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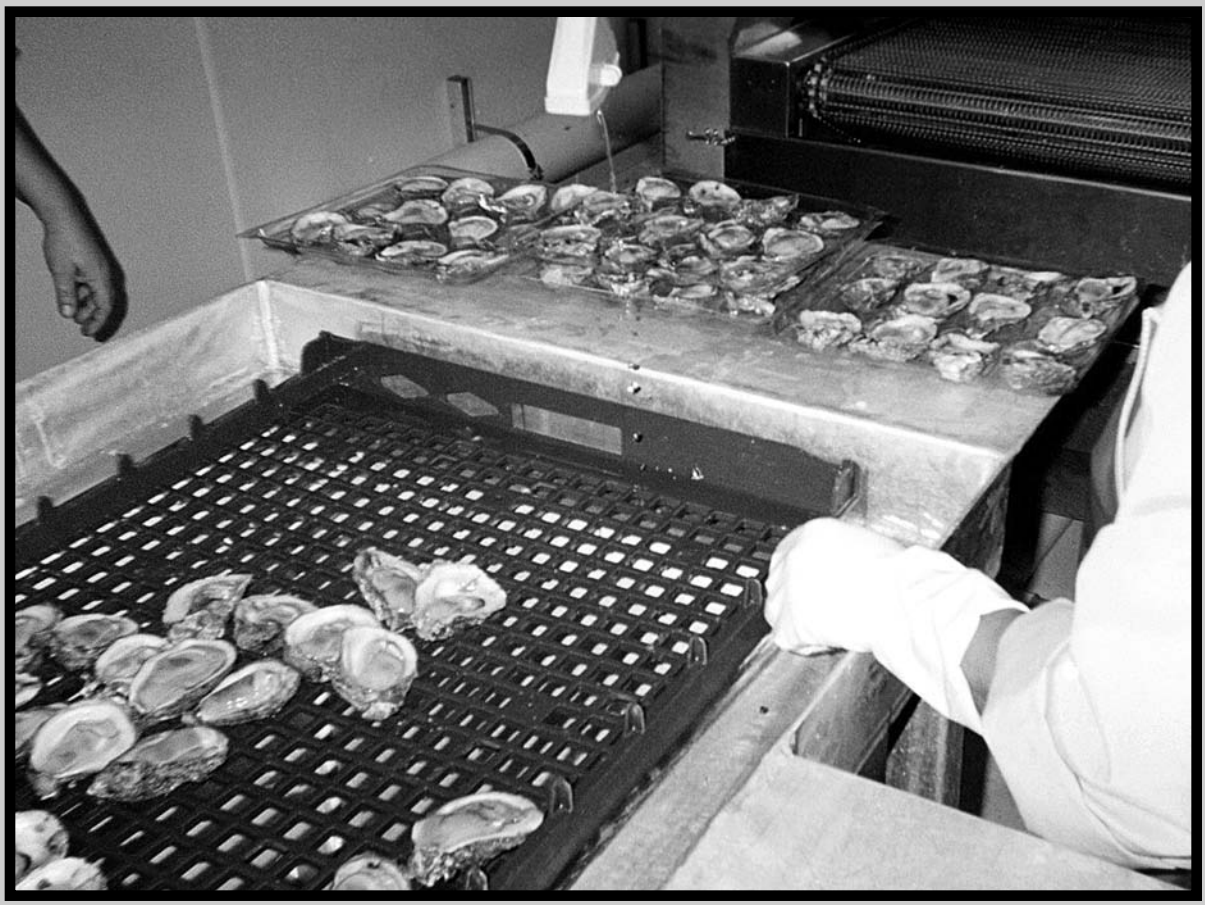
Consumer Preferences for Postharvest-Processed Raw Oyster *Products in Southern California*



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Consumer Preferences for Postharvest-Processed Raw Oyster Products in Southern California

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ABSTRACT

The Gulf of Mexico states had been supplying California with shucked and half-shell oyster products for raw consumption. In April 2003, however, California began requiring that raw Gulf oysters from April through October had to be postharvest processed to reduce the level of *V. vulnificus* bacteria to nondetectable levels. The Mississippi Department of Marine Resources Seafood Technology Bureau and the Mississippi State University Coastal Research and Extension Center conducted a collaborative research and outreach program on oyster postharvest processing. The primary goal of this program was to evaluate consumers' acceptance of postharvest-processed raw oyster products and to determine economic viability of postharvest-processing systems that complied with federal and state regulations. Personal and telephone interviews were conducted to evaluate consumer preferences for postharvest-processed raw oyster products in southern California in 2003 and in 2007. Results of the consumer surveys would provide guidance to oyster processors, distributors, and researchers to concentrate on important quality attributes as perceived by the respondents for the development and promotion of postharvest-processed raw oyster products. It was expected that these consumer surveys would identify several market segments of consumers, including those who did or did not consume traditional raw oysters, as well as those who would or would not be willing to buy postharvest-processed raw oysters.

oyster prices were lower, product safety was guaranteed, and availability of fresh products was increased.

Mississippi, along with the other states along the Gulf of Mexico, has been supplying California and other Western states with shucked and half-shell oyster products for raw consumption. There were 29 *V. vulnificus* cases reported in California due to shellfish consumption between 1998 and 2004 (SafeOysters.org, 2010). In April 2003, California instituted new requirements for oysters sold for raw consumption. All Gulf oysters harvested between April 1 and October 1 must be subjected to approved postharvest processing (Intrafish, 2009; Romney et al., 2003; SafeOysters.org, 2010). At-risk consumers face the danger of illness or death associated with the consumption of raw oyster products contaminated with *V. vulnificus*. This risk prompted the U.S. Food and Drug Administration (FDA) to specify that oyster-producing Gulf states process a certain percentage of their raw products with approved postharvest-processing methods (Romney et al., 2003).

Federal regulatory mandates and market constraints set by individual states would eventually require that a significant portion of raw oyster production undergo postharvest processing. As of spring 2010, 11 commercial raw oyster postharvest-processing plants were operating in the Gulf of Mexico states. The commercially available systems approved by FDA for postharvest processing (PHP) of raw oysters include heat-cool pasteurization (HCP), high-hydrostatic pressure (HHP), individually quick freezing (IQF), and low-dose irradiation (IRO). These raw oyster PHP technologies significantly reduce levels of certain bacteria that naturally occur in waters where oysters are found, provide quality raw oysters, and enhance the shelf life of raw oysters (Andrews, et al., 2000; Andrews, et al., 2002; Cook, 1997; Cook and Ruple, 1992).

