ASSESSMENT STUDIES FOR POST-HARVEST (PHP) OYSTERS:

Part 1. Consumer and Expert Sensory Assessments

Joint Project conducted for the
Interstate Shellfish Sanitation Conference (ISSC)

Steve Otwell, Laura Garrido, Victor Garrido and Dr. Charlie Sims
Food Science and Human Nutrition Department
University of Florida

Final Report

May 2011

ASSESSMENT STUDIES FOR POST-HARVEST (PHP) OYSTERS:

Part 1. Consumer and Expert Sensory Assessments

Acknowledgements

This project would not have been possible without collaborative assistance by numerous individuals with special talents and shared concerns for the oyster industry and consumer health. Participants included:

Charlene Burke, University of Florida, Apalachicola, FL. Served as technical advisor and assisted in coordination and logistics of product.

David Heil, FL Department of Agriculture and Consumer Service, Tallahassee, FL. Served as a regulatory advisor to the project.

Rick Hunter, Food Technology Service, Inc. Provided plant time and personnel for Gamma Irradiation (GI) oyster process.

Jim Jones, Food Technology Service, Inc. Provided plant time and personnel for Gamma Irradiation (GI) oyster process.

Grady Leavins, Leavins Seafood, Inc., Apalachicola, FL. Served as an industry advisor to the project.

William T. Mahan, Sea Grant College Program, Apalachicola, FL. Served as technical advisor and local liaison for the project.

Michael Voisin, Motivatit Seafood, Inc. Houma, LA. Provided plant time and personnel for high pressure (HP) oyster processing.

Tommy Ward, Buddy Ward and Sons Seafood, Inc. Apalachicola, FL. Provided access to the company's oyster lease and harvest vessel necessary for the product procurement.

T.J. Ward and Jordan Todd, Apalachicola, FL. Served as expert shuckers for the project.

Robert Webb, Webb's Seafood, Inc. Youngstown, FL. Provided plant time and personnel for Heat Intervention (HI) and Low Temperature Freezing (LTF) oyster processing.

ASSESSMENT STUDIES FOR POST-HARVEST (PHP) OYSTERS:

Part 1. Consumer and Expert Sensory Assessments

TABLE OF CONTENTS

ASSESSMENT STUDIES FOR POST-HARVEST (PHP) OYSTERS:

Part 1. Consumer and Expert Sensory Assessments

Executive Summary

Persistent concerns for illnesses associated with certain consumers eating raw oysters harvested during the warmer months about the Gulf of Mexico are calling for more use of post-harvesting processing (PHP) methods that reduce or eliminate the microbial culprits, *Vibrio vulnificus and Vibrio parahaemolyticus*. While the PHP methods can provide reduction of the bacterial concerns they can also introduce changes in the sensory attributes of the raw oysters that could influence consumer acceptance. The successful implementation of PHP methods will depend on consumer preferences and acceptance. This situation calls for a non-biased, science-based study to determine consumer preferences and acceptance for PHP versus traditional processed oysters destine for raw consumption.

In response, a series of consumer and expert sensory assessments were conducted to better understand the sensory consequences that influence acceptance and preferences for PHP oysters. The approach involved raw oysters, *Crassostera virginica* harvested from a single site and single time to assure a homogenous product that had been pre-screened for customary product quality as associated with summer harvest. The products were subject to a continuous chain of custody to assure product identity and appropriate handling during four validated PHP operations (HP –high pressure, LTF –low temperature freezing, GI – gamma irradiation and MH – mild heat). The volume of product harvested allowed assessments through 14 days of storage after processing.

Consumer preferences and acceptance were determined based on paired comparison tests and acceptability ratings. All comparisons used half-shelled oysters from the same homogenous harvest. Raw oysters from untreated, traditional (T) processing were compared with each of the four PHP methods. The intent was to assess preferences and acceptance for traditional verses PHP oysters rather than comparisons amongst PHP products. Comparison trials were conducted after 7 and 14 days storage utilizing the same number (approx. 90 participants) of pre-screened consumers for both sessions. Concurrently, a trained expert oyster sensory panel provided sensory profiles for all oyster products based on an established set of product standards previously developed for raw oysters. The profiles provided an objective measure of factors that may influence consumer preference and acceptance.

Typical raw oyster consumers preferred the traditional raw oysters in comparisons with PHP oysters prepared from the same harvest during September from a typical Gulf of Mexico source (Apalachicola Bay, FL), yet this preference is diminished during prolonged refrigerated storage. The primary sensory attributes affecting preference were flavor and texture. These attributes are less distinguishable in comparisons between traditional and PHP oysters as the products aged in refrigeration. As a perishable product, the refrigerated oysters progressively change during storage. Apparently the changes caused a shift in product preference. In contrast, the preference for traditional oysters in comparisons with frozen PHP oysters (LFT) remained similar during storage as the frozen state preserves the oysters.

Despite the consumer preference expressed for traditional raw oysters during initial storage, the consumers rated all oyster products, both traditional and PHP, as acceptable. The acceptability ratings initially favored traditional raw oysters, as noted by the preference, but acceptability ratings became similar for all oyster products during more prolonged storage. Based on expert sensory profiling of the respective oyster products, the dominant sensory attributes affecting favorable acceptance were salty taste and less earthy tones in flavor and aroma.

These conclusions are based on a warm month harvest from the Gulf of Mexico. Harvest during other months with differing water temperatures that are known to influence the composition and sensory character of oysters could alter the results

Interest for implementation of PHP methods for raw oysters harvested during warm months about the Gulf of Mexico should recognize a distinct and demonstrated consumer preference for traditional, fresh (non-frozen) products, yet a clear acceptance for both traditional and PHP oysters. This situation provides opportunities to market oysters in both traditional and PHP forms to suit particular markets relative to consumer demand, cost, convenience, and regulatory guidance.

ASSESSMENT STUDIES FOR POST-HARVEST (PHP) OYSTERS:

Part 1. Consumer and Expert Sensory Assessments

Introduction

Persistent concerns for illnesses associated with certain consumers eating raw oysters harvested during the warmer months about the Gulf of Mexico are calling for more use of post-harvesting processing (PHP) methods that reduce or eliminate the microbial culprits, *Vibrio vulnificus and Vibrio parahaemolyticus*. The PHP methods in question include validated operations involving the application of mild temperatures, gamma irradiation, high pressure, or low temperature freezing. These methods are in various stages of commercial use and they have been validated in accordance with required analytical protocols to verify the reduction and/or elimination of the naturally occurring yet potentially pathogenic *Vibrio* bacteria. The traditional processing methods for untreated oysters do not incorporate a similar bacteria kill step.

While the PHP methods can provide reduction of the bacterial concerns they can also introduce changes in the sensory attributes of the raw oysters that could influence consumer acceptance. The successful implementation of PHP methods will depend on consumer preferences and acceptance. This situation calls for a non-biased, science-based study to determine consumer preferences and acceptance for PHP versus traditional processed oysters destine for raw consumption.

The objectives of this project were to measure consumer preference and acceptance for raw oysters from untreated, traditional (T) processing compared with each of the four PHP methods (MH- mild heat intervention, HP-high pressure, GI-gamma irradiation, and LTF-low temperature freezing) using live oysters from the same harvest based on paired comparison tests and acceptability ratings. The intent was to assess preferences and acceptance for traditional verses PHP oysters rather than comparisons amongst PHP products. Procedures incorporated shelf-life considerations during the consumer sensory testing to account for any changes in PHP product attributes versus the traditional raw oysters. The comparisons were conducted through two separate periods of storage common in summer commerce. In addition, the same traditional and respective PHP oyster products were formally evaluated for sensory characteristics (i.e., taste, aroma, color, and texture) based on the established oyster sensory profiling system developed for ISSC (http://fshn.ifas.ufl.edu/seafood). Sensory profiling can provide some explanation for any differences measured for consumer preference and acceptance.

