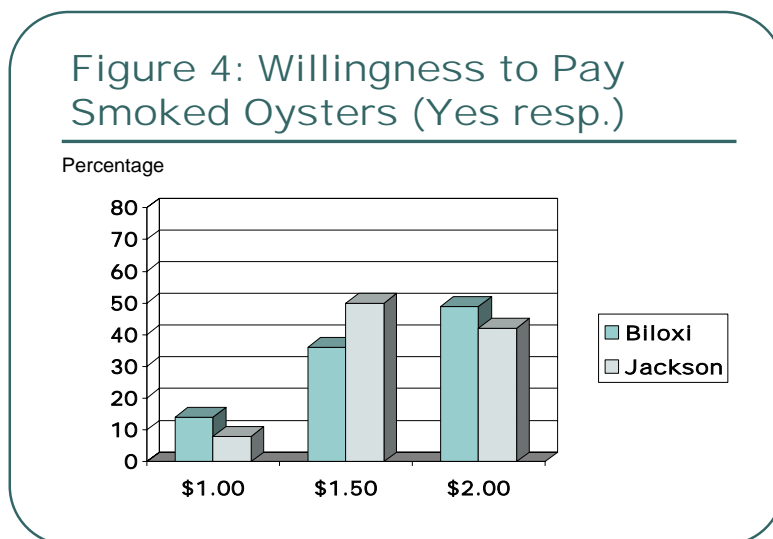
Objective 2: Panelists were asked if they would consume more raw oysters if free of bacterial pathogens. Of those 76.6 % said yes. This included persons at all three consumption levels, Figure 3.

Figure 3: Would you consume more raw oysters if free of bacterial pathogens?



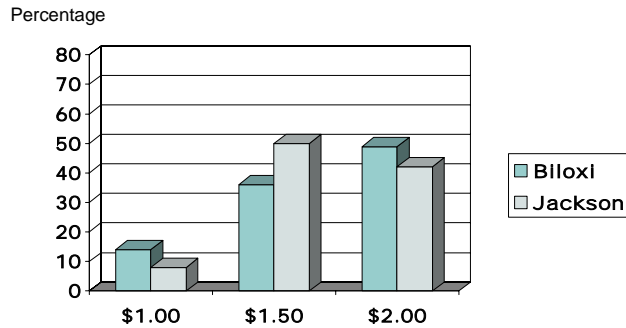
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Objective 3. Consumer acceptance of value-added oyster products was surveyed at the Biloxi Crawfish Festival, 2003 and the Jackson Wildlife Extravaganza, August 2003. There were 357 volunteers who evaluated the smoked oysters and 280 volunteers who evaluated the smoked oyster cheese spread. On a scale of 0-10, the smoked oysters received a mean acceptability of 7.90, with 75% saying they would purchase the product if available on the market. The product would be marketed as a frozen smoked oyster appetizer, low fat since not packed in oil, as is the usual packaging for canned smoked oysters. The willingness to pay by the yes respondents is presented in Figure 4.



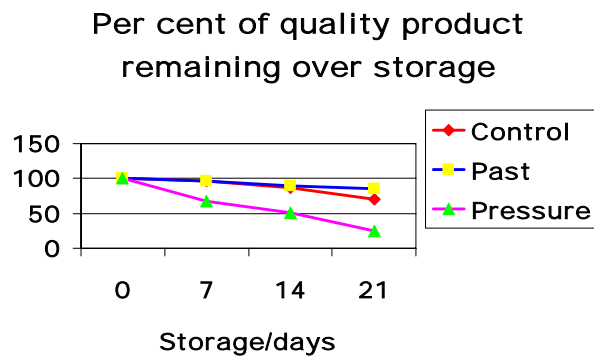
The mean acceptability score for the smoked oyster cheese spread was 7.99 out of a possible 10. 70% said they would purchase the product. This product would be marketed as a fresh packaged “deli” product. It is low fat being made with reduced fat cream cheese. The willingness to pay by the 70% who were willing to purchase the product is presented in Figure 5

Figure 5: Willingness to Pay Smoked Oyster Cheese Spread (Yes resp.)



Objective 5: Results of the shelf life study indicated that for the two refrigerated PHP oyster products there was a significant difference in the keeping quality. The pasteurized oysters maintained the same sensory parameters throughout the three weeks of storage. The hydrostatic pressure processed oysters began deteriorating after the first 5 days of storage and at 7 days 33 % of the oysters were of poor quality either due to bad odor or lack of moisture. At day 14, only about 50% of the pressure processed oysters were still palatable (Figure 6). The frozen product maintained its same quality throughout the 6 months storage period. Frozen oysters when thawed and served immediately as was the case in the consumer studies were of good quality. However, when IQF oysters were thawed and allowed to sit on ice for greater than 30 minutes, they began to lose moisture and sensory appeal as well as having a “washed out” flavor.

Figure 6: Shelf life of PHP oysters



Significant problems:

There were no significant problems. However, since it was very important to test all the oysters for safety prior to consumer evaluation, the time constraints were a little tight to fit processing, transportation, and culturing all in one long day, between Franklin and Pascagoula.

Project evaluation

The objectives were met. In year 3, we plan to do more in depth study of the descriptive sensory attributes among the three post harvest treatments and raw and cooked processed and non-processed oysters.

Specific accomplishments

The main accomplishments, so far, established that all of the post harvest processes are highly acceptable to consumers. The most important information gained was that 77% of persons surveyed would purchase more oysters if they were free of bacterial pathogens.

Benefits to industry:

It is believed that the benefits to the oyster industry will be very good, once more processors are post harvest processing. As consumers become aware of the PHP and VAP oyster products it will boost oyster sales and market price.

Conclusions:

Many oyster lovers have shied away from eating raw oysters due to the perceived risk of danger from bacterial pathogens. This study has shown that oyster sales can be increased through building consumer confidence by making available post harvest processed oysters and value added oyster products. By educating the consumer and through proper marketing the oyster industry throughout the Gulf States will benefit.

Acknowledgements:

The project coordinator would like to thank all industry partners, who through their efforts, made this project successful. I would also like to thank the Seafood Technology Bureau of the Mississippi Department of Marine Resources for their valuable time spent assisting with the panels and providing space for us to conduct the panels in Biloxi, Jackson, Crystal Seas Seafood, at the Crawfish Festivals of 2003 and 2004 and the Jackson Wildlife Extravaganza. Other MSU participants included Susan DeBlanc, Tommy Schultz, and Patrick Broussard.

SENSORY DIFFERENCES OF GULF POST HARVEST PROCESSED OYSTERS

Dr. Patti Coggins

Assistant Research Professor of Food Science and Technology
Garrison Sensory Evaluation Laboratory
Department of Food Science, Nutrition and Health Promotion
Mississippi State University

Introduction

Oyster consumption remains a well-liked seafood product among dedicated American consumers but others shy away because of health or safety issues. However, results of studies conducted by the Gulf Oyster project as well as the Interstate Shellfish Sanitation Conference (ISSC) indicate that a large majority of these of those surveyed will eat oysters if proven to be safe. Given the ability of oyster post harvest processing techniques to reduce harmful *Vibrio vulnificus* species to non-detectable levels, there is a huge possibility that the oyster industry, especially those located in the Gulf of Mexico, could increase their market significantly. This research project was designed to determine the overall acceptability of post harvest processed oysters using descriptive sensory analysis techniques.

Purpose:

The main objectives of this project were:

- (1) To determine through descriptive sensory analysis techniques any post harvest processing differences among attributes developed through lexicon development of oysters.
- (2) Statistically determine significant difference and overall acceptability of the tested post harvest processed oyster products.
- (3) To determine consumer acceptance of value added products developed using post harvest treated processed oysters.

Approach:

Mississippi oysters were harvested on December 2, 2002 and January 3, 2003. On the day of harvest, the oysters were transported by refrigerated truck to Houma, Louisiana. The next day the oysters were split into three lots, with each lot receiving one of three post harvest processes. i.e., Individually Quick Frozen (IQF), Heat Pasteurization Process (HPP), or High Hydrostatic Pressure (HPP). The oysters were transported to Pascagoula, MS on the same day. The oysters were then placed under appropriate storage, either frozen or refrigerated. Samples were analyzed for microbial safety before

GULF OYSTER PROJECT

presentation to consumers. Samples from each of the three post harvest processes were shipped overnight or transported on the second day to the Garrison Sensory Evaluation Laboratory on the main campus of Mississippi State University at Mississippi State, Mississippi. Sensory descriptive analysis was performed along with value-added product development.

A descriptive analysis instrument (score sheet) was developed and used by the expert, trained panelists to test the descriptive attributes of the treated oysters (Table 1). A semi-descriptive language was developed for Gulf oysters. This semi-descriptive language summarizes the descriptive attributes observed by a trained sensory panel for the Gulf oysters alone and not for any other oyster varieties.

Among the available descriptive analysis techniques, the Spectrum[®] method was utilized based on ease of use and flexibility of scale development and usage by the panelists.

Table 1. Descriptive Analysis Instrument (Score Sheet).