Intrafish (2009) reported that FDA proposed new regulations that would require U.S. Gulf of Mexico oysters to undergo treatment to kill potential bacteria during the warmer months, between May and October. An industry-wide estimate of the economic impact of mandatory postharvest processing of Gulf raw shucked and half-shell oyster products conducted by Muth et al. (2000, 2002) showed that price increases would be less than 20% and that producer and consumer losses in the half-shell market would be partially or more than offset by gains in the shucked market. Estimates made by Posadas and Posadas (2004) showed that postharvest processing of oyster products for raw consumption — either by high pressure, heat-cool pasteurization, or individually quick freezing — would add $0.16 to $0.30 to the price of each half-shell oyster ($1.92 to $3.60 per dozen).

With these market limitations imposed by federal and state regulatory agencies, it was deemed necessary to first explore raw oyster consumption behavior in selected markets and then evaluate the potential markets for postharvest-processed raw oyster products in these markets. The overall goal of this consumer survey was to evaluate consumer preferences for PHP raw oyster products in southern California. There were five specific objectives of this study:

(1) Determine consumer characteristics affecting raw oyster consumption;

(2) Determine consumer perceptions of raw oyster characteristics influencing consumption;

(3) Evaluate consumption patterns and sources of raw oyster purchases;

(4) Measure willingness to buy and to pay for PHP raw oyster products; and

(5) Evaluate packaging preferences for PHP raw oyster products.

Survey results will help guide oyster processors, distributors, and researchers as they concentrate on important quality attributes identified by respondents in the development and promotion of PHP raw oyster products. Additional surveys on PHP raw oyster consumption were conducted in selected Metropolitan Statistical Areas (MSA). It was expected that these surveys would identify several market segments of consumers, including those who did and did not eat traditional raw oysters, in addition to those who would and would not be willing to buy PHP raw oysters.

Consumer Preferences for Postharvest-Processed Raw Oyster Products in Southern California

Introduction

The Mississippi State University (MSU) Coastal Research and Extension Center and the Mississippi Department of Marine Resources (DMR) Seafood Technology Bureau collaborated on a research and outreach program on oyster postharvest processing. The primary goal of this program was to evaluate consumers' acceptance of postharvest-processed (PHP) raw oyster products and to determine economic viability of PHP systems that comply with federal and state regulations.

The apparent U.S. per-capita oyster consumption declined from about 0.35 pound in 1971–1989 to less than 0.25 pound starting in 1990 (Figure 1). Oyster consumption may be affected by many determinants, including age, gender, ethnicity, income, region of origin, and awareness of potential risks. National surveys have revealed that taste, texture, and smell are the most widely cited reasons for not consuming oyster products (Hanson et al., 2003). Survey respondents who ate oyster products considered price, product safety concerns, and lack of fresh products as the top three reasons for not eating them more frequently.

In a similar survey conducted in coastal Mississippi, respondents who did not eat raw oysters cited several factors that influenced their decisions to not consume the product (Posadas and Posadas, 2011). The reasons cited by the respondents for not eating raw oysters were smell, color, taste, appearance, sliminess, grittiness, internal waste, and personal safety. Based on national survey results, House et al. (2003) concluded that oyster consumers would increase consumption if

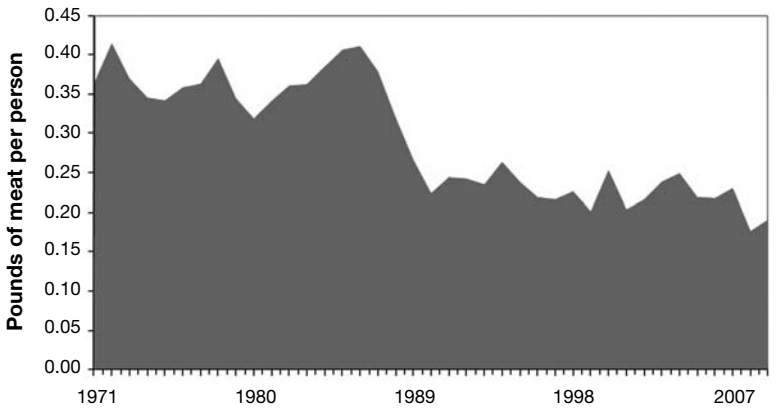

Figure 1. Apparent per-capita consumption of oyster products, United States, 1971-2006. Sources of raw data: National Marine Fisheries Service (1977, 1987, 1997, 2007, 2010).

METHODS

Data Collection

Consumer preferences for traditional and PHP raw oyster products were evaluated from results of voluntary consumer surveys of adults who attended the Western International Seafood Show in Long Beach, California, October 12–14, 2003. All interviews were conducted by staff of the DMR Seafood Technology Bureau and MSU Experimental Seafood Processing Laboratory. The Seafood Technology Bureau developed the questionnaire used in the survey. There were 183 adults who participated in the interviews conducted in Long Beach.

Telephone interviews with simple random samples of adults living in the Long Beach-Los Angeles-Santa Ana Metropolitan Statistical Area (MSA) were conducted in June 2007. Of the eligible respondents contacted, 424 completed the interview. The MSU Survey Research Unit conducted these telephone interviews.

Respondents were asked to specify their socioeconomic characteristics, including gender, age, marital status, ethnic origin, annual household income, and formal educational attainment. They were asked whether or not they consumed raw oysters and to indicate the main reasons for consuming or not consuming the product. They also were asked to identify their sources of raw oyster purchases, annual frequency of eating raw oysters, and primary food safety bacteriological and viral concerns about raw oysters. Another series of questions gauged respondents' awareness, sources of information, level of interest, willingness to pay, and packaging preferences for PHP raw oysters (Appendix A).

Data Analysis

Consumers' decisions associated with traditional raw oyster consumption and willingness to buy and to pay for PHP products could be significantly related to their perceptions about the characteristics of these products and their own personal characteristics. Participants were categorized into consumers and nonconsumers of traditional raw oysters. Raw oyster consumers were those respondents who answered "yes" to the question, "Do you eat raw oysters?". Respondents specified their reasons for eating or not eating raw oysters and their primary food safety concerns about them. They also identified their personal characteristics, including gender, age, marital status, ethnic origin, annual household income, and formal educational attainment. Consumer awareness of PHP oyster products and sources of information could be significantly related to their willingness to buy and to pay for these products.