Methodology

All project work depended on industry cooperation in procurement and processing of the raw oysters. The work was conducted in a manner to exemplify typical oyster processing and marketing practices through existing commercial operations. All oyster products and processing were subject to a chain of custody arrangement that included continuous participation and monitoring of all products by the project investigators from the moment of harvest through processing, distribution, storage and preparation for consumer testing and sensory profiling. This approach was necessary to assure proper care and identity of the original screened harvest through all stages of processing and distribution

All oysters (*Crassosteria virginica*) were harvested from approved waters with existing commercial procedures (small vessel dredging) from one selected site in Apalachicola Bay, Florida. The site was a private lease maintained by owner, Tommy Ward, in Apalachicola, Florida. This harvest site is identified by the official Florida state designation, FL-1632 L-525. Site selection involved pre-monitoring of weather conditions and on-site prescreening by the experienced project investigators to assure the live oysters had a consistent salt flavor not subject to freshwater exposure that tends to dilute flavors. The site selection was critical in terms of uniform product condition and quality. All oysters used in this study were from the same harvest site and could not be distinguished or culled by any quality differences at the moment of harvest. Simply stated, the oysters were a collection of similar, homogenous products.

The oysters were harvested in two installments, one on September 6th , 2010 and one on September 7th, 2010 (Table 1). Each harvest consisted of 15 bushels (900 lbs) that were collected in the morning and delivered to an approved processing plant (Tommy Ward's; 13 Mile) for an initial wash to remove external mud and debris. The washing procedure was a simple, short time rinse through a typical stainless-steel tumbling unit that applied a water spray on the surface of the oysters. Product post-harvest handling achieved an internal product temperature below 50^{o}F within 2 hours of delivery in accordance with the prevailing harvest regulations stipulated by the Florida Department of Agriculture and Consumer Services regulations (FL DOACS, 2009).

The quantity of harvest from the selected site and time was determined by the required amount of product for testing and to assure a simultaneous period of processing through the traditional and all PHP procedures within 48 hours post-harvest. The anticipate product volume and flow of work allowed two periods for sensory assessments for shelf-life consequences after 7 and 14 days post-harvest. The work plan is illustrated in Table 1.

Table 1. Illustration of the work schedule from harvest through respective processing methods and eventual consumer and expert assessments. Oysters for traditional (T) processing were collected simultaneously during each harvest September 6 and 7 (Harvest site – Apalachicola Bay, Florida site designation FL-1632 L-525)

<table>
<tr><th rowspan="2">Days in storage</th><th colspan="4">Post-Harvest Processing (PHP) Methods</th></tr>
<tr><th>HP</th><th>LTF</th><th>GI</th><th>MH</th></tr>
<tr><td>0</td><td colspan="2">Harvest and refrigeration</td><td>Harvest & transported to Panama City, FL - Iced and processed (stored at 0°F)</td><td>Harvest & transported to Panama City, FL - Iced</td></tr>
<tr><td>1</td><td>Transport to Houma, LA - Iced</td><td>Transported to Mulberry, FL - Iced</td><td>Transported to Gainesville, FL – Dry ice</td><td>Processed and transported to Gainesville, FL - Iced</td></tr>
<tr><td rowspan="2">2</td><td>Processed and transported to Gainesville, FL - Iced</td><td>Processed and transported to Gainesville, FL - Iced</td><td rowspan="2">Frozen storage (0°F)</td><td rowspan="2">Refrigerated storage (35°F)</td></tr>
<tr><td colspan="2">Refrigerated Storage (35°F)</td></tr>
<tr><td>7</td><td colspan="2">Day 7 Consumer & Expert Sensory Assessments</td><td colspan="2">Day 7 Consumer & Expert Sensory Assessments</td></tr>
<tr><td>7</td><td colspan="4">Focus Groups (Orlando; Univ. West Florida)</td></tr>
<tr><td>10</td><td colspan="4">Experimental Economic Markets (Univ. West Florida)</td></tr>
<tr><td>14</td><td colspan="2">Day 14 Sensory Evaluations & Expert Evaluations</td><td colspan="2">Day 14 Sensory Evaluations & Expert Evaluations</td></tr>
</table>

Key: HP – high pressure; LTF – low temperature freezing; GI – gamma irradiation ; MH – mild heat

Oyster Processing Methods

The traditional (T) processing involved simple refrigerated storage in customary burlap oyster bags stored in refrigeration (35°F). Each PHP method was conducted in accordance with prior validated and published procedures currently available for commercial use. The protocol for PHP validation is specified and maintained by the National Shellfish Sanitation Conference (NSSP 2007a and 2007b). Each State Shellfish Certification Authority is responsible for the evaluation and approval of the PHP methods with concurrence from Food and Drug Administration (FDA).

High Pressure (HP): Refrigerated oysters were initially banded with plastic strips to maintain closure before placing in a cylindrical metal container that was filled with potable water and pressurized to approximately 36,000 PSI for 3 minutes. The treated oysters were then unloaded on a table for visual sorting and final packaging in an igloo cooler with ice, then transported to the University of Florida in Gainesville for storage refrigerated (35°F) and sensory evaluations. These procedures were conducted at the validated and approved HP processing facilities of Motivatit Seafood in Houma, Louisiana.

Gamma Irradiation (GI): Oysters were banded with rubber bands to maintain closure while being held in 30 lbs waxed carton boxes that were placed on metal racks that carried the product into the irradiation chamber. The oysters were exposed to gamma radiation for a period of time necessary to achieve a minimum absorbed dose of 0.82 kGy as indicated by dosimeters placed on the waxed cartons. This dose was consistent with prior validated PHP procedures recognized by FDA. Treated product was then placed into an igloo cooler with ice, then transported to the University of Florida in Gainesville for refrigerated storage (35°F) and sensory evaluations. The irradiation procedures were conducted at processing facilitates maintained by Food Technology Services, Inc based in Mulberry, Florida. This is the same operation where the gamma irradiation procedures were validated for raw oyster PHP in December 2008.

Low Temperature Freezing (LTF): Oysters were manually shucked by removing the top shell, leaving the meat attached to the bottom shell. The half-shell product was placed on a conveyor belt that traveled through a nitrogen freezing tunnel set at an ambient temperature of – 170^{o}F with a belt speed of 3 ft/minute. Product exiting the nitrogen tunnel was solidly frozen. A potable, cold tap water glaze (no salt added) was applied on the top of each frozen oyster to provide protection against freezer burn and dehydration. All frozen oysters were placed in an igloo cooler with dry ice for transport to the University of Florida in Gainesville for frozen storage (0°F) and sensory evaluations. The validated low temperature freezing operations were conducted at Webb's Seafood, Inc in Youngstown, Florida.

Mild Heat Treatment (MH): Oysters were banded with rubber bands to assure closure during submersion in a tank of water maintained at 150^{o}F +/- 2^{o}F. Product was kept in the warm water for approximately 5 minutes to achieve an internal temperature of 122^{o}F for 1 - 2 minutes, then immediately placed in an ice slush for 2 minutes. The treated product was drained and placed in igloo coolers with ice, then transported to the University of Florida in Gainesville for refrigerated storage (35°F) and sensory evaluations. The mild heat interventions were conducted at Webb's Seafood, Inc in

Youngstown, Florida. The mild heat interventions were based on prior work by Hesselman et al 1999.

Sample Preparation

The preparation of all oysters for sensory assessments was conducted in the Aquatic Food Products Lab at the University of Florida under supervision of the project investigators. All samples were presented in half-shell product form. Shucking was performed by professional oyster shuckers hired to assure the task was done correctly so as not to damage the oyster tissues and to present a whole edible oyster product with some accompanying 'liquor' or product fluids that are commonly associated with the consumption of half-shell oysters. Shucking involved carefully severing of the adductor muscles to remove the top shell followed by careful severing of adductor muscles from the bottom shell that provided a container for the product. In order to maintain a uniform, cold product temperature and to prevent dehydration, the oysters were shucked 20 minutes prior to each sensory session and the half-shell products were placed on ice until served. The frozen, LTF half-shell oysters were thawed in containers held at room temperature for less than one hour then placed on ice until served. After thawing, the adductor muscle was severed from the bottom shell which served as a product container. All oysters used for the consumer and the expert panels were served at an average temperature of 45^{o}F or less which is the temperature customarily used for serving raw oysters in restaurants.