SCORE SHEET:

NAME: _____ DATE: _____

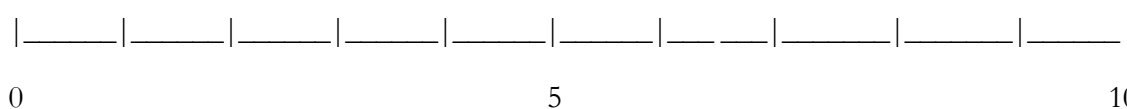
Sensory Evaluation (Quantitative Descriptive Analysis)

OYSTERS

Appearance (*Overall*)

Not Acceptable

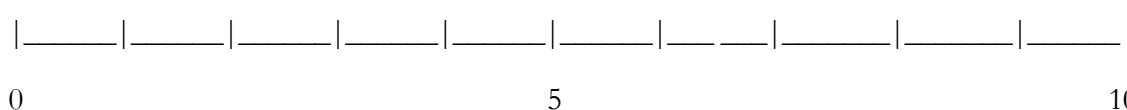
Acceptable



Volume – Flesh (*Size*)

None (No volume)

Extreme Volume

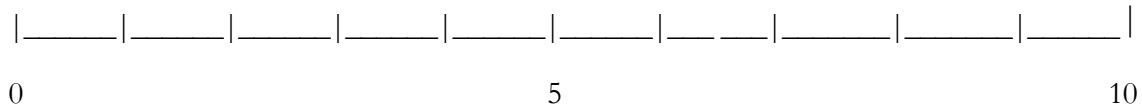


GULF OYSTER PROJECT

Shape *(Overall)*

Not Acceptable (Changed)

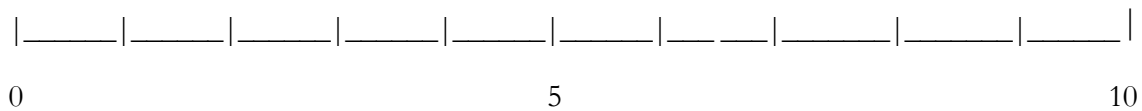
Acceptable (Not Changed)



Color *(Overall)*

Not Acceptable

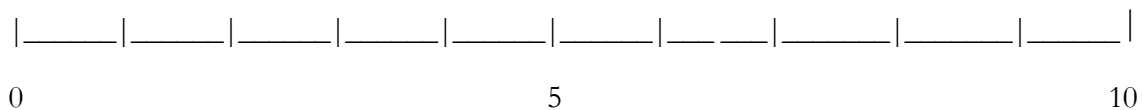
Acceptable



Color *(Range)*

Very Light

Very Dark



Color Break-down (Check all that apply)

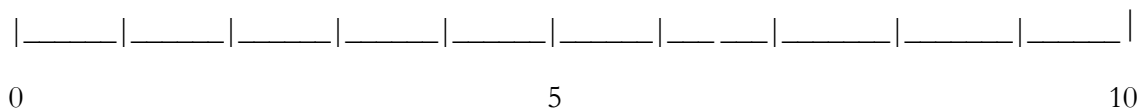
White/Pale _____ Lt. Tan _____ Lt. Gray _____ Lt. Green _____ Brown _____

Other _____ Other _____ Other _____ Other _____ Other _____

Other: _____

Not Acceptable

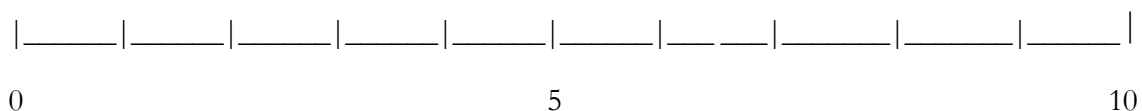
Acceptable



Aroma *(Overall)*

Not Acceptable

Acceptable

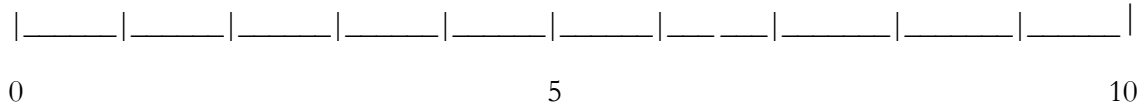


GULF OYSTER PROJECT

Aroma (*Typical Oyster*)

Not Typical

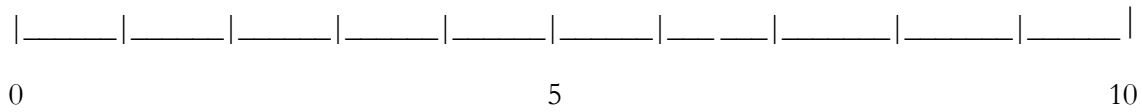
Very Typical



Fishy (*Overall*)

Not Fishy

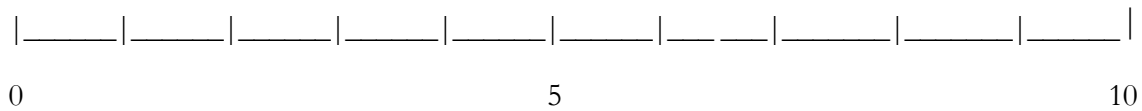
Extremely Fishy



Pungent (*Overall*)

Not Pungent

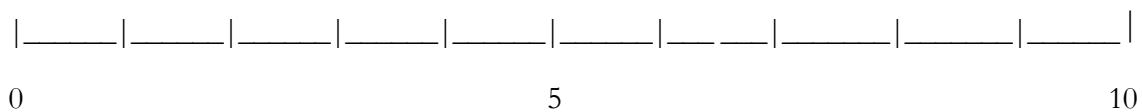
Extremely Pungent



Sour (*Overall*)

Not Sour

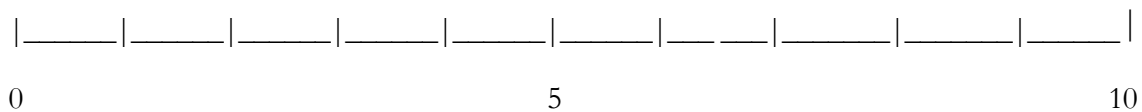
Extremely Sour



Boiled Potato (*Overall*)

Not Boiled Potato

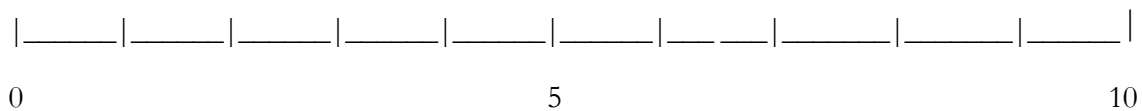
Extreme Boiled Potato



Other: _____ (*Overall*)