Chi-square analysis was used to compare the qualitative responses between consumers and nonconsumers of raw oysters, their perceptions of product properties, and their personal characteristics. Analysis of variance (ANOVA) was used to compare the quantitative responses between consumers and nonconsumers of raw oysters and the types of PHP oyster products.

RESULTS AND DISCUSSION

Raw Oyster Consumption

Market segments describing different traditional raw oyster consumption behavior were observed during the 2003 and 2007 surveys in southern California. By looking at the percent of respondents who reported eating raw oysters, we observed marked differences. Among the 183 respondents who participated in personal interviews in October 2003, 69% reported that they consumed raw oyster products. Of the 424 participants in the 2007 telephone survey, 16% stated that they consumed raw oysters. The differences in the percent of respondents who ate raw oysters during the two surveys could be explained by the selection and composition of the participants. At the 2003 Western International Seafood Show, survey participants were mostly seafood producers, dealers, or buyers, as well as seafood-processing equipment manufacturers, dealers, or buyers. Participants at the 2007 telephone interviews were randomly selected adults residing in the Long Beach-Los Angeles-Santa Ana MSA.

Socioeconomic characteristics **—** The decisions made by participants to consume raw oysters were significantly related to their own personal characteristics. Raw oyster consumption behavior revealed during the 2003 personal interviews was strongly related to the age and ethnic origin of the respondents. Gender, mar-

Table 1. Number and percent of all respondents in 2003 survey by age group and raw oyster consumption.

Age group	Nonconsumer (N=56)		Consumer (N=127)		Total (N=183)	
	no.	%	no.	%	no.	%
18-29	8	4.5	14	7.9	22	12.4
30-39	16	9.0	36	20.3	52	29.4
40-49	11	6.2	33	18.6	44	24.9
50-59	12	6.8	32	18.1	44	24.9
60 & above	3	1.7	12	6.8	15	8.5
Total	50	28.2	127	71.8	177	100.0
Chi-square value = 15.625 *						

* The chi-square values of the 2003 survey results were significant at 0.05.

Table 2. Number and percent of all respondents in 2003 survey by racial origin and raw oyster consumption.

Race	Nonconsumer (N=56)		Consumer (N=127)		Total (N=183)	
	no.	%	no.	%	no.	%
White or Caucasian	31	17.8	55	31.6	86	49.4
Hispanic	8	4.6	23	13.2	31	17.8
American Indian	6	3.4	39	22.4	45	25.9
Other races	5	2.9	7	4.0	12	6.9
Total	50	28.7	124	71.3	174	100.0
Chi-square value = 16.021*						

* The chi-square values of the 2003 survey results were significant at 0.05.

ital status, education, household size, and household income did not have significant effects on raw oyster consumption behavior in 2003. The raw oyster consumption decisions reported during the 2007 telephone interviews were significantly related to the gender and household income of participants. There was no significant relationship during the 2007 survey between raw oyster consumption and participants' age, racial origin, marital status, education, and household size.

Most of the 2003 respondents belonged to the 30–39, 40–49, and 50–59 age groups. Survey results showed that the age of the participants had a strong relationship with their raw oyster consumption in 2003. The percent of respondents who ate raw oysters was higher than the percent who did not among all the age groups (Table 1). More participants reported eating raw oysters in the 30–59 age groups of seafood-related professionals.

Participants of the 2003 survey were mostly Caucasian (49%), American Indian (26%), and Hispanic (18%) (Table 2). Results indicated that racial origin had a strong influence on raw oyster consumption among southern California participants in 2003. The percent of respondents who ate raw oysters was higher than the percent who did not among all racial groups. About 32% of the Caucasian respondents reported eating raw oysters. Among American Indian participants, 22% reported eating raw oysters. Among the Hispanic participants, 13% reported consuming raw oysters.

A majority of the 2007 respondents in southern California were female (61%). Results of this 2007 survey indicated that gender had a significant impact on raw oyster consumption (Table 3). Approximately 9% of the male respondents reported eating raw oysters, while 7% of the female respondents reported eating them.

Thirty-six percent of the 2007 respondents reported annual household incomes exceeding $75,000 (Table 4). The results of this survey showed that annual household income and raw oyster consumption were significantly related in southern California in 2007. More than 7% of respondents who earned more than

Table 3. Number and percent of all respondents in 2007 survey by gender and raw oyster consumption.

Gender	Nonconsumer (N=355)		Consumer (N=69)		Total (N=423)	
	no.	%	no.	%	no.	%
Male	127	30.0	37	8.7	164	38.8
Female	228	53.9	31	7.3	259	61.2
Total	355	83.9	68	16.1	423	100.0
Chi-square value = 13.425 ***						

*** The chi-square values of the 2007 survey results were significant at 0.001.

Table 4. Number and percent of all respondents in 2007 survey by annual household income and raw oyster consumption.

Income	Nonconsumer (N=355)		Consumer (N=69)		Total (N=424)	
	no.	%	no.	%	no.	%
Less than $25,000	51	17.6	11	3.8	62	21.5
$25,000-$50,000	62	21.5	8	2.8	70	24.2
$50,001-$75,000	48	16.6	5	1.7	53	18.3
$75,001-$100,000	29	10.0	6	2.1	35	12.1
More than $100,000	48	16.6	21	7.3	69	23.9
Total	238	82.4	51	17.6	289	100.0
Chi-square value = 14.290 *						

* The chi-square values of the 2003 survey results were significant at 0.05.

Table 5. Number and percent of nonconsumers by reason for not eating raw oysters.

Reason	2003 Survey (N=56)		2007 Survey (N=355)	
	no.	%	no.	%
Think would taste bad	15	26.8	116	32.7
Appearance	35	62.5	114	32.1
Slimy	27	48.2	106	29.9
Personal safety and concerns/illness, not allergies	20	35.7	83	23.4
Smell	22	39.3	78	22.0
Aversion to new things (No specific reasons)	10	17.9	75	21.1
Color	11	19.6	64	18.0
Think grit, sandy/internal waste is bad	19	33.9	63	17.7
Allergies (doctor's advice/ personal experience)	5	8.9	37	10.4
Doctor's advice due to illness	2	3.6	32	9.0
Price of oysters	9	16.1	31	8.7
Not sure where to get them	6	10.7	—	—
Don't know what to do with them	1	1.8	—	—

$100,000 per year consumed raw oysters. Less than 4% of respondents who belonged to the lower income groups reported eating raw oysters.