Note, during the shucking and thawing process any defective products were discarded (rejects). Defects included dead oysters for traditional products, any excessive mud or debris, or product damaged during processing. At 7 days post-harvest, the traditional oysters were the sample with the highest amount of rejects (49) followed by LTF (11), MH (11) and GI (4). After 14 days post-harvest, again the traditional oysters resulted in the highest rate of rejects (68), followed by HP (16), MH (10), GI (3) and LTF (3). The higher rate of rejects for the traditional product was due to mortality which is not an issue with PHP and banded oysters.

Consumer Sensory Assessments

Consumer preferences and acceptance were determined based on paired comparison tests and acceptability ratings. The tests were conducted with a group of consumers prescreened to assure familiarity with oyster consumption and a balance for various demographics (Table 3). Although the participants were recruited from one location, Gainesville, Florida, this college location included individuals from across the United States. Total participants ranged from 84 to 90 consumers per session. In each session the consumers were presented with a set of two different, unidentified oyster products served in the same manner at the same time with instructions to direct their responses. There were four possible sets for each consumer; T vs. HP; T vs. MH; T vs. GI; or T vs. LTF. All sets compared traditional (T) oysters to one of the PHP

methods. Two sets were presented per session and there were two sessions per each period of storage, 7 and 14 days post-harvest. This approach allowed comparison tests for all possible sets at both 7 and 14 days post-harvest.

The sets were presented in a random order per consumer so as not to introduce any unintended bias by order of presentation. During each session the consumers were asked to examine and consume at least two oysters from each oyster product presented. Thus the consumers ate at least 4 oysters for each set presented. To avoid sensory exhaustion only two sets were presented during one session and consumers were only allowed to participate in one session per day (two sets and 8 oysters per session). The same consumers were used in two sessions through two consecutive days to assure the same consumers responded to all possible sets of oyster products. The sample procurement and processing schedule (Table 1) were arranged to provide sessions for all the oyster products after 7 and 14 days post-harvest. There were no intermittent questions, discussions or interviews with the consumers between sessions or the separate periods of shelf-life that would have influenced their ratings or identity of the products.

All oyster products were presented utilizing blind codes so that the consumers were not aware of traditional or PHP products. The panelists were first asked to examine then taste both products per set and select the product they preferred. Then, they were asked to rate the acceptability of each product in the set. Acceptability ratings included measures for overall likeability, appearance, flavor and texture. A 9-point hedonic scale (1=dislike extremely, 5=neither like nor dislike, 9=like extremely) was used for all acceptability ratings (Attachment #1).

All consumer paired comparison tests were conducted in the Food Science and Human Nutrition Department's sensory laboratory equipped with sensory booths and computer data entry for real-time results. Instruction was limited to only assure consumer understood of procedures. Water and un-salted crackers were provided to panelists to cleanse the palate between samples. Their responses were recorded via computer entry using the program *Compusense*. The number of responses required to distinguish a significant preference was based on reference to the established paired comparison table number 17-12 in Meilgarrd et al. 2007. The acceptability ratings were subjected to analysis of variance and mean separations (Tukey's HSD, 0.05).

It is important to note that the preferences and acceptable ratings are strictly based on sets of comparisons between traditional and each individual PHP oyster product. There were no measures or ratings based on comparisons amongst any PHP products.

Table 3. Demographics for consumers prescreened for participation in the preference and acceptance tests.

Age Range		Gender		Raw Oyster Consumption	
20-40 yrs.	66%	Female	49%	> Once /month	43%
40-60 yrs.	34%	Male	51%	< Once/month but >twice /year	41%
				Twice /year or less	16%

Expert Sensory Assessments

The trained expert panel evaluated the oyster products using standard sensory profiling concurrently (same day) with the consumer sensory assessments for both periods of shelf-life, days 7 and 14 post-harvest. Expert profiling involved an established Oyster Sensory Panel that was trained and developed for ISSC. The expert panel has been maintained with continuous raw oyster assessments since 2008 (http://fshn.ifas.ufl.edu/seafood). The expert panel involved 10 screened and trained adults using standard protocol for sensory profiling stipulated in Meilgarrd et al. 2007. This panel has developed a full slate of lexicons and respective standards for a multitude of oyster product characteristics involving appearance, flavor, aroma, texture, mouthfeel and other sensory attributes. They rated or scored the various raw oyster products relative to the established standards and score sheets (http://fshn.ifas.ufl.edu/seafood; (Attachment #2 and Attachment #3). The expert panel scores were subjected to analysis of variance and mean separations (Tukey's HSD, 0.05).

Results

Consumer Sensory Assessments

Consumer preference was influenced by oyster processing methods and duration of storage after processing (Table 2). The majority of consumers preferred traditional (T) oysters at the initial 7 days post-harvest. This initial preference for traditional oysters was significant at the 95% confidence level in comparisons with MH, HP and GI oysters. The difference in preference for traditional oysters was less distinct in comparisons with LTF oysters. These initial preferences shifted as the product was held in refrigeration. After 14 days post-harvest there were no significant differences in consumer preferences at 95% confidence levels. Although the totaled preferences per comparisons on day 14 appeared to favor traditional and GI oysters, the differences in preference ratings were not significant. The loss in distinct preference can be partially explained by changes in the sensory attributes as the products aged in refrigeration (see Expert Panel results). Likewise, the preference comparisons involving LTF oysters were less

subject to sensory changes during the short period of frozen storage.

Table 2. Results of the paired comparison preference tests through 7 and 14 days post-harvest storage. The number of consumers per session and the respective preferences per oyster process are tallied under each column.

PHP Oysters	7 days post-harvest			14 days post-harvest		
	No. Consumers	PHP	Traditional	No. Consumers	PHP	Traditional
Mild Heat (MH)	89	34	55**	84	34	50
Gamma Irradiation (GI)	89	26	63**	84	49	35
High Pressure (HP)	90	28	62**	86	38	48
Low Temp Freezing (LTF)	90	36	54	86	43	43

** indicates these values are significantly different at the p= 0.05 or 95% confidence level

Consumer acceptability ratings indicated general acceptance for all oyster products regardless of processing method (Figures 1-4). Average consumer ratings remained above scores of 5.0 which represents the median transition from unacceptable to acceptable products relative to overall likeability, appearance, texture and flavor. Ratings for overall likeability followed the pattern of consumer preference that was influenced by post-harvest refrigeration of the products (Figure 1). Likeability was scored significantly higher at the 95% confidence level for traditional oysters in comparisons with all PHP products after 7 days post-harvest, but there was no difference in likeability for any of the various processed oysters after 14 days post-harvest. Appearance after 7 days post-harvest was not a significant factor in acceptability except in comparisons with the LTF oysters (Figure 2), but the significantly higher ratings for acceptable texture and flavor explain the acceptability differences and preferences scored for traditional products after 7 days post-harvest (Figures 3 and 4). Most acceptability ratings were not significantly different in comparison for all oyster products after 14 days post-harvest which explains the lack of difference in preference. In general, the acceptability ratings slightly decreased as the products aged in refrigeration and the appearance and texture of the LFT oysters still rated significantly lower than the traditional oysters after 14 days post-harvest.

Figure 1. Acceptance ratings for Overall Likeability of each PHP oyster in comparison with the traditional oysters. Significant differences (p=0.05 or 95% confidence levels) in ratings per comparisons are denoted by different letters ‘a and b’.