Not Acceptable

Acceptable

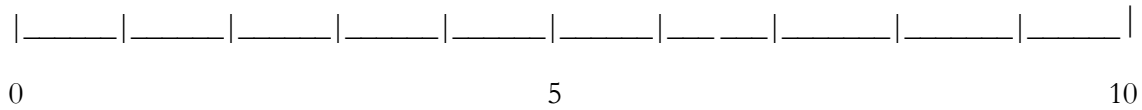


GULF OYSTER PROJECT

Flavor *(Overall)*

Not Acceptable

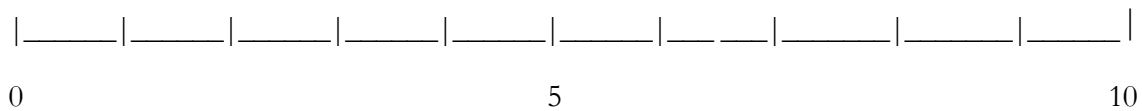
Acceptable



Typical Oyster *(Overall)*

Not Typical

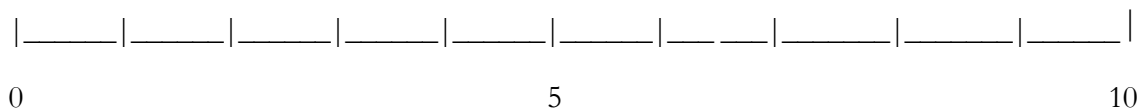
Very Typical



Freshness *(Overall)*

Not Fresh

Extremely Fresh

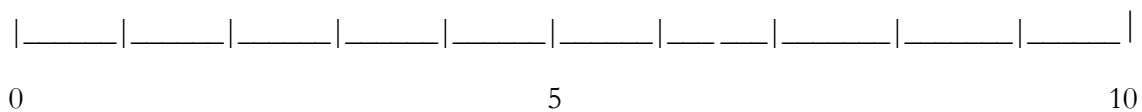


Flavor Intensity *(Intensity of Flavor)*

No Flavor

Moderate Flavor

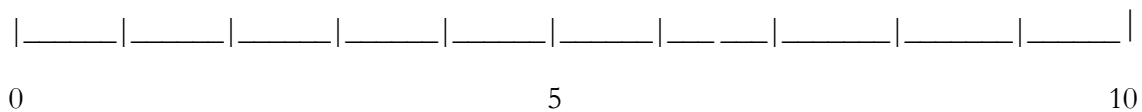
Extremely Intense



Fishy *(Flavor)*

Not Fishy

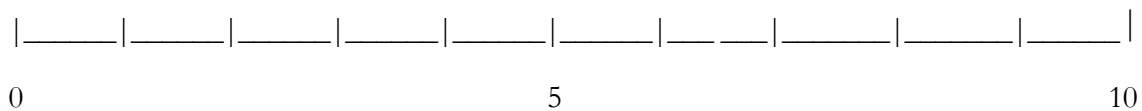
Extremely Fishy



Bitter *(Overall)*

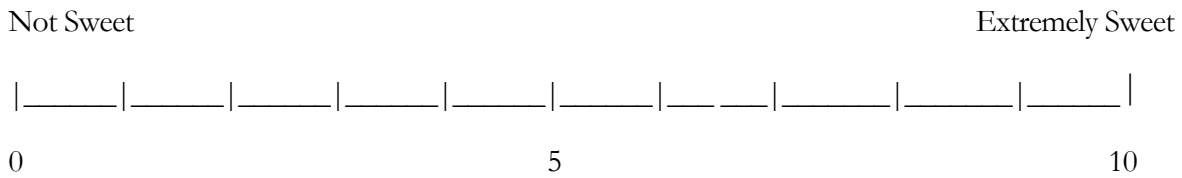
Not Bitter

Extremely Bitter

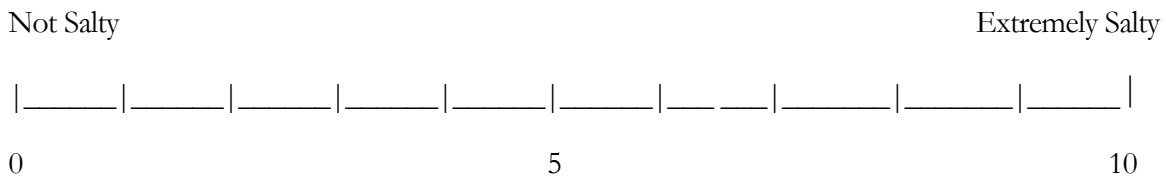


GULF OYSTER PROJECT

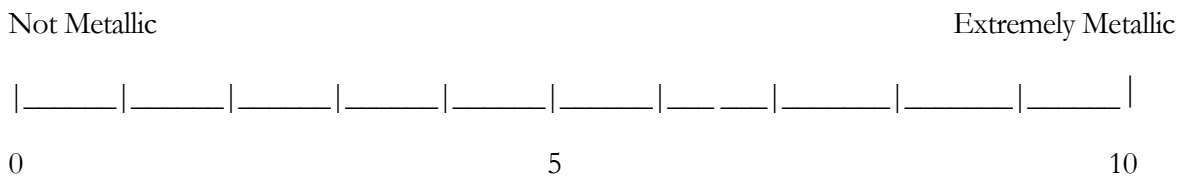
Sweet *(Overall)*



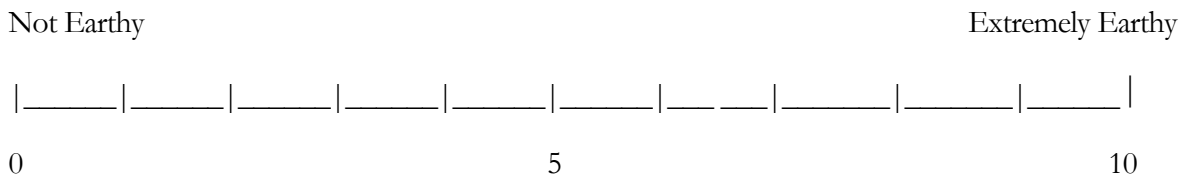
Salty *(Overall)*



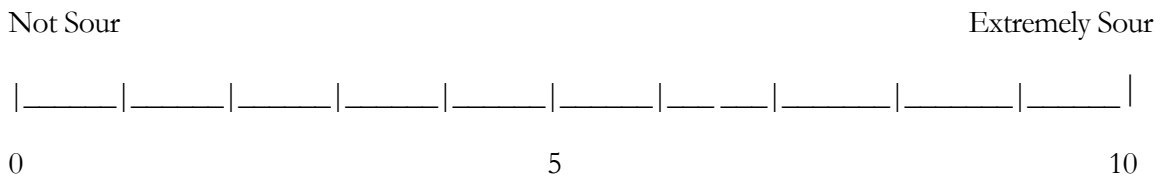
Metallic *(Overall)*



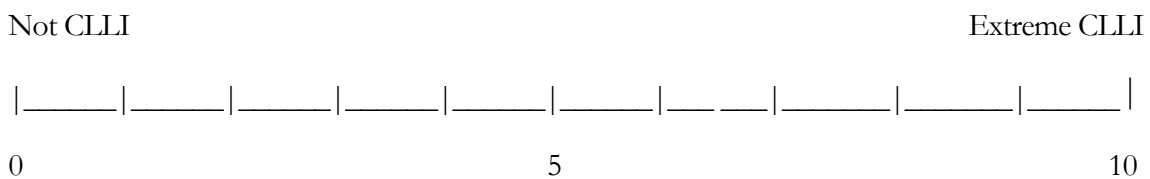
Earthy *(Overall)*



Sour *(Overall)*



Chicken-Liver-Like/Iron *(Overall)*

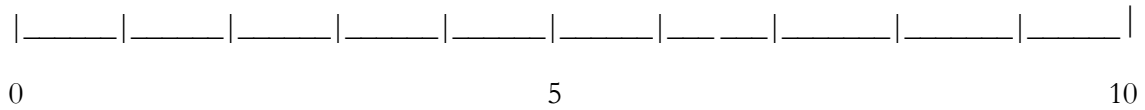


GULF OYSTER PROJECT

Boiled Potato-Like (Overall)

Not BPI

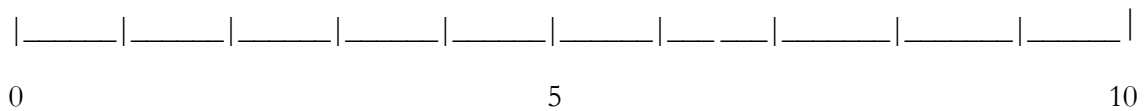
Extreme BPI



Astringent (Feeling Factor) (Overall)

Not Astringent

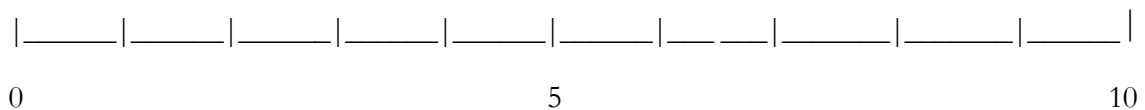
Extreme Astringent



Other: _____ (Overall)

Not Acceptable

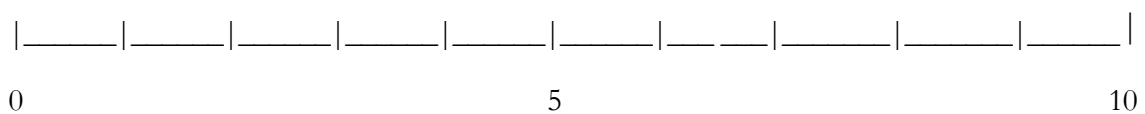
Acceptable



Texture (Overall)

Not Acceptable

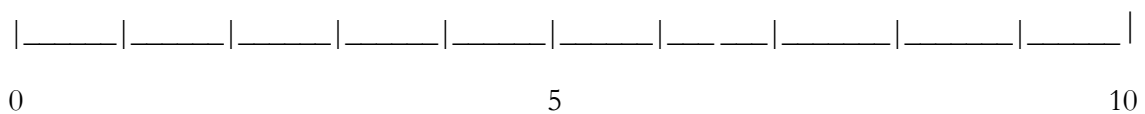
Acceptable



Firmness (Overall)

Not Firm (Mushy)

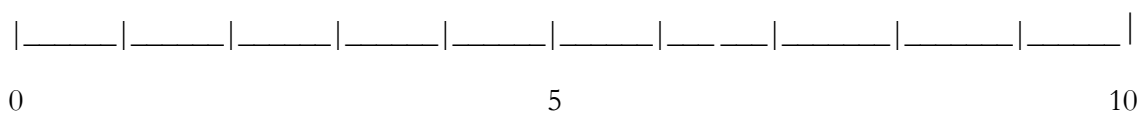
Extremely Firm



Chewiness (Overall)