Reasons for not eating raw oysters — Participants who reported not eating raw oysters represent large market segments consisting of 84% of the 2007 southern California respondents and 31% of the 2003 Western International Seafood Show attendees. Reasons cited by these respondents could be important for oyster industry and seafood professionals to carefully consider in further product development and promotion of oyster products.

Decisions not to consume a certain product could be driven by the consumers' own perceptions about oysters. During the surveys, the participants were asked to reveal their reasons for not eating raw oysters (Table 5). Following are several reasons and the percent of nonconsumers who reported them in 2003 and 2007, respectively:

- Think that oysters would taste bad (27%, 33%);
- Appearance of oysters (63%, 32%);
- Oysters are slimy (48%, 30%);
- Smell of oysters (39%, 22%);
- Color of oysters (20%, 18%);
- Think grit, sandy or internal waste is bad (34%, 18%); and
- Price of oysters (16%, 9%).

Personal characteristics of individuals could influence their decisions not to consume a certain product. Survey respondents were asked to indicate their own personal characteristics that influenced their decisions not to eat raw oysters. Following are several personal characteristics cited by nonconsumers and the percent who reported them in 2003 and 2007, respectively:

- Personal safety and concerns or illness, not allergies (36%, 23%);
- Aversion to new things, no specific reasons (18%, 21%);
- Allergies, doctor's advice, or personal experience (9%, 10%); and
- Doctor's advice due to illness (4%, 9%).

Bacterial and viral food safety concerns — Consumption decisions regarding raw oysters could be driven by food safety bacterial and viral concerns associated with the products. Participants from southern California during the 2003 survey were asked to specify their primary food safety concerns associated with eating raw oysters (Table 6).

The most frequently cited food safety concern was *Escherichia coli* (33%), with oyster consumers voicing higher levels of concern (26%) than nonconsumers (7%). About 28% of the respondents were concerned

Table 6. Number and percent of all respondents in 2003 survey by food safety bacterial and viral concerns.

Concern	Nonconsumer (N=56)		Consumer (N=127)		Total (N=183)	
	no.	%	no.	%	no.	%
Escherichia coli *	12	6.6	48	26.2	60	32.8
Salmonella	12	6.6	40	21.9	52	28.4
Vibrio vulnificus	11	6.0	27	14.8	38	20.8
Hepatitis virus	8	4.4	26	14.2	34	18.6
Vibrio parahaemolyticus	7	3.8	19	10.4	26	14.2
Vibrio cholera	6	3.3	19	10.4	25	13.7
Listeria monocytogenes	7	3.8	16	8.7	23	12.6
Norwalk virus	2	1.1	9	4.9	11	6.0

* The chi-square values were significantly different at 0.05.

Table 7. Number and percent of respondents who consumed raw oysters in 2003 survey by reason for eating the product.

Reason for eating	Number (n=127)	Percent
Tastes good	95	74.8
Fun to eat	67	52.8
Nutritional benefits	40	31.5
Habit (become used to eating oysters)	12	9.4
Believe to be an aphrodisiac	10	7.9
Image (peer pressure)	10	7.9

Table 8. Number and percent of respondents who consumed raw oysters by annual frequency of eating the product.

Frequency	2003 Survey (N=127)		2007 Survey (N=69)	
	no.	%	no.	%
Less than six times a year	33	26.0	50	79.4
Six times a year	47	37.0	5	7.9
Twelve times a year	9	7.1	3	4.8
Weekly	31	24.4	2	3.2
Daily	7	5.5	3	4.8
Total	127	100.0	63	100.0

about Salmonella; 21%, *Vibrio vulnificus*; 19%, Hepatitis virus; 14%, *Vibrio cholera* and *parahaemolyticus*; 13%, *Listeria monocytogenes*; and 6%, Norwalk virus.

Reasons for eating raw oysters — Consumption of raw oysters was driven by the respondents' perceptions about oysters. In the 2003 survey, southern California respondents who ate raw oysters specified three major raw oyster properties that influenced their decisions to eat them (Table 7). Three-fourths of the consumers stated that they ate raw oysters because "oysters taste good." About 53% of the consumers indicated that "oysters are fun to eat," and 31% said "oysters have nutritional benefits." Other reasons for liking raw oysters included "habit or becoming used to eating oysters" (9%), "oysters are believed to be aphrodisiac" (8%), and "image or peer pressure" (8%).

Frequency of eating raw oysters — Southern California residents who reported eating raw oysters during the 2003 and 2007 surveys consumed the products at different annual frequencies (Table 8). Among the 127 respondents who reported eating raw oysters during the 2003 survey, 37% ate them six times a year, while 26% ate them less than six times a year. Some respondents consumed raw oysters more often — monthly (7%), weekly (24%), and daily (6%).

Sixty-nine southern California residents identified themselves as raw oyster consumers during the 2007 survey. More than 79% of these respondents indicated that they consumed raw oysters less than six times a year, while 8% had them six times a year or more. Some ate raw oysters daily (5%), weekly (3%), or monthly (5%).

In the 2007 survey, respondents were asked, "On average, how many whole oysters did you eat each time?". Their responses ranged from one to 12 whole oysters, averaging 5.72 ± 3.56 whole oysters.

Table 9. Number and percent of all respondents by awareness of potential risks associated with eating raw oysters.

Awareness	Nonconsumer		Consumer		Total	
	no.	%	no.	%	no.	%
2003 Survey						
Not aware	21	11.5	39	21.3	60	32.8
Aware	34	18.6	88	48.1	122	66.7
Don't know/not sure	1	0.5	0	0.0	1	0.5
Total	56	30.6	127	69.4	183	100.0
Chi-square value = 2.976 [ns]						
2007 Survey						
Not aware	156	36.8	24	5.7	180	42.5
Aware	188	44.3	44	10.4	232	54.7
Don't know/not sure	11	2.6	1	0.2	12	2.8
Total	355	83.7	69	16.3	424	100.0
Chi-square value = 4.766 [ns]						

[ns] The chi-square values were not significant at 0.05.

Table 10. Number and percent of all respondents who would eat more raw oysters if health and safety concerns were reduced or eliminated.