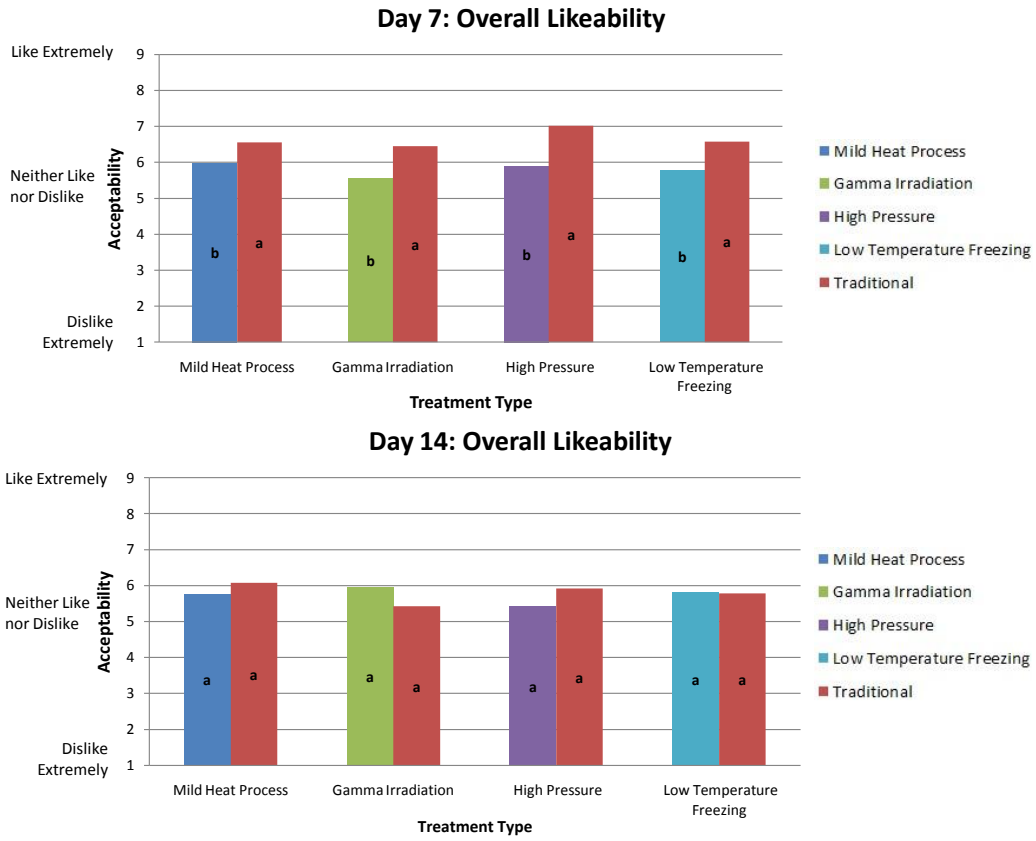


Figure 2. Acceptance ratings for Appearance of each PHP oyster in comparison with the traditional oysters. Significant differences (p=0.05 or 95% confidence levels) in ratings per comparisons are denoted by different letters ‘a and b’.

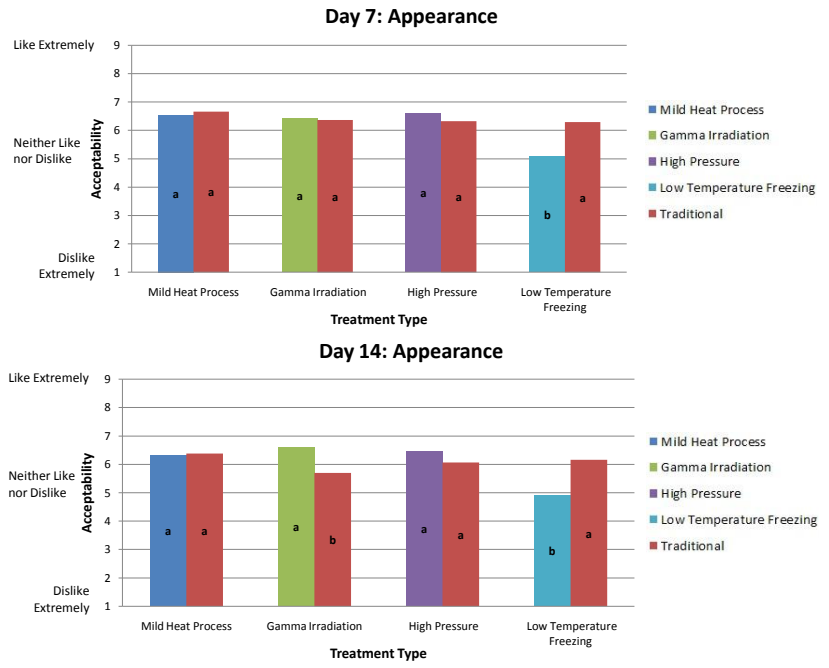


Figure 3. Acceptance ratings for Texture of each PHP oyster in comparison with the traditional oysters. Significant differences (p=0.05 or 95% confidence levels) in ratings per comparisons are denoted by different letters ‘a and b’.

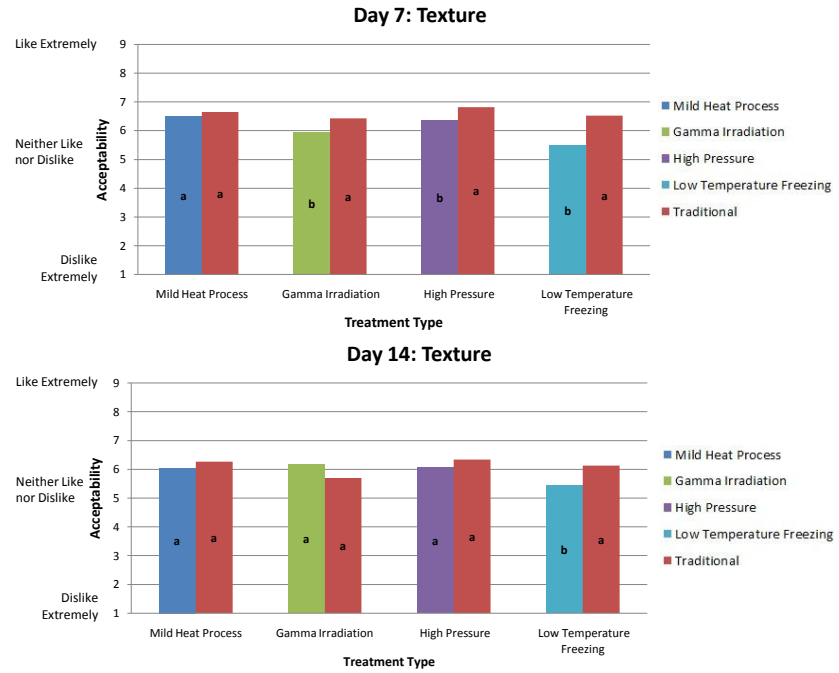
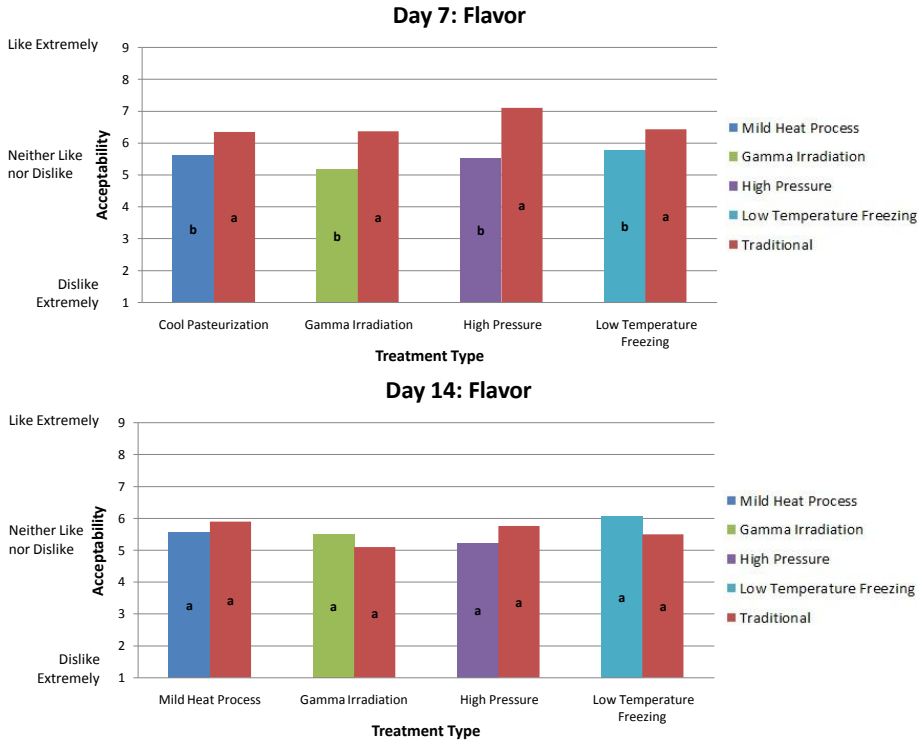


Figure 4. Acceptance ratings for Texture of each PHP oyster in comparison with the traditional oysters. Significant differences (p=0.05 or 95% confidence levels) in ratings per comparisons are denoted by different letters ‘a and b’.