Not Chewy

Extremely Chewy

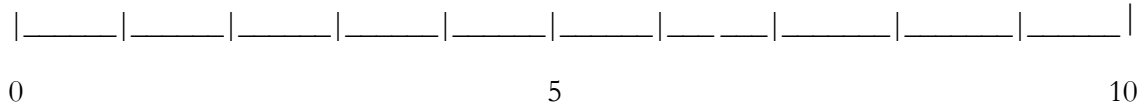


GULF OYSTER PROJECT

Tenderness *(Overall)*

Not Tender

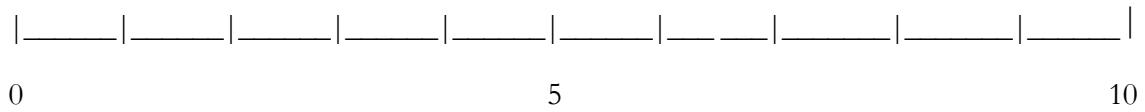
Extremely Tender



Juiciness *(Overall)*

Not Juicy

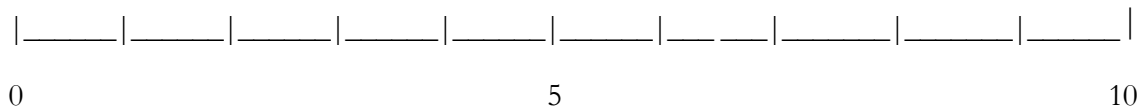
Extremely juicy



Gritty *(Overall)*

Not Gritty

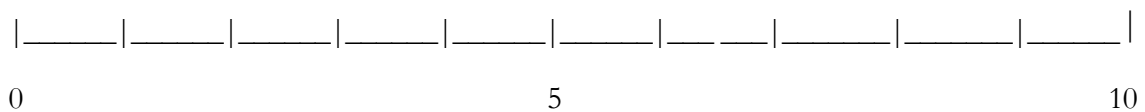
Extremely Gritty



Fibrous *(Overall)*

Not Fibrous

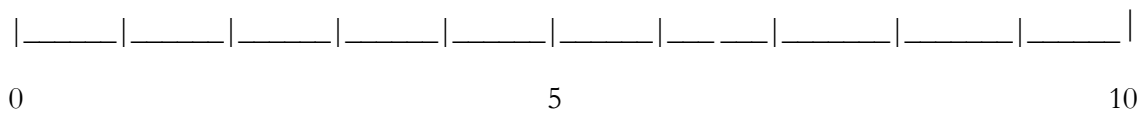
Extremely Fibrous



Rubbery *(Overall)*

Not Rubbery

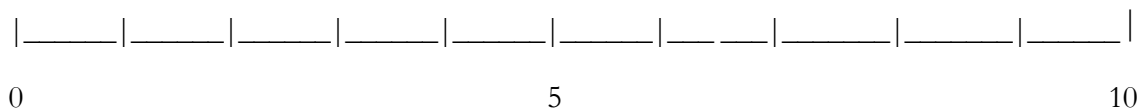
Extremely Rubbery



Other: _____ *(Overall)*

Not Acceptable

Acceptable



The subjects or panelists were trained for a period of four months prior to the evaluation of the first set of oysters. The panelist training was this extensive due to the highly diverse nature of the typical oyster and also to insure that the panelists were familiar with oysters harvested over several months.

Statistical Analysis:

Oyster sensory attribute data were analyzed using multivariate statistics as well as the general linear model (GLM). The possibility of some sensory attributes changing with post harvest processing of oysters added complexity of the sensory analysis.

Value-Added New Product Development Research:

Information regarding the consumption of oysters was obtained during the consumer study. The consumer portion of the value added study indicated viable acceptance for complete and ready-to-eat oyster products that require minimal preparation. Following the survey results, a total of 53 formulations were developed for this portion of the study. Of the 53 formulations, the top five were selected for further consumer acceptability work. It was determined that the average oyster used in this research weighed 13 grams, so formulations were developed based on this amount.

The oyster shortbread selected as the top ranking formulation in the group. This formulation also has the advantage of being easy to adapt to the grocer's freezer section. Only commercially available food service, user-friendly ingredients were used and cheese was also incorporated into this formulation to make it more enticing to consumers.

The oyster dip was the second ranking formulation. Again, the incorporation of cheese (cream cheese) adds to the marketability of this formulation.

The oyster lasagna was another formulation that is easy to adapt into the food service and restaurant markets. Traditional lasagna recipes were used and tested but instead of ground beef, ground oysters were substituted in the recipe.

For oyster appetizer, deep-fried oyster nuggets with cheese, spinach, and onions was selected and developed.

Results and Discussion

Descriptive sensory analysis scores are presented in the form of mean separation and difference tables as well as spider plot graphics (see Tables 2 to 6 and accompanying figures). The results of the analysis show no significant difference between raw oyster attributes and various PHP oysters.

Table 2. Descriptive Analysis for Appearance of Processed Gulf Oysters

	HPP	HHP	IQF	Control
Appearance	7.81 ^A	6.29 ^B	6.54 ^B	6.90 ^{AB}
Volume	5.86 ^B	5.68 ^B	5.11 ^C	6.45 ^A
Shape	7.24 ^A	6.50 ^B	6.87 ^{AB}	6.79 ^{AB}
Color	7.40 ^A	6.91 ^B	6.73 ^B	7.00 ^{AB}
Color Range	5.31 ^C	5.75 ^B	6.55 ^{AB}	5.72 ^{B C}

Processed Oyster Descriptive Analysis Appearance^a Attribute^b

^a Attribute scores are on a 15 point scale

^b ABC Means within a row with the same letter are not significantly different (P>0.05) as determined by proc mixed and means by pglm procedures of SAS

Descriptive Analysis for Appearance of Processed Gulf Oysters

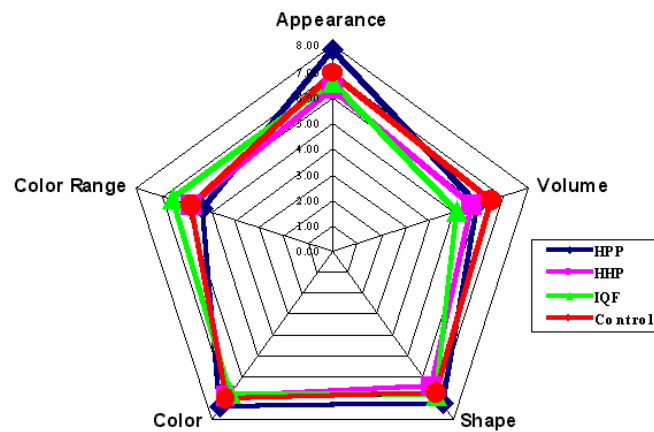


Table 3. Descriptive Analysis for Aroma of Processed Gulf Oysters

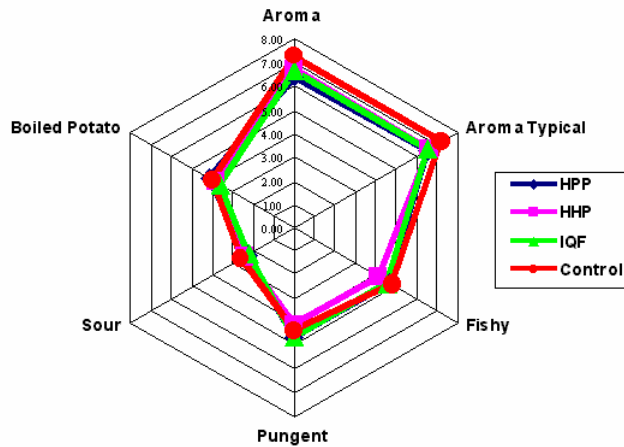
	HPP	HHP	IQF	Control
Aroma	6.37 ^B	6.69 ^B	6.66 ^B	7.22 ^A
Aroma Typical	6.50 ^B	6.66 ^B	6.59 ^B	7.19 ^A
Fishy	4.68 ^{AB}	4.13 ^B	4.62 ^{AB}	4.80 ^A
Pungent	4.64 ^A	4.13 ^A	4.64 ^A	4.35 ^A
Sour	2.25 ^A	2.41 ^A	2.16 ^A	2.56 ^A
Boiled Potato	4.07 ^A	3.82 ^A	3.66 ^A	3.94 ^A

Processed Oyster Descriptive Analysis Aroma^a Attribute^b

^a Attribute scores are on a 15 point scale

^b ^{AB} Means within a row with the same letter are not significantly different (P>0.05) as determined by proc mixed and means by pglm procedures of SAS

Descriptive Analysis for Aroma of Processed Gulf Oysters



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Table 4. Descriptive Analysis for Flavor of Processed Gulf Oysters

	HPP	HHP	IQF	Control
Flavor	6.57 ^B	6.81 ^{AB}	6.93 ^{AB}	7.26 ^A
Typical Oyster Flavor	6.45 ^B	6.84 ^{AB}	6.93 ^{AB}	7.13 ^A
Freshness	6.30 ^B	6.78 ^{AB}	6.78 ^{AB}	7.12 ^A
Flavor Intensity	6.25 ^A	5.75 ^B	5.99 ^{AB}	5.88 ^A
Fish Flavor	4.18 ^A	3.94 ^A	3.85 ^A	3.78 ^A

Processed Oyster Descriptive Analysis Flavor^a Attribute^b

^a Attribute scores are on a 15 point scale

^b ^{AB} Means within a row with the same letter are not significantly different (P>0.05) as determined by proc mixed and means by pglm procedures of SAS