Decision	Nonconsumer		Consumer		Total	
	no.	%	no.	%	no.	%
2003 Survey						
Will not eat more	33	18.0	29	15.8	62	33.9
Will eat more	11	6.0	89	48.6	100	54.6
Don't know/not sure	12	6.6	9	4.9	21	11.5
Total	56	30.6	127	69.4	183	100.0
Chi-square value = 40.988 ***						
2007 Survey						
Will not eat more	0	0.0	29	6.8	29	6.8
Will eat more	0	0.0	30	7.1	30	7.1
Don't know/not sure	355	83.7	10	2.4	365	86.1
Total	355	83.7	69	16.3	424	100.0
Chi-square value = 384.145 ***						

*** The chi-square values were significant at 0.001.

Table 11. Number and percent of respondents who consumed raw oysters by source of the product.

Sources	2003 Survey (N=127)		2007 Survey (N=69)	
	no.	%	no.	%
Restaurant	105	82.7	50	72.5
Oyster bar	65	51.2	6	8.7
Seafood market	42	33.1	15	21.7
Retail grocery store	10	7.9	2	2.9
Direct from the dock	9	7.1	3	4.3
Recreational catch	8	6.3	1	1.4

Potential risks of eating raw oysters — Awareness of the potential risks associated with eating raw oysters would enable consumers to make consumption decisions. Most southern California respondents during the 2003 survey (67%) and the 2007 survey (55%) were aware of the potential risks of eating raw oysters (Table 9). Results of both surveys, however, showed that consumption of raw oysters was not significantly related to the awareness of these potential risks.

Changes in the perceptions of the potential risks associated with raw oysters would alter consumer preferences with regards to raw oyster consumption. Approximately 55% of southern California respondents in 2003 and 7% in 2007 said they would eat more raw oysters if their health and safety concerns were reduced or eliminated (Table 10). During the 2003 survey, 49% of raw oyster consumers and 6% of nonconsumers said they would eat more raw oysters if their concerns were reduced or eliminated. In the 2007 survey, 7% of raw oyster consumers said they would eat more raw oysters if their concerns were adequately addressed; none of the nonconsumers said they would change their preferences. About 18% of the nonconsumers in 2003 and 7% of raw oyster consumers in 2007 said they were not interested in eating more raw oysters.

Sources of raw oysters for consumption — The decisions made by respondents to consume raw oysters could be related to their sources of the product. A large majority of southern California raw oysters consumers in the 2003 and 2007 surveys preferred to buy most of their oysters from restaurants (Table 11). The next most preferred sources were oyster bars and seafood markets. Consumers bought some raw oysters from retail grocery stores or directly from the dock. Some consumers ate oysters caught recreationally.

When asked about the sources of the raw oysters they ate in the previous year, consumers provided some insights about the geographical origins of their oysters. About 42% of raw oyster consumers either did not know, were not sure, or did not respond to this question. Thirty percent said that the raw oysters they consumed came from the Pacific Coast. Twenty percent indicated that their oysters came from the Gulf Coast. The remaining 8% reported eating raw oysters from the Atlantic Coast.

The year-round availability of the product would alter southern California consumers' preferences with regards to raw oyster consumption. More than 44% of all 2003 survey respondents and 9% of all 2007 survey respondents said they would eat more raw oysters if they become widely available (Table 12). Among raw oyster consumers, 42% in 2003 and 9% in 2007 said they would eat more raw oysters if they become available year-round. However, some raw oyster consumers — more than 13% in 2003 and 5% in 2007 — were not interested in eating more raw oysters even if the product becomes available year-round.

Table 12. Number and percent of all respondents who would eat more raw oysters if they were available year-round.

Decision	Nonconsumer		Consumer		Total	
	no.	%	no.	%	no.	%
2003 Survey						
Will not eat more	10	5.5	24	13.1	34	18.6
Will eat more	5	2.7	76	41.5	81	44.3
Don't know/not sure	41	22.4	27	14.8	68	37.2
Total	56	30.6	127	69.4	183	100.0
Chi-square value = 56.1999 ***						
2007 Survey						
Will not eat more	0	0.0	22	5.2	22	5.2
Will eat more	0	0.0	36	8.5	36	8.5
Don't know/not sure	355	83.7	11	2.6	366	86.3
Total	355	83.7	69	16.3	424	100.0
Chi-square value = 384.145 ***						

*** The chi-square values were significant at 0.001.

Table 13. Number and percent of all respondents in 2003 survey by awareness of different types of postharvest-processed raw oysters.

Product	Nonconsumer (N=56)		Consumer (N=127)		Total (N=183)	
	no.	%	no.	%	no.	%
High hydrostatic pressurized (HHP) [ns]	17	30.4	46	36.2	63	34.4
Heat-cool pasteurized (HCP) [ns]	15	26.8	44	34.6	59	32.2
Individually quick frozen (IQF) [ns]	12	21.4	33	26.0	45	24.6

[ns] The chi-square values were significant at 0.05.

Table 14. Number and percent of all respondents in 2003 survey by source of information about postharvest-processed raw oysters.

Information source	Number (n=183)	Percent
Trade shows	54	29.5
Magazines	25	13.7
Conferences	24	13.1
Somebody told me	20	10.9
Newspapers	13	7.1
Scientific journals	13	7.1
Television	6	3.3
Radio	4	2.2
Brochures	3	1.6
Symposia	2	1.1

Postharvest-Processed Raw Oysters

Product awareness — The willingness to buy and to pay for PHP oyster products could be related to consumer awareness of the availability of these products. Southern California respondents during the 2003 survey reported they were not widely aware of the availability of PHP raw oyster products (Table 13). More than one-third of all respondents were familiar with raw oysters processed with the high-hydrostatic-pressure (HHP) method. Thirty-two percent of respondents knew about heat-cool pasteurization (HCP) of raw oysters. Less than 25% of respondents said they knew of individually quick-frozen (IQF) raw oysters. The levels of awareness about PHP raw oysters were similar between nonconsumers and consumers of raw oysters during the 2003 survey.

Respondents in the 2003 southern California survey received information about PHP methods through a wide variety of delivery methods. The most widely cited means of delivery were trade shows (30%), magazines (14%), conferences (13%), and word of mouth (11%) (Table 14). Other delivery methods used by less than 10% of respondents were newspapers, scientific journals, television, radio, brochures, and symposia.