Expert Sensory Assessments

The sensory profiles developed by the expert panel provide some explanation for the consumer preferences and acceptability ratings (Figures 5-10). For example, the higher ratings for the traditional oysters after 7 days post-harvest can be partially explained by the higher perceived salty taste (Figure 8) and less earthy tones in flavor (Figure 9). Despite the low ratings, earthy tones are objectionable. The earthy tones noted in the flavor of the MH oysters reduced the preference for MH oysters in comparison with traditional oysters which had a similar salty taste rating. All PHP oysters had slightly higher earthy tones in aroma and flavor which persisted through 14 days shelf-life (Figure 9). Likewise, the PHP product aromas were initially scored as more briny and seaweed-like than the traditional oysters after 7 days post-harvest (Figure 7). These sensory attributes were not rated during the consumer comparison tests but they may play a role in influencing preference and acceptance. Additionally, the appearance and texture of all oyster products were similar across both periods of shelf-life, with the exception of a drier and less plumb LTF product and the firmer more prominent textured HP product. The firmer texture attributes were persistent and more obvious for HP oysters through 14 days storage. Plump appearance and firm mouth feel or bites can influence consumer preferences.

Interestingly, the LTF oysters had the lowest score for salty taste (Figure 8) due to the use of the fresh water glaze to protect the product during frozen storage. This sensory attribute could be influenced by use of salt water glazes.

The shift in preferences and acceptance after 14 day post-harvest is distinctly obvious due to the perceived decreases in oyster liquor color (Figure 5), product aromas (Figure 7), and salty taste which was accompanied by a slight decrease in sweet and umami tastes (Figure 8). Overall, the sensory attributes became more similar as the oyster products aged in refrigerated storage. Likewise, an adverse aftertaste began to increase (Figure 10) and actual bitter flavors were noted as side observations with the standard sensory profiling. These negative attributes decrease preference and acceptance.

The various expert color ratings for shell and meats were more variable within individual oyster products than in comparisons between the various oyster products. This is not unexpected since the oysters were harvested from the same location and were similar in size and season of harvest. Likewise, the variation in color ratings did not change during storage such that color was not a useful attribute to distinguish differences between traditional and PHP products.

Figure 5. Expert sensory profiles for the volume, viscosity and color of the liquor that accompanies the oyster products are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

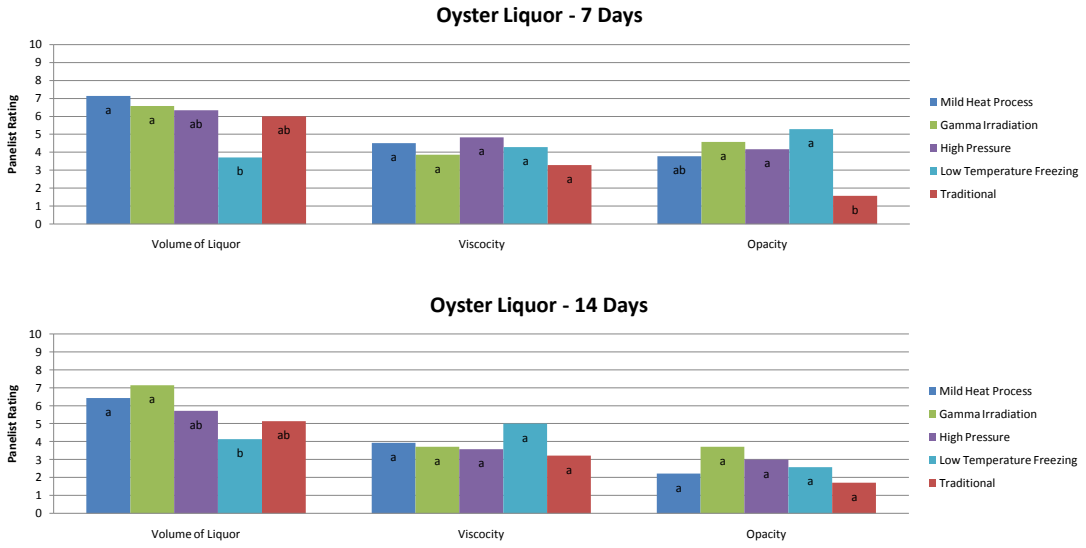


Figure 6. Expert sensory profiles for the volume, plumpness and various texture measures for the edible oyster meats are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

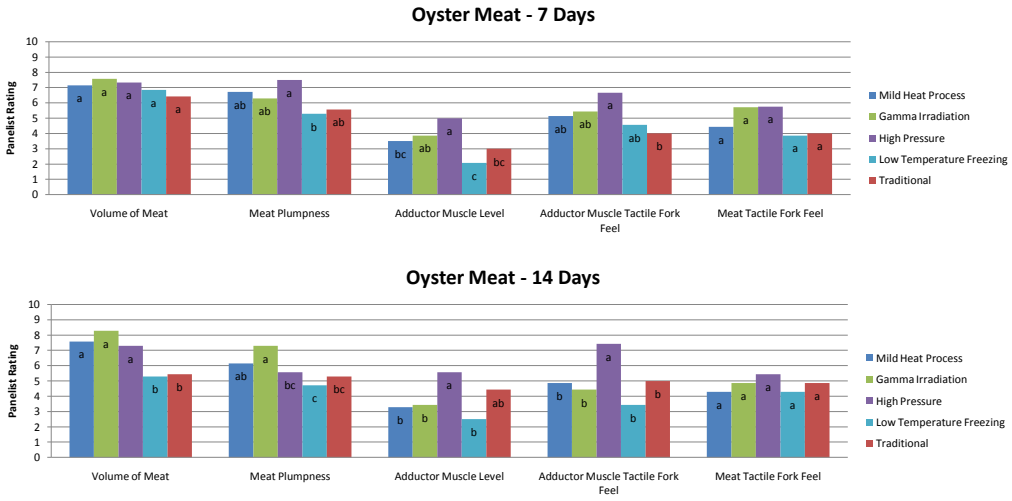


Figure 7. Expert sensory profiles for the briny, seaweed, earthy and metallic aromas associated with the oyster products are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

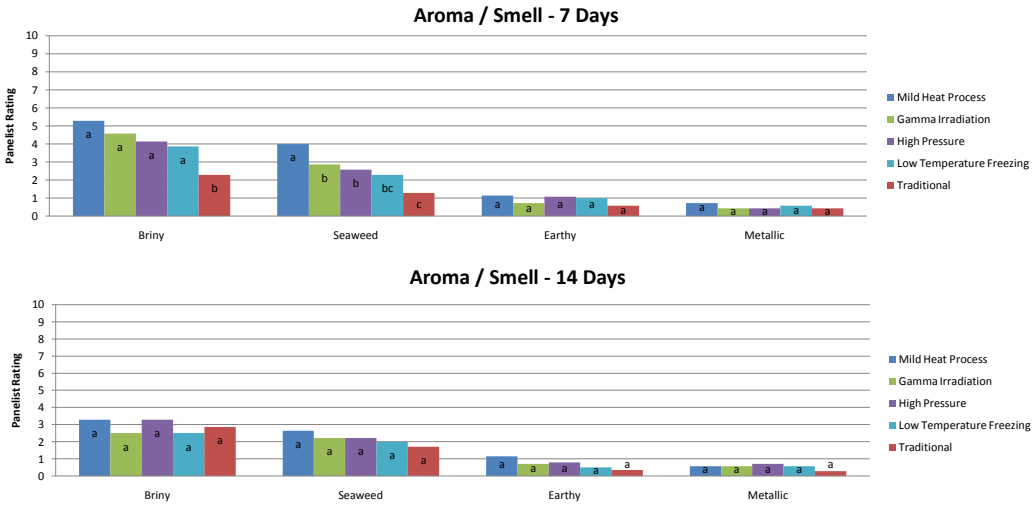


Figure 8. Expert sensory profiles for the salty, sweet and umami tastes associated with the oyster products are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