Descriptive Analysis for Flavor of Processed Gulf Oysters

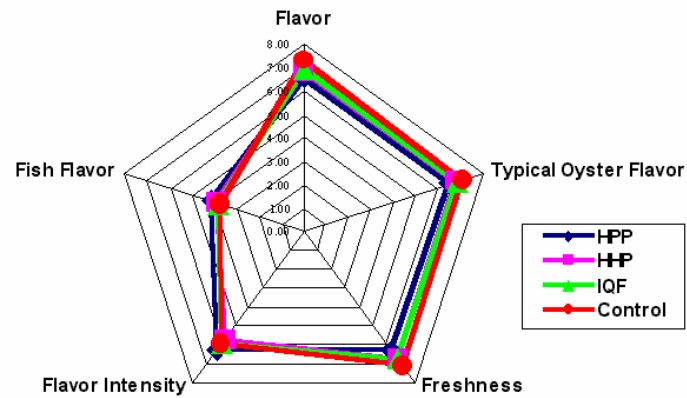


Table 5. Descriptive Analysis for Basic Tastes of Processed Gulf Oysters

	HPP	HHP	IQF	Control
Bitter	2.66 ^A	2.36 ^{AB}	2.26 ^{AB}	2.08 ^B
Sweet	1.96 ^{AB}	1.76 ^B	2.31 ^A	1.97 ^{AB}
Salty	2.69 ^A	2.52 ^A	2.46 ^A	2.65 ^A
Metal	3.30 ^A	2.89 ^A	3.38 ^A	2.92 ^A
Earthy	4.47 ^A	4.04 ^{AB}	4.01 ^A	3.75 ^B
Sour	2.25 ^A	2.41 ^A	2.16 ^A	2.56 ^A
Liver/Iron	3.76 ^A	3.34 ^A	3.39 ^A	3.38 ^A
Boiled Potato	3.39 ^A	3.41 ^A	3.23 ^A	3.25 ^A
Astringent	3.40 ^A	2.96 ^{AB}	2.78 ^B	2.86 ^{AB}

Processed Oyster Descriptive Analysis Basic Tastes^a Attribute^b

^a Attribute scores are on a 15 point scale
^b ^{AB} Means within a row with the same letter are not significantly different (P>0.05) as determined by proc mixed and means by pglm procedures of SAS

Descriptive Analysis for Basic Tastes of Processed Gulf Oysters

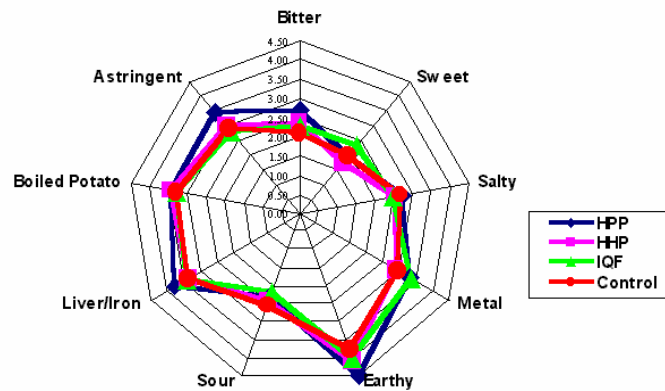


Table 6. Descriptive Analysis for Texture of Processed Gulf Oysters

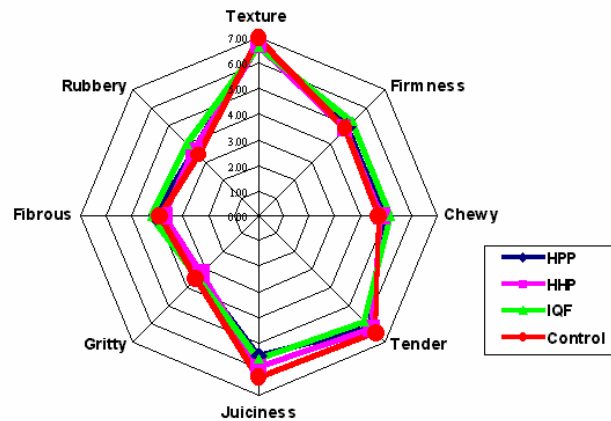
	HPP	HHP	IQF	Control
Texture	6.85 ^A	6.66 ^A	6.62 ^A	6.96 ^A
Firmness	4.87 ^A	4.82 ^A	5.24 ^A	4.84 ^A
Chewy	4.92 ^A	4.80 ^A	5.15 ^A	4.71 ^A
Tender	6.21 ^{AB}	6.28 ^{AB}	5.87 ^B	6.47 ^A
Juiciness	5.48 ^C	5.93 ^{AB}	5.61 ^{BC}	6.35 ^A
Gritty	3.29 ^A	3.13 ^A	3.43 ^A	3.46 ^A
Fibrous	4.01 ^A	3.67 ^A	4.19 ^A	3.85 ^A
Rubbery	3.54 ^{AB}	3.60 ^{AB}	4.00 ^A	3.28 ^B

Processed Oyster Descriptive Analysis Texture^a Attribute^b

^a Attribute scores are on a 15 point scale

^b ABC Means within a row with the same letter are not significantly different (P>0.05) as determined by proc mixed and means by pglm procedures of SAS

Descriptive Analysis for Texture of Processed Gulf Oysters



Conclusion:

From the results of the study, it does not appear that the processing treatments (HPP, HHP, IQF) applied to the samples changed the acceptability of the Gulf oyster products. Although the trained descriptive panel detected some sensory differences, they were very minute to be noticed by the typical consumer. Based on the information obtained, there seems to be a real potential for growth of safer, equally tasty value added products within the current raw oyster market.

The results of this study (as well as those of Dr. Andrews) have confirmed that all of the post harvest processes results in oyster products that are highly acceptable to the consumers. Sensory evaluation procedures utilizing Descriptive Analysis Techniques, Spectrum Methodology also confirm this statement.

Another valuable information obtained after the completion of this work is the development of an Oyster Lexicon. This lexicon is an attribute language that, together with descriptive sensory analysis, could be used in other oyster marketing studies as well as a measurement or determinant of quality.

Acknowledgements:

The project coordinator would like to thank all industry partners, who through their efforts, made this project successful. Thanks are extended to the Department of Marine Resources and the members of the Coastal Research Extension Center at Mississippi State University. Also, special thanks are given to Dr. Linda Andrews and Ruth Posadas for their consistent and persistent determination to see this project to the completion stage.

Post-Harvest Processing Bibliography

An extensive review of the literature pertaining to various post-harvest processing technologies for oysters were compiled by Jeff Davis and Ruth Posadas of the Seafood Technology Bureau, Office of Marine Fisheries, Mississippi Department of Marine Resources. Website uniform resource locators (URL) address links are current as of the time that this list was created, however, they may have changed thereafter as individual websites are updated.

DEPURATION LIST

- Andrews, L.S., R.M. Grodner, and M.W. Moody. 1990. Microbial Safety of *Rangia cuneata*, Louisiana Estuarine Clam, at Harvest and Following Relaying. *Food Microbiology* 7:107-111.
- Bayne, B.L. 1999. Some Physiological Effects of Depurating Oysters.
www.eicc.bio.usyd.edu.au/scripts/database/view.pl?DB=pubs&id=152.
- Billups, Andrea. N.d. Through the Help of Copper, Silver Ions: Soon all the World May Have its Oysters.
www.flseagrant.org/library/publications/fathom_magazine/volume-6_issue-4/copper-silver.htm.
- Blake, Norman J., Gary E. Rodrick, Marck Tamplin, and Paul Luth. 1985. Uptake and Fate of Bacteria by Shellfish in a Laboratory Depuration System. *Proceedings of the 10th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. New Orleans, July 7-10.
- Boutin, B.K., A.L. Reyes, J.T. Peeler, and R.M. Twedt. 1985. Effect of Temperature and Suspending Vehicle on Survival of *Vibrio parahaemolyticus* and *Vibrio vulnificus*. *Journal of Food Protection* 48(10): 875-878.