Willingness to buy — When asked about their willingness to buy PHP oyster products, less than 35% of all respondents in 2003 and less than 9% of all respondents in 2007 were interested in buying the different PHP products (Table 15). However, statistically significant differences were observed between consumers and nonconsumers in willingness to buy (WTB) each of the three PHP raw oyster products. The scale used to measure WTB in the 2003 survey was 0–5 with "0 = not interested" and "5 = very interested." In the 2007 survey, WTB was measured as a 0–1 scale with "1 = willing to buy" and "0 = not willing to buy." The 2003 results were converted into the 2007 scale by using this conversion procedure: "0–2 = not willing to buy" and "3-5 = willing to buy."

Thirty-four percent of respondents in 2003 and 8% in 2007 said they were willing to buy HHP raw oysters. Raw oysters consumers showed more interest in this product than nonconsumers. Among raw oyster consumers, about 44% in 2003 and 48% in 2007 said they were interested in buying HHP products. The willingness to pay (WTP) for HHP raw oyster products reported by 22% (n = 40) of the 2003 respondents ranged from $3.20 to $25 per dozen if bought in supermarkets. There were no significant differences in WTP reported by consumers and nonconsumers of raw oysters. The average and standard deviation of WTP were $7.19 ± $5.58 per dozen. Estimates made by Posadas and Posadas (2004) on the average costs of HHP oyster processing were between $0.17 and $0.30 per half-shell oyster or between $2.04 and $3.60 per dozen.

Slightly more than 30% of all respondents in 2003 and 7% in 2007 said they were interested in buying HCP raw oysters. Raw oyster consumers were more willing to buy this product than nonconsumers. At least 35% of raw oyster consumers in the two surveys said they would buy PHP products. The WTP for HCP raw oyster products reported by 20% (n = 36) of the 2003 survey respondents ranged from $2 to $40 per dozen if bought in supermarkets. Due to large variations, we observed no significant differences in WTP between consumers and nonconsumers of raw oysters. The average and standard deviation of WTP of HCP raw oysters were $7.68 ± $6.85 per dozen. Due to the presence of a few extremely high lower and upper values of WTP for

this product, it would be necessary to use further econometric modeling to eliminate them to reduce respondents' bias for this type of product. The estimated average HCP oyster processing costs averaged from $0.17 to $0.25 per half-shell oyster or from $2.04 to $3.00 per dozen (Posadas and Posadas, 2004).

About 27% of all respondents in 2003 and 6% in 2007 said they were interested in buying the IQF raw oysters. Raw oyster consumers showed stronger interest in this type of PHP product than nonconsumers. At least one-third of raw oyster consumers in the two surveys said they would be interested in buying IQF products. The WTP for HHP raw oysters ranged from $3.50 to $20 per dozen if bought in supermarkets. There were no significant differences in WTP between consumers and nonconsumers. The average and standard deviation of WTP for this type of PHP oyster product were $6.09 ± $3.67 per dozen, as reported by 18% (n = 33) of 2003 survey respondents. Average IQF processing costs ranged from $0.16 to $0.27 per half-shell oyster or from $1.92 to $3.24 per dozen (Posadas and Posadas, 2004).

Consumer Packaging Preferences — Packaging of PHP raw oysters varies among market outlets. PHP products are differentiated from non-PHP raw oysters by the way the products are labeled and tagged. When asked about their packaging preferences for whole PHP raw oysters at supermarkets or seafood stores, 23% of the 2003 southern California survey respondents said they preferred the traditional sack packaging. Respondents suggested other preferred types of packaging for whole PHP raw oysters, including "vacuum packed" (19.1%), "packed in solid boxes" (16.9%), "packaged loose in plastic containers" (9.3%), and "clean plastic tubes" (3.8%).

2003 survey respondents were asked about their preferred methods of packaging for half-shell PHP raw oysters at supermarkets or seafood stores. The three most preferred packaging methods were "shrink-wrapped trays in solid boxes," "vacuum-packed in solid cardboard box with a window," and "shrink-wrapped trays in solid boxes with a window." Each of these methods was selected by 16.4% of the 2003 southern California respondents. Twelve percent of the respondents said they preferred the other packaging method for half-shell PHP oysters, "vacuum-packed in a solid cardboard box."

Twenty-four percent of the 2003 respondents said they preferred a pint-sized plastic container when buying PHP shucked raw oysters at supermarkets or seafood stores. The other preferred plastic container sizes were quart, 14.8%; half gallon, 9.3%; and gallon, 8.2%.

Consumption of PHP Raw Oyster Products — Respondents in 2003 reported significant consumption of PHP raw oyster products. More than 20% (n = 37) of all 183 respondents reported that they had eaten pressurized PHP raw oyster products in the year before the 2003 survey. About 18% (n = 33) of the respondents reported consuming pasteurized PHP raw oysters. More than 16% (n = 30) of the 2003 southern California respondents said they had consumed individually quick-frozen PHP raw oysters.

We identified specific PHP oyster market segments in southern California by comparing traditional raw oyster consumption behavior of the 2003 respondents with specific PHP raw oyster consumption behavior. Traditional raw oyster consumers could be defined as those respondents who reported consuming raw oysters when the surveys were conducted. PHP raw oyster consumers, on the other hand, are those respondents who consumed PHP raw oyster products the year before the survey was conducted.

Sixty-nine percent (n = 127) of all 2003 respondents reported consuming raw oysters when the survey

Table 15. Number and percent of all respondents by willingness to buy postharvest-processed raw oysters.

Oyster products	Nonconsumer		Consumer		Total	
	no.	%	no.	%	no.	%
2003 Survey[1]						
High hydrostatic pressurized (HHP)	7	3.8	56	30.6	63	34.4
Heat-cool pasteurized (HCP)	10	5.5	45	24.6	55	30.1
Individually quick frozen (IQF)	7	3.8	42	23.0	49	26.8
Chi-square values = 19.559**, 7.368*, 9.609*						
2007 Survey[2]						
High hydrostatic pressurized (HHP)	2	0.5	33	7.8	35	8.3
Heat-cool pasteurized (HCP)	1	0.2	29	6.8	30	7.1
Individually quick frozen (IQF)	0	0.0	26	6.1	26	6.1
Chi-square values were not acceptable since some cells have fewer than five observations.						