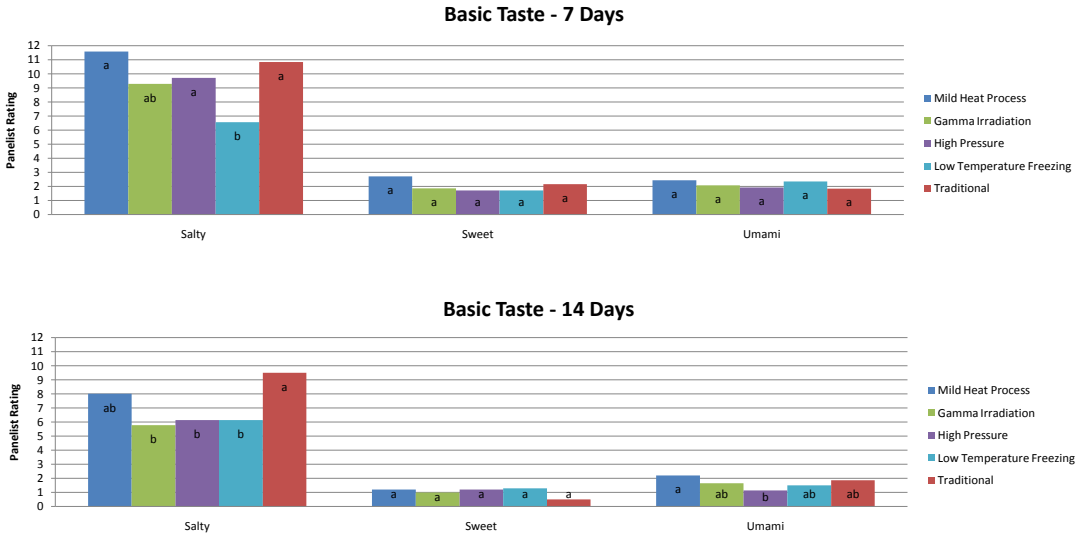


Figure 9. Expert sensory profiles for the seaweed, chick-liver-like, earthy and green-leafy flavors associated with the oyster products are represented by bars for the average ratings based on 10 expert scores. The term CLL represents chick-like-liver flavor. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

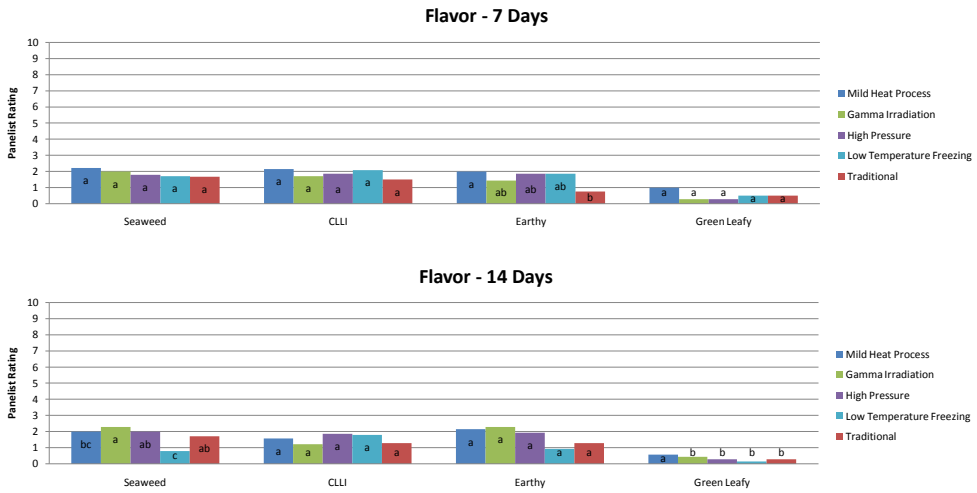


Figure 10. Expert sensory profiles for metallic and astringent aftertastes associated with the oyster products are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.

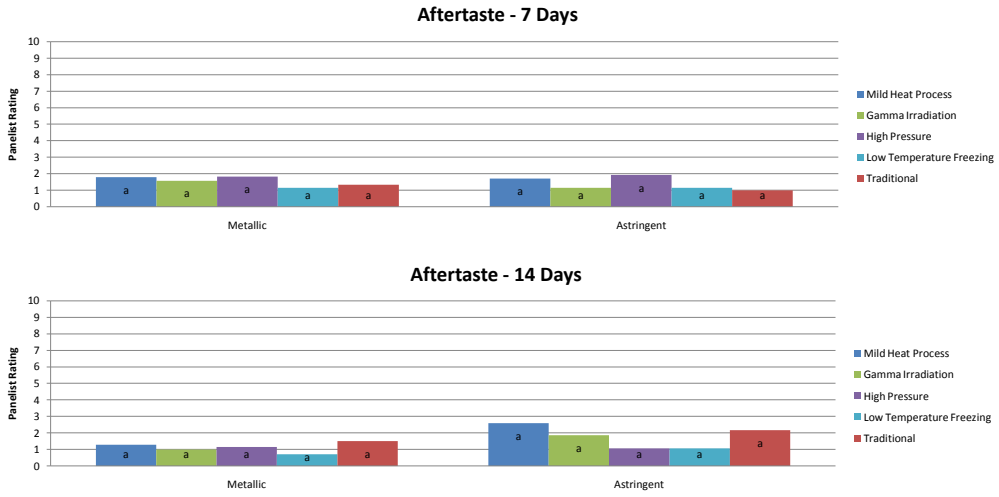
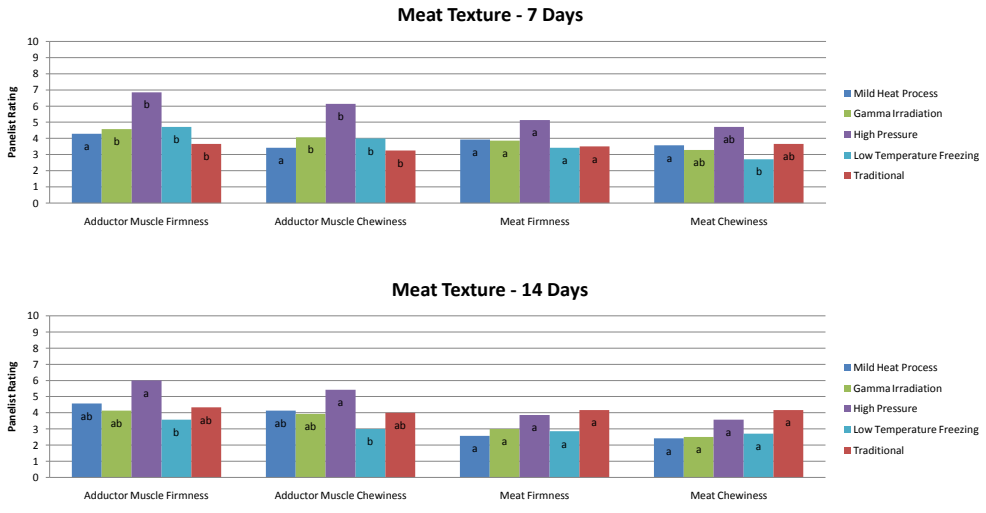


Figure 11. Expert sensory profiles for meat texture in the adductor muscle and general body or oyster meat for the oyster products are represented by bars for the average ratings based on 10 expert scores. Any bars marked by the same letter are not significantly different at the p = 0.05 or 95% confidence level.



CONCLUSIONS

Typical raw oyster consumers preferred the traditional raw oysters in comparisons with PHP oysters prepared from the same harvest during September from a typical Gulf of Mexico source (Apalachicola Bay, FL), yet this preference is diminished during prolonged refrigerated storage. The primary sensory attributes affecting preference were flavor and texture. These attributes are less distinguishable in comparisons between traditional and PHP oysters as the products aged in refrigeration. As a perishable product, the refrigerated oysters progressively change during storage. Apparently the changes caused a shift in product preference. In contrast, the preference for traditional oysters in comparisons with frozen PHP oysters (LFT) remained similar during storage as the frozen state preserves the oysters.