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- Buisson, D.H., G.C. Fletcher, and C.W. Begg. 1981. Bacterial Depuration of the Pacific Oyster (*Crassostrea gigas*) in New Zealand. *New Zealand Journal of Science* 24: 253-262.
- Colby, Jhung-Won and George J. Flick. 1991. Distribution of *Vibrio vulnificus* in Oysters (*Crassostrea virginica*) Tissues During Artificial Inoculation and Depuration. *Proceedings of the 16th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*.
- Cook, David W. and R.D. Ellender. 1986. Relaying to Decrease the Concentration of Oyster-Associated Pathogens. *Journal of Food Protection* 49(3): 196-202.
- Dixon, Dustin W. and Gary E. Rodrick. 1990. Comparative Effects of Ionizing Radiation and High Energy Electron Beams on Molluscan Shellfish. *Proceedings of the 15th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Orlando, December 2-5.
- Doré, W.J., K. Henshilwood, and D.N. Lees. 1998. The Development of Management Strategies for Control of Virological Quality in Oysters. *Water Science and Technology* 38(12): 29-35.
- Eyles, Michael J. and George R. Davey. Microbiology of Commercial Depuration of the Sydney Rock Oyster, *Crassostrea commercialis*. *Journal of Food Protection* 47(9): 703-706.
- Fauvel, Y., G. Pons, and J.P. Legeron. 1979. Seawater Ozonization and Shellfish Depuration. *Ozone: Science and Engineering* 1: 147-165.
- Fox, Joe M. 2003. Depuration of Galveston Bay Oysters (*Crassostrea virginica*) against *Vibrio vulnificus* Using Probiotic Bacteria. Oyster Research and Restoration in U.S. Coastal Waters: Strategies for the Future. <http://www.mdsg.umd.edu/oysters/meeting/abstracts/abstract70.html>. Annapolis, September 8-9.
- Grantham, Susan. N.d. Putting Oysters and Clams Back on the Menu. *Fathom Magazine*. http://www.flseagrant.org/library/publications/fathom_magazine/volume-6_issue-4/oysters_clams.htm#top.
- Greig, Richard A. and Douglas R. Wenzioff. 1978. Metal Accumulation and Depuration by the American Oyster, *Crassostrea virginica*. *Bulletin of Environmental Contamination and Toxicology* 20: 499-504.
- Hanson, Terrill R., Lisa O. House, and Benedict Posadas. 2003. Gulf Oyster Industry Initiative – Consumer Attitudes and Preferences for Oysters. Oyster Research and Restoration in U.S. Coastal Waters: Strategies for the Future. www.mdsg.umd.edu/oysters/meeting/abstracts/abstract78.html. Annapolis, September 8-9.

GULF OYSTER PROJECT

- Jackson, K.L. and D.M. Ogburn. 1999. Review of Depuration and Its Role in Shellfish Quality Assurance.
www.fisheries.nsw.gov.au/sci/outputs/aqua_sust/s_depuration_shellfish.htm.
- Jones, Stephen H., Thomas L. Howell, and Kathleen R. O'Neill. 1991. Differential Elimination of Indicator Bacteria and Pathogenic *Vibrio* Sp. From Eastern Oysters (*Crassostrea virginica* Gmelin, 1791) in a Commercial Controlled Purification Facility in Maine. *Journal of Shellfish Research* 10(1): 105-112.
- Ladner, Cornell M., Richard L. Leard, and James S. Franks. 1986. Oyster Depuration in Managed On-Shore Facilities in Mississippi.
- Lin, Jordan C.T., Charles M. Adams, Robert L. Degner, and Rebecca D. Dunning. 1995. Exploring the Supply of Safer Foods: A Case Study of Oyster Depuration in Dixie and Levy Counties, Florida. Proceedings of NE – 165 Conference. June 6-7.
http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=79&ftype=.pdf.
- Lorio, Wendall J. and Sandra Malone. 1994. The Cultivation of American Oysters (*Crassostrea virginica*).
<http://wildlife.tamu.edu/publications/TAEXAqua/432FS.PDF>.
- Motes, Miles L. and Angelo DePaola. 1996. Offshore Suspension Relaying to Reduce Levels of *Vibrio vulnificus* in Oysters (*Crassostrea virginica*). *Applied and Environmental Microbiology* 62(10): 3875-3877.
- Ogden, ID, M. Macrae, S. Wright, J. Heron, and J. Graham. N.d. Depuration of *Cryptosporidium parvum*, *Vibrio parahaemolyticus*, and *Campylobacter jejuni* from Bivalve Molluscs.
<http://www.marlab.ac.uk/FRS.Web/Uploads/Documents/poster%20v3%20all%20blue.pdf>. Poster.
- Parveen, Salina, William Wolfe, and Gary Richards. N.d. Uptake, Persistence, and Localization of Virulent and Avirulent *Vibrio vulnificus* in the Eastern Oyster, *Crassostrea virginica*.
http://www.ars.usda.gov/research/publications/Publications.htm?seq_no_115=142391. (abstract).
- Richards, Gary P. 1988. Microbial Purification of Shellfish: A Review of Depuration and Relaying. *Journal of Food Protection* 51(3): 218-251.
- Scanes, P. 1997. Uptake and Depuration of Organochlorine Compounds in Sydney Rock Oysters *Saccostrea commercialis*.
www.eicc.bio.usyd.edu.au/scripts/database/view.pl?DB=pubs&id=53. (summary and abstract).

- Schneider, Keith R., Frank A. Steslow, Frank J. Sierra, Gary E. Rodrick, and Charles I. Noss. 1988. Ozone Depuration of *Vibrio vulnificus* From the Southern Quahog Clam. *Proceedings of the 13th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Gulf Shores, October 16-18.
- Son, Nguyen Thi and Graham H. Fleet. 1980. Behavior of Pathogenic Bacteria in the Oyster, *Crassostrea commercialis*, During Depuration, Re-laying, and Storage. *Applied and Environmental Microbiology* 40(6): 994-1002.
- Tamplin, Mark L. and Gesa M. Capers. 1992. Persistence of *Vibrio vulnificus* in Tissues of Gulf Coast Oysters, *Crassostrea virginica*, Exposed to Seawater Disinfected with UV Light. *Applied and Environmental Microbiology* 58(5): 1506-1510.

Heat- Cool Pasteurization List

- Andrews, L.S., S. DeBlanc, C.D. Veal, and D.L. Park. 2003. Response of *Vibrio parahaemolyticus* 03:K6 to a Hot Water/Cold Shock Pasteurization Process. *Food Additives and Contaminants* 20(4): 331-334.
- Andrews, L.S., D.L. Park, and Y.P. Chen. 2000. Low Temperature Pasteurization to Reduce the Risk of *Vibrio* Infections From Raw Shellstock Oysters. *Journal of Food Additives and Contaminants* 19(7): 787-791.
- Andrews, Linda S. N.d. Consumer Acceptability of Post Harvest Processed and Value Added Oysters. Power Point Presentation.
- Andrews, Linda S. and Susan DeBlanc. N.d. Response of *Vibrio vulnificus* and *V. parahaemolyticus* 03:K6 to hot water/cold shock pasteurization process. Invited paper on Oyster Post Harvest Treatments. (abstract).
- Boutin, B.K., J.G. Bradshaw, and W.H. Stroup. 1982. Heat Processing of Oysters Naturally Contaminated with *Vibrio cholerae* Serotype 01. *Journal of Food Protection* 45(2): 169-171.
- Chai, T., K.T. Liang, J. Pace, and D.V. Schlimme. 1991. Effect of Heat Processing on Quality of Pasteurized Oysters. *Journal of Food Science* 56(5): 1292-1294.
- Chai, T., J. Pace, and T. Cossaboom. 1984. Extension of Shelf-Life of Oysters by Pasteurization in Flexible Pouches. *Journal of Food Science* 49: 331-333.

GULF OYSTER PROJECT

- Chen, Y.P., L.S. Andrews, R.M. Grodner, and D.L. Park. 1995. Use of “Cool Pasteurization” to Control *Vibrio vulnificus* in Raw Shellstock Oysters. *Proceedings of the 20th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Humacao, Puerto Rico, November 5-8.
- Cook, David W. and Angela D. Ruple. 1992. Cold Storage and Mild Heat Treatment as Processing Aids to Reduce the Numbers of *Vibrio vulnificus* in Raw Oysters. *Journal of Food Protection* 55(12): 985-989.
- Gates, Keith W., Amanda H. Parker, Diana L. Bauer, and Yaowen Huang. 1991. Evaluation of Packaging Alternatives for Fresh and Pasteurized Crab Meat. *Proceedings of the 16th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*.
- Goldmintz, Daniel, John A. Babinchak, Gary P. Richards, and John T. Graikoski. 1983. Bacteriological Evaluation of Steam Pasteurized Oysters, *Crassostrea virginica*. *Developments in Industrial Microbiology* 24: 457-465.
- Goldmintz, D., R.C. Ernst, and J. Rasekh. 1978. Development of a Pasteurized Oyster Product. *Proceedings of the 3rd Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. New Orleans, April 23-26.
- Guardia, Enrique J. and Alexander M. Dollar. 1970. Pasteurization of Pacific Oysters by Radiation: Post-Mortem Changes in Nucleotides During Storage at 0-2°C. *Journal of Food Science* 35: 22-25.
- Hoff, J.C., W.J. Beck, T.H. Ericksen, J.G. Vasconcelos, and M.W. Presnell. 1967. Time-Temperature Effects on the Bacteriological Quality of Stored Shellfish. Bacteriological Changes in Live Shellfish: Pacific Oysters (*Crassostrea gigas*), Olympia Oysters (*Ostrea lurida*), Native Littleneck Clams (*Protothaca staminea*), and Manila Clams (*Venerupis japonica*). *Journal of Food Science* 32:121.
- Hoff, J.C., W.J. Beck, T.H. Erickson, J.G. Vasconcelos, M.W. Presnell. 1967. Time-Temperature Effects on the Bacteriological Quality of Stored Shellfish II. Bacteriological Changes in Shucked Pacific Oysters (*Crassostrea gigas*) and Olympia Oysters (*Ostrea lurida*). *Journal of Food Science* 32:125.
- Johnston, M.D., and M.H. Brown. 2002. An Investigation Into the Changed Physiological State of *Vibrio* Bacteria as a Survival Mechanism in Response to Cold Temperatures and Studies on Their Sensitivity to Heating and Freezing. *Journal of Applied Microbiology* 92(6): 1066-1077.
- Liuzzo, Joseph A., Mohammed K. Farag, and Arthur F. Novak. 1971. Storage Temperature Effects on the Proteolytic Activity of Radiation Surviving Bacteria in Oysters. *Journal of Food Science* 36:287.