***, * The chi-square values were significant at 0.001 and 0.05.
[1]Nonconsumer (N=56); Consumer (N=127); and Total (N=183).
[2]Nonconsumer (N=355); Consumer (N=69); and Total (N=424).

was conducted. Within this group of traditional raw oyster consumers, we identified specific market segments of PHP raw oyster products. These market segments consisted of those consumers of traditional raw oysters who would also consume PHP raw oyster products:

- Thirty consumers (16.4% of the total 2003 sample) reported consuming both traditional raw oysters and HHP raw oyster products.
- Thirty-three consumers (14.8% of the 2003 sample) reported consuming both HCP raw oyster products and traditional raw oysters.
- Twenty-seven consumers (14.8% of the 2003 sample) reported consuming both traditional raw oysters and IQF raw oyster products.

Thirty-one percent (n = 56) of all the 2003 southern California respondents reported not consuming traditional raw oysters. Within this group of nonconsumers of traditional raw oysters, we discovered additional specific market segments of PHP raw oyster products. These PHP oysters market segments included those currently not consuming traditional raw oysters but who would consume PHP raw oyster products:

- Seven respondents (3.8% of the total 2003 sample) reported not consuming traditional raw oysters but were consuming HHP raw oyster products.
- Six respondents (3.3% of the 2003 sample) reported consuming HCP raw oyster products but were not consuming traditional raw oysters.
- Three respondents (1.6% of the 2003 sample) reported consuming IQF raw oyster products but were not consuming traditional raw oysters.

Southern California respondents cited several factors in 2003 that might change their minds about trying PHP raw oysters. Fourteen percent of the respondents said they would consider eating PHP raw oysters if "recommended by a friend or family member," making this the most frequently considered type of inducement. "Education on health benefits" and "guarantee of safe product" were each cited by 12% of all the respondents. At least 7% of respondents would consider eating PHP raw oysters as a result of "good presentation," "good advertising on nutritional values," and "get paid to try eating." Other inducements to consume PHP oyster products selected by less than 6% of respondents are shown in Table 16.

Table 16. Number and percent of respondents in 2003 survey by type of inducement to consume postharvest-processed raw oysters.

Inducement	Nonconsumer (N=56)		Consumer (N=127)		Total (N=183)	
	no.	%	no.	%	no.	%
Recommended by a friend or family member	7	3.8	18	9.8	25	13.7
Education on health benefits	4	2.2	18	9.8	22	12.0
Guarantee of a safe product	7	3.8	15	8.2	22	12.0
Good presentation	3	1.6	12	6.6	15	8.2
Good advertising on nutritional values	2	1.1	11	6.0	13	7.1
Get paid to try eating	9	4.9	4	2.2	13	7.1
Product should be labeled as treated	4	2.2	6	3.3	10	5.5
Knowledge where to get or buy	3	1.6	4	2.2	7	3.8
Use of winter oysters	1	0.5	1	0.5	2	1.1

Summary and Implications

With increasing regulations imposed by federal and state agencies on raw oyster products produced by the Gulf of Mexico states, an evaluation was needed of traditional raw oyster consumption behavior and potential markets for PHP raw oyster products in Western states, particularly in southern California. Consumer preferences for traditional and PHP raw oyster products were evaluated from survey results conducted in October 2003 and June 2007.

Consumers' personal characteristics and their perceptions about the characteristics of oysters were significantly related to decisions to consume traditional raw oysters and willingness to buy and to pay for PHP products. Traditional raw oyster consumption behavior revealed during the 2003 personal interviews was strongly related to the age and ethnic origin of respondents. Raw oyster consumption decisions documented in the 2007 telephone interviews were significantly related to the gender and household income of participants. The percent of raw oyster consumers was higher among older respondents. More male respondents consumed raw oysters than female respondents.

Survey results indicated that at least 20% of the southern California respondents consumed raw oysters from the Gulf of Mexico states. These survey participants reported consuming raw oysters about six times each year. At most, 9% of the respondents who did not consume raw oysters said they would eat them if the shellfish were more widely available. However, at least 52% of raw oyster consumers said they would eat more if the product became available year-round. If health and safety concerns were reduced or eliminated, up to 20% of nonconsumers said they would try raw oysters. On the other hand, at least 43% of raw oyster consumers reported that they would consume more if health and safety concerns were reduced or eliminated.

Respondents reported significant awareness, willingness to buy, and consumption of PHP raw oyster products in southern California. Participants reported receiving information about raw oyster PHP methods through a wide variety of delivery methods. The most widely used means of delivery were trade shows, magazines, conferences, and word of mouth.

We identified several raw oyster market segments from the personal characteristics and perceptions about raw oysters reported by participating southern California respondents. We also identified specific PHP raw oyster market segments from the consumption behavior reported by the survey participants. Processors of PHP raw oyster products have the potential to increase sales quantity and revenue by responding to the market segments identified in these surveys. The processing margins for PHP raw oyster products, however, could be considerably reduced to cover the added costs of postharvest processing raw oyster products.

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APPENDIX A. OYSTER CONSUMPTION SURVEY

POSTHARVEST RAW OYSTER CONSUMPTION SURVEY

The aim of this survey is to evaluate consumer attitudes and preferences toward postharvest processed raw oyster products. Your response to this survey is anonymous. Please answer the following questions, giving your best estimate where exact answers are not known. These questions are very important, they will help us relate your responses to characteristics of your household.

We thank you for your participation in this survey.

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POSTHARVEST RAW OYSTER CONSUMPTION SURVEY

Please answer the following questions by checking [✓] the appropriate box or boxes (☐).

RESPONDENT CHARACTERISTICS

Age
- ☐ 18-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60 & above

Marital Status
- ☐ Single
- ☐ Married
- ☐ Divorced
- ☐ Widowed
- ☐ Separated

Race
- ☐ Caucasian
- ☐ African American
- ☐ Hispanic
- ☐ Native American
- ☐ Asian or Pacific Islander
- ☐ Others _____

Household Income ($/year)
- ☐ <$20,000
- ☐ 20-39K
- ☐ 40-59K
- ☐ 60-79K
- ☐ 80-99K
- ☐ 100-120K
- ☐ >$120,000

Formal education completed
- ☐ Elementary
- ☐ High school
- ☐ Some college, Junior college, vocational school
- ☐ Completed college (BA, BS)
- ☐ Advance degree (MS, MBA, Ph. D, MD, Law degree, etc.)