Despite the consumer preference expressed for traditional raw oysters during initial storage, the consumers rated all oyster products, both traditional and PHP, as acceptable. The acceptability ratings initially favored traditional raw oysters, as noted by the preference, but acceptability ratings became similar for all oyster products during more prolonged storage. Based on expert sensory profiling of the respective oyster products, the dominant sensory attributes affecting favorable acceptance were salty taste and less earthy tones in flavor and aroma.

These conclusions are based on a warm month harvest from the Gulf of Mexico. Harvest during other months with differing water temperatures that are known to influence the composition and sensory character of oysters could alter the results.

RECOMMENDATIONS

Interest for implementation of PHP methods for raw oysters harvested during warm months about the Gulf of Mexico should recognize a distinct and demonstrated consumer preference for traditional, fresh (non-frozen) products, yet a clear acceptance for both traditional and PHP oysters. This situation provides opportunities to market oysters in both traditional and PHP forms to suit particular markets relative to consumer demand, cost, convenience, and regulatory guidance.

References

FL DOACS 2009 Regulation references on harvest time-temperature handling: Department of Agriculture and Consumer Services. Division of Aquaculture. Chapter 5L-1, The Comprehensive Shellfish Control Code. Section 5L-1.008 – Shellfish Handling (subsections (5) - (9) https://www.flrules.org/gateway/ChapterHome.asp?Chapter=5L-1

Garrido, L.R., Garrido, V.M. Bogan D.M. and Otwell W.S. 2007 Product Characterization to advance the postharvest treatments of Oysters. Presented at Institute of Food Technologists annual meeting, Chicago, Illinois.

Hesselman, D., Motes, M. and Lewis, J., 1999. Effects of a Commercial Heat-Shock Process on Vibrio vulnificus in the American Oyster, *Crassotrea virginica*, Harvested from the Gulf Coast. J. of Food Protection, Vol. 62 No. 11, 1999. P. 1266 - 1269

Meilgaard, M., Civille, G., and Carr, B. 2007. Sensory Evaluation Techniques. Fourth Edition. Boca Raton, FL: CRC Press.

NSSP. 2007a. National Shellfish Sanitation Program. Guide for the Control of Molluscan Shellfish. 2007a. Model Ordinance Section II Chapter XVI. Post Harvest Processing. www.issc.org

NSSP. 2007b. National Shellfish Sanitation Program. Guide for the Control of Molluscan Shellfish 2007b. Section IV Chapter IV. Naturally Occurring Pathogens. www.issc.org

ATTACHMENTS

ATTACHMENT #1

Excerpt of the questionnaire presented to the consumers for each raw oyster product evaluated during the consumer acceptability ratings

Please indicate how much you like or dislike the following attributes in **sample A**

Sample A

Overall Likeability

dislike extremely	dislike very much	dislike moderately	dislike slightly	neither like nor dislike	like slightly	like moderately	like very much	like extremely
1	2	3	4	5	6	7	8	9

Appearance

dislike extremely	dislike very much	dislike moderately	dislike slightly	neither like nor dislike	like slightly	like moderately	like very much	like extremely
1	2	3	4	5	6	7	8	9

Texture

dislike extremely	dislike very much	dislike moderately	dislike slightly	neither like nor dislike	like slightly	like moderately	like very much	like extremely
1	2	3	4	5	6	7	8	9

Flavor

dislike extremely	dislike very much	dislike moderately	dislike slightly	neither like nor dislike	like slightly	like moderately	like very much	like extremely
1	2	3	4	5	6	7	8	9

Please indicate how much you like or dislike the following attributes in **sample B.**

ATTACHMENT #2

Sensory Standards for the
Evaluation of Raw Oyster Products

Contains standards for the various sensory attributes use in the profiling of raw oysters by expert panel. This document aligns with the score sheets (Attachment 3).

Source:

http://fshn.ifas.ufl.edu/seafood/oysters/sensory%20school/services.shtml#tools

Contact: **Laura Garrido**
University of Florida
shrimp@ufl.edu

Sensory Standards for the Evaluation of Raw Oyster Products

The following attributes are rated using a scale 0-10; 0 typically represents absence , 1 represents very low, 5 represents either moderate or intermediate while10 represents either very high or extreme. For each of the attributes one or more standards were developed to help guide the panelists. The rating of the standards for each attribute can be identified by the number (i.e. Std 4,Std 5, etc) and the triangle(s) placed on each respective rating scale (attachment 3). For example a standard 4 represents the 4 in the scale 1-10.

Lexicon	Description	Scale
APPEARANCE		
Color	**Color (s) of the oyster parts captured by human eye**	**Figures 1 & 2**
APPEARANCE OF OYSTER LIQUOR		
Milkiness	**Presence of a milky-like substance more noticeable in the oyster liquor. This is related to reproduction not to processing.**	**Figure 3- Presence or absence**
Air Bubbles	**Presence of small air bubbles trapped in the oyster's liquor, most likely around the meat.**	**Figure 4 - Presence or absence**
Volume of Liquor	**Quantity of oyster liquor in the shell.**	**Figure 5**
Viscosity	**How freely the liquor flows on the shell (watery vs. gluey).**	**Actual samples**
Opacity	**How clear/translucent or how cloudy/opaque the oyster liquor is.**	**Figure 6**
APPEARANCE OF OYSTER MEAT		
Shattered Meat	**If the meat appears and/or is broken into pieces.**	**Actual samples - Presence or absence**
Volume of the Meat	**Refers to how much of the oyster shell is covered by the meat.**	**Figure 7**
Plumpness	**How well-rounded and full in form the oyster meat.**	**Figure 8**
Adductor muscle	**How raised the adductor muscle is when compared to the meat.**	**Figure 9**
Adductor muscle tactile-fork feel	**How the adductor muscle feels when touch by a plastic fork.**	**Std 2 - Soft Gelatine (Knox)*** Std 5 - Canned Peaches-Diced-4oz pull top cup (Del Monte) Std 8 – Hard Gelatine Knox****
Meat tactile-fork feel	**How the meat feels when touch by a plastic fork.**	

AROMA		
Briny	**Related to or resembling saltiness or the sea**	**Std 5* &10**- Ito-Wakame dried seaweed imported by Rhee Bros, Inc - Columbia, MD**
Seaweed	**Related to the aroma of seaweed.**	
Earthy	**Refers to the characteristics of damp soil, and wet plants.**	**Std 10 - Whole White Mushrooms with soil - cut in half and smell.**
Metallic	**Relating to, or having the characteristic of a metal.**	**Std 10 - 2 capsules of Sundown Iron 28 mg capsules in 440 ml of water. Rub on skin and smell; or shake bottle, open and smell.**
UNDESIRABLE/OBJECTIONABLE AROMAS		
Agar	**Related to the odor of agar.**	**Std 10 - Difco Bacto Agar (Fisher Scientific Catalog)**
Ammonia	**Related to ammonia.**	**Std 10 - Ammonia for household cleaning.**
Boiled potato	**Refers to earthy/dirty aroma in the internal portion of a boiled potato.**	**Std 10 - Canned Potato (Del Monte fresh cut whole new potatoes)**
Fecal	**Aroma associated with feces.**	**Std 10 - Past experiences**
Fishy	**Refers to the aroma associated with strong fish odors.**	**Std 10 - Can of Sardines in water(King Oscar) Std 10 - Clam Juice (Doxsee/Snows Clam juice)**
Garlic	**Refers to the aroma of garlic.**	**Std 5 - Garlic Butter Papa John's Std 10 - Kalsec Garlic Oil**
Sour	**The aroma stimulated by acids, such as citric, malic, phosphoric, etc. (Meilgaard, Civille et al.)**	**Std 10 - shucked oyster placed in the refrigerator for about 21-28 days will produce a maximum sour odor.**
Wet dog	**Refers to smell of a wet dog.**	**Std 8 - Canned of shrimp (Chicken of the sea or bumble bee)**
Wet burlap sack	**Refers to the smell of a wet burlap sack used in the oysters business to transport oysters**	**Std 10 - wet burlap sacks (cream, brown, or beige) from Wal-Mart.**