Pace, J., C.Y. Wu, and T. Chai. 1988. Bacterial Flora in Pasteurized Oysters after Refrigerated Storage. *Journal of Food Science* 53(2): 325-327, 348.

Heat Shock List

Bolton, Greg, Wayne Mobley, and David Green. 2002. A Sanitary Audit of the Heat Shock Process for Shell Oysters. *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando, October 9-11.

Cook, D.W., S.R. Lofton, G.M. Brooks, and J.H. McGilberry. 1980. Steam Unit to Aid in Oyster Shucking. *Proceedings of the 5th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Charleston, April 27-30.

Garrido, Victor, Diana Ramirez, Don Noel, and Gary Rodrick. N.d. Heat Shock – A Tool to Increase Productivity and Reduce *Vibrios* in Oyster Processing. <http://sst.ifas.ufl.edu/25thAnn/file27.pdf>. (abstract).

Hesselman, Donald M., Miles L. Motes, and James P. Lewis. 1999. Effects of a Commercial Heat-Shock Process on *Vibrio vulnificus* in the American Oyster, *Crassostrea virginica*, Harvested from the Gulf Coast. *Journal of Food Protection* 62(11): 1266-1269.

Hinton, Arthur Jr. and Robert M. Grodner. 1982. Determination of Thermal Death Time of *Vibrio cholerae* In Oyster Meat Homogenates (*Crassostrea virginica*). *Proceedings of the 7th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. New Orleans, January 11-14.

Werner, Elizabeth, Fu-Lin Chu, and Vincent Encomio. 1999. Duration of Sublethal Heat Shock Response in Oysters.

High Hydrostatic Pressure List

Alpas, H., N. Kalchayanand, F. Bozoglu, A. Sikes, C.P. Dunne, and B. Ray. 1999. Variation in Resistance to Hydrostatic Pressure among Strains of Food-Borne Pathogens. *Applied and Environmental Microbiology* 65(9): 4248-4251.

GULF OYSTER PROJECT

- Andrews, Linda S. 2003. Consumer Acceptability of Post Harvest Processed and Value Added Oysters. *27th Annual Conference of the Seafood Science and Technology Society of the Americas*. Biloxi, MS.
- Anonymous. N.d. High Pressure Food Processing. http://courses.foodsci.purdue.edu/fs442/high_pressure_.../high_pressure_food_processing.html. pp.1-11.
- Ariefdjohan, M.W., P.E. Nelson, R.K. Singh, A.K. Bhunia, V.M. Balasubramaniam, and N. Singh. 2004. Efficacy of High Hydrostatic Pressure Treatment in Reducing *Escherichia coli* 0157 and *Listeria monocytogenes* in Alfalfa Seeds. *Journal of Food Science* 69(5): M 117-M 120.
- Benito, Amparo, Georgia Ventoura, Maria Casadei, Tobin Robinson, and Bernard Mackey. 1999. Variation in Resistance of Natural Isolates *Escherichia coli* 0157 to High Hydrostatic Pressure, Mild Heat, and Other Stresses. *Applied and Environmental Microbiology* 65(4): 1564-1569.
- Berlin, D.L., D.S. Herson, D.T. Hicks, and D.G. Hoover. 1999. Response of Pathogenic *Vibrio* Species to High Hydrostatic Pressure. *Applied and Environmental Microbiology* 65(6): 2776-2780.
- Brown, Paul, Richard Meyer, Franco Cardone, and Maurizio Pocchiari. 2003. Ultra-High-Pressure Inactivation of Prion Infectivity in Processed Meat: A Practical Method to Prevent Human Infection. *Proceedings of the National Academy of Sciences* 100(10): 6093-6097.
- Bouton, P.E., A.L. Ford, P.V. Harris, J.J. MacFarlane, and J.M. O'Shea. 1977. Pressure-Heat Treatment of Postrigor Muscle: Effects on Tenderness. *Journal of Food Science* 42: 132-135.
- Bouton, P.E., P.V. Harris, and J.J. MacFarlane. 1980. Pressure-Heat Treatment of Meat: Effect of Prior Aging Treatments on Shear Properties. *Journal of Food Science* 45: 276-278.
- Bouton, P.E., P.V. Harris, J.J. MacFarlane, and J.M. O'Shea. 1978. Pressure-Heat Treatment of Meat: Effect on Connective Tissue. *Journal of Food Science* 43: 301-303, 326.
- Calci, Kevin, David Kingsley, and Rukma Reddy. N.d. Mitigation of Hav in Shucked Oysters Using High Hydrostatic Pressure Treatment. http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=144903. (abstract).

GULF OYSTER PROJECT

- Calik, H. M.T. Morrissey, P.W. Reno, and H. An. 2002. Effect of High-Pressure Processing on *Vibrio parahaemolyticus* Strains in Pure Culture and Pacific Oysters. *Journal of Food Science* 67(4): 1506-1510.
- Calik, Hakan, M.T. Morrissey, P. Reno, R. Adams, and H.An. N.d. The Use of High Hydrostatic Pressure for Reduction of *Vibrios* in Oysters. (abstract).
- Carballo, J., P. Fernandez, A.V. Carrascosa, M.T. Solas, and Colmenero F. Jiminez. 1997. Characteristics of Low-and High-Fat Beef Patties: Effect of High Hydrostatic Pressure. *Journal of Food Protection* 60(1): 48-53.
- Chen, Haiqiang, Rolf D. Joerger, David H. Kingsley, and Dallas G. Hoover. 2004. Pressure Inactivation Kinetics of Phage λ cl 857. *Journal of Food Protection* 67(3): 505-511.
- Chew, Kenneth K. 2001. Prospects For High Pressure Processing on Bacteria in Pacific Oysters. *Aquaculture Magazine* 27(6): 72-74.
- Chung, Y.C., A. Gebrehiwot, D.F. Farkas, and M.T. Morrissey. 1994. Gelation of Surimi by High Hydrostatic Pressure. *Journal of Food Science* 59(3): 523-524, 543.
- Cléry-Barraud, Cécile, Agnes Gaubert, Patrick Masson, and Dominique Vidal. 2004. Combined Effects of High Hydrostatic Pressure and Temperature for Inactivation of *Bacillus anthracis* Spores. *Applied and Environmental Microbiology* 70(1): 635-637.
- Cook, David W. 2003. Sensitivity of *Vibrio* Species in Phosphate-Buffered Saline and in Oysters to High-Pressure Processing. *Journal of Food Protection* 66(12): 2276:2282.
- Cook, David W. and Errol V. Raghebeer. 2002. Effect of High Hydrostatic Pressure on Pathogenic Strains of *Vibrio parahaemolyticus*. *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando October 9-11. (abstract).
- Corwin, H. and T.H. Shellhammer. 2002. Combined Carbon Dioxide and High Pressure Inactivation of Pectin Methyltransferase, Polyphenol Oxidase, *Lactobacillus plantarum* and *Escherichia coli*. *Journal of Food Science* 67(2): 697-701.
- He, H., R.M. Adams, D.F. Farkas, and M.T. Morrissey. N.d. The Use of High Hydrostatic Pressure to Shuck Oysters and Extend Shelf-Life. <http://oregonstate.edu/Dept/IIFET/2000/abstracts/morrissey.html>. (abstract).
- _____. 2002. Use of High-Pressure Processing for Oyster Shucking and Shelf-Life Extension. *Journal of Food Science* 67(2): 640-645.