Gender
- ☐ Male
- ☐ Female

Number of persons in your household _____

Do you eat raw oysters?
- ☐ Yes
- ☐ No

RAW OYSTER CONSUMPTION

What are the main reasons you do not eat raw oysters? (Check all that apply)
- ☐ Appearance
- ☐ Smell
- ☐ Slimy
- ☐ Color
- ☐ Think would taste bad
- ☐ Think grit, sandy/internal waste is bad
- ☐ Aversion to new things (no specific reasons)
- ☐ Allergies (Doctor's advice/Personal Experience)
- ☐ Not sure where to get them
- ☐ Doctor's advice due to illness
- ☐ Don't know what to do with them
- ☐ Personal safety and concerns/illness, not allergies
- ☐ Price of raw oysters
- ☐ Others, please specify _____

What are your primary food safety bacterial and viral concerns about eating raw oysters? (Check all that apply)
- ☐ E. coli
- ☐ Vibrio vulnificus
- ☐ Vibrio parahaemolyticus
- ☐ Salmonella
- ☐ Listeria monocytogenes
- ☐ Vibrio cholera
- ☐ Hepatitis virus
- ☐ Norwalk virus
- ☐ Others, please specify _____

What are the main reasons why you eat raw oysters? (Check all that apply)
- ☐ Nutritional benefits
- ☐ Fun to eat
- ☐ Tastes good
- ☐ Habit (Become used to eating oysters)
- ☐ Image (Peer pressure)
- ☐ Believed to be an aphrodisiac
- ☐ Price of raw oysters
- ☐ Others, please specify _____

How often did you eat raw oysters during the past year?
- ☐ Never
- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Three times a year
- ☐ Six times a year
- ☐ Once a year
- ☐ Others _____

Are you aware of potential health risks with eating raw oysters?
☐ Yes ☐ No ☐ Don't know/Not sure

Would you eat raw oysters more often if they were readily available year round?
☐ Yes ☐ No ☐ Don't know/Not sure

Would you eat raw oysters more often if health and safety concerns were reduced or eliminated?
☐ Yes ☐ No ☐ Don't know/Not sure

SOURCES OF RAW OYSTERS

Where do you usually purchase raw oysters for consumption? (Check all that apply)
- ☐ Restaurant
- ☐ Oyster Bar
- ☐ Seafood market
- ☐ Retail Grocery Store
- ☐ Recreational catch
- ☐ Direct from the dock
- ☐ Do not purchase raw oysters
- ☐ Others, please specify _____

Please turn to the next page at the back.

POSTHARVEST RAW OYSTER CONSUMPTION SURVEY

Do you know where the raw oysters that you ate last year came from? (Check all that apply)

- ☐ Gulf Coast
- ☐ Atlantic Coast
- ☐ Pacific Coast
- ☐ Don't know/Not sure
- ☐ Other, please specify_____

POSTHARVEST PROCESSING OF RAW OYSTERS

Presently, there are different methods of processing oysters that render them safe and leave no detectable levels of harmful bacteria. Are you aware of processed or treated raw oysters? (Check all that apply)

- ☐ Pressure treated (Whole/Shucked/Half shell)
- ☐ Pasteurized (In-shell/Shucked)
- ☐ Heat shocked (In-Shell/Shucked)
- ☐ Individually quick frozen (IQF)

How did you learn about processed or treated raw oyster products? (Check all that apply)

- ☐ Magazines ☐ Television
- ☐ Radio ☐ Somebody told me
- ☐ Newspapers ☐ Scientific Journals
- ☐ Conferences ☐ Symposia
- ☐ Trade Shows ☐ Brochures
- ☐ Others, please specify_____

Do you believe that there are methods that can safely render harmful bacteria to non-detectable levels in raw oyster products?

☐ Yes ☐ No ☐ Don't know/Not sure

If yes, would you like to purchase any of the processed or treated raw oyster products? (Check all that apply)

- ☐ Whole/Full Shell
- ☐ Half-Shell
- ☐ Shucked

Please indicate your interest in buying the following processed or treated raw oyster products. (Encircle all that apply, where 0= not interested ,…, 5= very interested)

Pressure treated	0 1 2 3 4 5
Pasteurized	0 1 2 3 4 5
Heat shocked	0 1 2 3 4 5
Individually quick frozen	0 1 2 3 4 5

How much would you be willing to pay for a dozen processed or treated raw oysters in half shell if purchased in supermarkets? (Answer all that apply)

Pressure treated	_____ $/dozen
Pasteurized	_____ $/dozen
Heat shocked	_____ $/dozen
Individually quick frozen	_____ $/dozen

Have you eaten the following processed or treated raw oyster products during the past year? (Check all that apply)

- ☐ Pressure treated
- ☐ Pasteurized
- ☐ Heat shocked
- ☐ Individually quick frozen

PACKAGING PREFERENCES

Packaging of processed or treated oysters varies when sold at different market outlets. They are differentiated from the traditional (unprocessed) oysters by the way the products are labeled and tagged. If you like to buy whole/full shell processed raw oysters, what type of packaging would you prefer when buying at supermarkets or seafood stores? (Check all that apply)

- ☐ Packed in sacks (Traditional)
- ☐ Packed in solid boxes
- ☐ Packaged loose in plastic containers
- ☐ Vacuum packed
- ☐ Clean plastic tubes
- ☐ Others, please specify_____

If you like to buy half shell processed or treated raw oysters, what type of packaging would you prefer when buying at supermarkets or seafood stores? (Check all that apply)

- ☐ Shrink wrapped trays in solid boxes
- ☐ Shrink wrapped trays in cardboard boxes with a window
- ☐ Vacuum packed in solid cardboard box
- ☐ Vacuum packed in solid cardboard box with a window
- ☐ Others, please specify_____

If you like to buy processed shucked raw oysters, what type of packaging would you prefer when buying at supermarkets or seafood stores? (Check all that apply)

- ☐ Packed in plastic containers (Traditional)
  - ☐ Gallon
  - ☐ Half Gallon
  - ☐ Quarts
  - ☐ Pint
- ☐ Others, please specify_____

If you don't eat raw oysters, what can change your mind to try and eat processed or treated raw oysters? (Check all that apply)

- ☐ Recommended by a friend or family member
- ☐ Good presentation
- ☐ Education on health benefits
- ☐ Good advertising on nutritional values
- ☐ Guarantee of a safe product
- ☐ Get paid to try eating
- ☐ Knowledge where to get or buy treated product (availability)
- ☐ Product should be labeled "treated"
- ☐ Use of winter oysters
- ☐ Others, please specify _____

Thank you very much for your participation. Please return this questionnaire to Booth Number 747 or 749.

Mississippi Department of Marine Resources
Mississippi State University-Coastal Research and Extension Center

Respondent's Number _____

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