GULF OYSTER PROJECT

- Kilgen, Marilyn B. N.d. Processing Controls for *Vibrio vulnificus* in Raw Oysters – Commercial Hydrostatic High Pressure. (abstract)
- Kingsley, David. N.d. High Hydrostatic Pressure Processing: A Potential Solution for Shellfish-Borne Viruses.
http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=155215. (abstract).
- Kingsley, David. N.d. Molecular Detection and High Pressure Sanitization of Shellfish – Borne Viruses.
http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=135274. (abstract).
- Kingsley, David. N.d. Virus and *Vibrio* Initiatives Within the USDA Microbial Food Safety Research Unit.
http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=140757. (abstract).
- Kingsley, David, Haiqiang Chen, and Dallas Hoover. N.d. Inactivation of Selected Picornavirus by High Hydrostatic Pressure.
http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=155791. (abstract).
- Kingsley, David, Dallas Hoover, Efi Parafraḡkow, and Gary Richards. N.d. Inactivation of Hepatitis a and a Calcivirus by High Hydrostatic Pressure.
http://www.ars.usda.gov/research/publications/publications.hym?seq_no_115=127430. (abstract).
- Kingsley, David and Gary Richards. Persistence of Hepatitis a Virus Within Oysters.
http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=127441. (abstract).
- Koo, Jaheon, Michael Jahncke, George Flick, Robert Lane, and Paul Reno. 2002. Effect of High Hydrostatic Pressure and IQF Freezing on Reduction of *Vibrio parahaemolyticus* and *Vibrio vulnificus* in Pure Cultures and Whole Eastern Oysters (*Crassostrea virginica*). *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando, October 9-11.
- López-Caballero, M.E., M. Pérez-Mateos, P. Montero, and A.J. Borderías. 2000. Oyster Preservation by High-Pressure Treatment. *Journal of Food Protection* 63(2): 196-201.
- Ting, Edmund. N.d. High Pressure Equipment and Economics for Shellfish *Vibrio* Elimination and Shucking. (abstract).

Individually Quick Freezing List

Andrews, Linda S. N.d. Consumer Acceptability of Post Harvest Processed and Value Added Oysters. Power Point Presentation.

Hillman, Clifford. N.d. Commercial Pioneering of Frozen Oysters. (abstract).

Koo, Jaheon, Michael Jahncke, George Flick, Robert Lane, and Paul Reno. 2002. Effect of High Hydrostatic Pressure and IQF Freezing on Reduction of *Vibrio parahaemolyticus* and *Vibrio vulnificus* in Pure Cultures and Whole Eastern Oysters (*Crassostrea virginica*). *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando, October 9-11.

Irradiation List

Ama, A.A., M.K. Hamdy, and R.T. Toledo. 1994. Effects of Heating, pH, and Thermoradiation on Inactivation of *Vibrio vulnificus*. *Food Microbiology* 11: 215-227.

Andrews, L.S., M. Ahmedna, R.M. Grodner, J.A. Liuzzo, P.S. Murano, E.A. Murano, R.M. Rao, S. Shane, and P.W. Wilson. 1998. Food Preservation Using Ionizing Radiation. *Reviews of Environmental Contaminant Toxicology* 154: 1-53.

Andrews, L.S., R.M. Grodner, and J.A. Liuzzo. 1995. Effect of Split Dose Application on the Radiosensitivity of *Listeria monocytogenes*. *Proceedings of the 19th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. New Orleans, September 11-13.

Andrews, Linda, Michael Jahncke, and Kumar Mallikarjunan. 2003. Low Dose Gamma Irradiation to Reduce Pathogenic *Vibrios* in Live Oysters (*Crassostrea virginica*). *Journal of Aquatic Food Product Technology* 12(3): 71-82.

Andrews, Linda, Benedict Posadas, and Mike Jahncke. Oyster Irradiation: Pathogenic *Vibrio* Response and Consumer Difference Testing. *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando, October 9-11.

Dixon, Dustin W. and Gary E. Rodrick. 1990. Comparative Effects of Ionizing Radiation and High Energy Electron Beams on Molluscan Shellfish. *Proceedings of the 15th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Orlando, December 2-5.

GULF OYSTER PROJECT

- Ford, Susan E., Zhe Xu, Gregory Debrosse. 2001. Use of Particle Filtration and UV Irradiation to Prevent Infection by *Haplosporidium nelsoni* (MSX) and *Perkinsus marinus* (Dermo) in Hatchery-Reared Larval and Juvenile Oysters. *Aquaculture* 194(1): 37-49.
- Gardner, Elizabeth Ann and Betty M. Watts. 1957. Effect of Ionizing Radiations on Southern Oysters. *Food Technology* 11: 329-331.
- Girolamo, Rudolph D., J. Liston, and J. Matches. 1972. Effects of Irradiation on the Survival of Virus in West Coast Oysters. *Applied Microbiology* 24(6): 1005-1006.
- Grodner, Robert M. 1966. Examination of Gamma Irradiated Gulf Shrimp and Oysters for *Clostridium botulinum* and Type E Toxin. *Sixth Annual AEC Food Irradiation Contractors Meeting*. pp. 128-130.
- Grodner, R.M. and M.B. Gutierrez-de-Zubiaurre. 1992. Low Dose Gamma Irradiation of *Plesiomonas shigelloides* in Louisiana Rangia Clams (*Rangia cuneata*). *Proceedings of the 17th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Merida, Yucatan, Mexico, November 4-6.
- Grodner, Robert M. and Arthur Hinton, Jr. 1987. Gamma Irradiation of *Vibrio cholerae* in Crayfish (*Procambrus clarkii* Gerard). *Proceedings of the 12th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Orlando, November 9-11.
- _____. 1985. Low Dose Gamma Irradiation of *Vibrio cholerae* in Oysters (*Crassostrea virginica*). *Proceedings of the 10th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. New Orleans, January 7-10.
- Grodner, Robert M. and Michael A. Land. 1991. Low Dose Gamma Irradiation of *Vibrio parahaemolyticus* in Crayfish Tail Meat. *Proceedings of the 16th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*.
- Jakabl, Miyoko, Dilma S. Gelli, Jussara C.M.D. Torre, Maria A.B. Rodas, Bernadette D.G.M. Franco, Maria T. Destro, and Mariza Landgraf. 2003. Inactivation by Ionizing Radiation of *Salmonella* Enteritidis, *Salmonella* Infantis, and *Vibrio parahaemolyticus* in Oysters (*Crassostrea brasiliana*). *Journal of Food Protection* 66(6): 1025-1029.
- Kilgen, Marilyn B. and Mary T. Hemard. 1995. Evaluation of Commercial Irradiation and Other Processing Methods for *Vibrio vulnificus* Control in Louisiana Oysters. *Proceedings of the 20th Annual Tropical and Subtropical Fisheries Technological Conference of the Americas*. Humacao, Puerto Rico, November 5-8.

GULF OYSTER PROJECT

- Liuzzo, J.A., W.B. Barone, and A.F. Novak. 1966. Stability of B-vitamins in Gulf Oysters Preserved by Gamma Irradiation. *Federation Proceedings* 25: 722. (abstract).
- Liuzzo, Joseph A., Mohammed K. Farag, and Arthur F. Novak. 1967. Effects of Low-Level Radiation on the Proteolytic Activity of Bacteria in Oysters. *Journal of Food Science* 32: 678-671.
- Mallett, John C., Leon E. Beghian, Theodore G. Metcalf, and John D. Kaylor. 1991. Potential of Irradiation Technology for Improved Shellfish Sanitation. *Journal of Food Safety* 11(4): 231-245.
- Novak, Arthur F., Robert M. Grodner, and M.R. Ramachandra Rao. 1967. Radiation Pasteurization of Fish and Shellfish. *Advances in Chemistry Series* 65: 142-151.
- Novak, Arthur F., Joseph A. Liuzzo, Robert M. Grodner, and Richard T. Lovell. 1966. Radiation Pasteurization of Gulf Coast Oysters. *Food Technology* 20(2): 103-104.
- Novak, Arthur F. and Joseph A. Liuzzo. 1996. Radiation Pasteurization of Shrimp and Oysters. *Sixth Annual AEC Food Irradiation Contractors Meeting*: Washington, D.C., October 3-4.
- Posadas, Benedict C., Linda S. Andrews, and Dave D. Burrage. 2002. Consumer Preferences and Attitudes Toward Irradiated Oysters at the 2002 Boston International Seafood Show. *Proceedings of the 6th Joint Meeting of SST & AFT Advancing Seafood Technology for Harvested & Cultured Products*. Orlando, October 9-11.
- Shiflett, Maureen A., J.S. Lee, and R.G. Sinnhuber. 1966. Microbial Flora of Irradiated Dungeness Crabmeat and Pacific Oysters. *Applied Microbiology* 14(3): 411-415.
- Vasconcelos, G.J. and J.S. Lee. 1972. Microbial Flora of Pacific Oysters (*Crassostrea gigas*) Subjected to Ultraviolet-Irradiated Seawater. *Applied Microbiology* 23(1): 11-16.

Value-Added Products List

- Andrews, Linda S. and Robert M. Grodner. 1995. Muddy Flavor and Acceptability of Fresh Iced-Stored and Value-Added Louisiana Rangia Clam. *Journal of Food Quality* 18: 445-453.

GULF OYSTER PROJECT

Dellenbarger, Lynn, Alvin Schupp, Joseph Liuzzo, and Linda Andrews. 1993. A Sensory Panel Evaluation of Selected Species of Finfish. *Journal of Food Products Marketing*, 1(3): 37-44.

Kuntz, Lynn A. N.d. Catching Value in Seafood.
www.foodproductdesign.com/archive/1997/1297AP.html Pp. 1-8.

Taylor, Gary, Linda Andrews, Jeffrey M. Gillespie, and Alvin Schupp. 1997. Sensory Panel Comparison of Ostrich and Emu Fillets with Top Sirloin Beef. *Journal of Restaurant & Foodservice Marketing* 2(3): 55-66.