BASIC TASTES		
Salty	**Taste stimulated by sodium salts, such as sodium chloride and sodium glutamate and in part by other salts such as potassium chloride. (Meilgaard, Civille et al.)**	**Std 5 - 0.3% salt Std 10 - 0.55% salt Std 15 - 0.7 % salt (Meilgaard, Civille et al.)**
Sweet	**Taste stimulated by sucrose and other sugars, such as fructose, glucose, etc. and by other sweet substances.(Meilgaard, Civille et al.)**	**Std 4 - Ritz crackers (Meilgaar Civille et al.)**
Umami	**Taste produced by substances such as Monosodium Glutamate (MSG). A meaty, savory, or mouth filling sensation (Codex).**	**Std 5 - 1/4 tsp Accent in 500 ml of water Std 10 - ½ tsp Accent in 500 ml of water**
UNDESIRABLE/OBJECTIONABLE BASIC TASTES		
Sour	**The taste stimulated by acids, such as citric, malic, phosphoric, etc. (Meilgaard, Civille et al.)**	**Std 5 - 0.1% citric acid; Presence or absence (Meilgaard, Civille et al.)**
Bitter	**The taste stimulated by substances such as caffeine, and hop bitters (Meilgaard, Civille et al.).**	**Std 5 - 0.08% caffeine solution Presence or absence (Meilgaard, Civille et al.)**
FLAVOR		
Seaweed	**Relating to or having the characteristic to a flavor like seaweed.**	**Std 10- Ito-Wakame dried seaweed imported by Rhee Bros, Inc Columbia,MD**
Chicken liver like / iron-	**Relating to the iron flavor of cooked liver (organ) meat.**	**Std 4 - Chicken liver (Tyson's) Add to boiling water and keep boiling for 10 minutes**
Earthy	**Refers to the characteristics of damp soil, and wet plants.**	**Std 10 – mushrooms, white and whole with soil - cut and taste.**
Green Leafy (spinach)-	**Relating to or having the characteristic flavor of spinach.**	**Std 5- Fresh spinach (ready pac)**
UNDESIRABLE/OBJECTIONABLE FLAVORS		
Boiled Potato	**Refers to earthy/dirty flavor in the internal portion of a boiled potato.**	**Std 6 - Potato (Del Monte fresh cut whole new potatoes)**
Fishy	**Refers to a fishy flavor.**	**Std 10 - Can of sardines in water (any brand)**
Garlic	**Relating to or having the characteristic flavor of garlic.**	**Std 4- Garlic butter Papa John's Std 10 - Kalsec garlic oil**
Raw Cabbage	**Relating to or having the characteristic to the flavor of raw cabbage.**	**Std 7 - Red cabbage Std 8 - Green cabbage**
Wet Burlap Sac	**Relating to or having the characteristic of the flavor imparted by a wet.**	**Std 10- wet burlap sacks (cream, brown, and beige) from Wal-Mart.**

Aftertastes		
Metallic	**Relating to or having the characteristic of a metal.**	**Std 5 - 1 capsules of Sundown Iron 28 mg capsules in 440 ml of water. Std 6 - Canned oysters - Chicken of the Sea whole oysters juice only (strain juice though fine wire strainer).**
Astringency	**The chemical feeling factor combining three different aspects: drying of the mouth, roughing of oral tissues and drawing (shrinking) sensation felt in the cheeks and the muscles of the face.**	**Std 5- 1/8 teaspoon (0.5g) of alum (McCormick) in 500 ml of water. Std 5- Fresh Spinach (Ready Pac).**
Chalkiness	**In reference to texture, a product which is composed of small particles which imparts a drying sensation in the mouth (Codex).**	**Std10- 14 ml of milk of magnesia in 400 ml of water or Std 10 - 3/4 teaspoon of Tricalcium phosphate food grade –Budenheim, Germany in 400 ml of water.**

Texture & Mouth feels		
Firmness Chewiness	**Refers to consistency of how soft versus how firm in resistance the oysters flesh holds. Amount of maceration required to comfortably swallow the oyster.**	**Std 1- Soft gelatin (Knox) *** Std 3 -Tofu – Nasoya soft Std 5 -Canned peaches-diced- 4oz pull top cups (Del Monte) Std 6 – Hard gelatine (Knox)**** Std 8 – Cooked chicken breast-salad topping (Plain-Purdue) Std 10 - Dried apricots (Sunmaid – Mediterranean)**
Grittiness	**Presence of sand**	**Actual samples**

***Briny Std 5**

Use approximately 1 to 1 1/2 cups of water for 2 to 3 strands of seaweed. Bring water to boil or close to boil. Break dried seaweed into 2 to 3 inch pieces and put in hot water. Allow to soak overnight and cool. Use seaweed for areas needed and liquid for briny standard. For a strong briny solution use more seaweed (about 6 - 8 strands) per cur of hot water.

****Briny Std 10**

For a strong briny (standard 10), leave the seaweed for48 hours or more at refrigerated temperature after warm liquid on the soaked seaweed cools down.

*****Soft Gelatin**

4 cups of water
2 envelopes KNOX Gelatine unflavored

Measure 4 cups of water.
Put 1 to 2 cups of the measured water in a container, (big enough for about 5 cups)
Doesn't have to be exact. Sprinkle 2 KNOX envelopes on top of the water, let it stand for 2 minutes or until the gelatin is hydrated. (DO NOT mix it or stir it it will be a mess!)
Meanwhile heat the rest of the water for 2 minutes in the microwave.
When hot pour the water into the hydrated gelatin and stir until it is completely dissolved. Pour the liquid gelatin in the little containers and let it stand in the refrigerator for about 5 hours.

******Hard Gelatin**

3 cups of water
6 envelopes KNOX Gelatine unflavored

Measure 3 cups of water.
Put 1 to 1 1/2 cups of the measured water in a container, (big enough for about 5 cups)
Doesn't have to be exact. Sprinkle 6 KNOX envelopes on top of the water, let it stand for 2 minutes or until the gelatin is hydrated. (DO NOT mix it or stir it it will be a mess!)
Meanwhile heat the rest of the water for 2 minutes in the microwave.
When hot pour the water into the hydrated gelatin and stir until it is completely dissolved. Pour the liquid gelatin in the little containers and let it stand in the refrigerator for about 5 hours.

Figure 1. Diagram of an oyster for color assessment

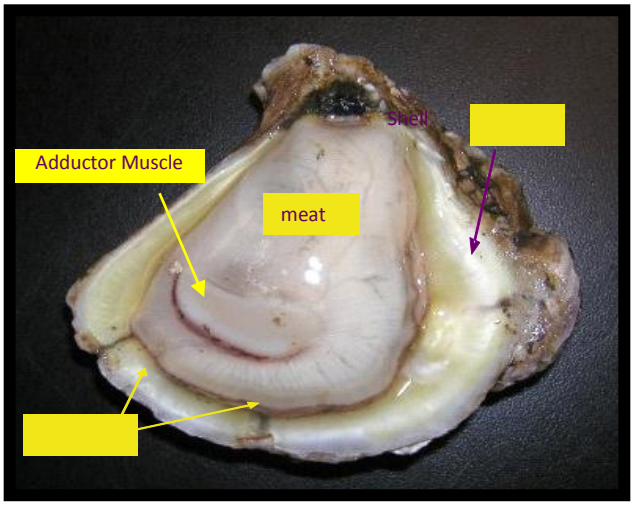


Figure 2. Color Scales

White

	1	***2***	***3***	***4***	***5***
Colors					
Munsell					
RGB					
Glidden Name	**Nature's Whisper**	**Natural White**	**Fencepost**	**White High**	**White Swan**
Glidden Code	**43YY 78/053**	**50YY 83/029**	**81YY 87/031**	**98YY 82/022**	**60YY 83/062**

Pink

	1 Lightest	***2***	***3***	***4***	***6 Darkest***
Colors					
Munsell					
RGB	**241/232/233**	**211/200/172**	**229/202/215**	**229/167/190**	**206/109/137**
Glidden Name	**Whimsical**	**Carnation Pink**	**Saltmarsh Pink**	**Checkerberry**	**Fiesta Pink**
Glidden Code	**30RR 83/040**	**41RR 79/079**	**29RR 66/154**	**32RR 50/260**	**53RR 27/417**

Gray to Black

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**217/219/217**	**204/205/204**	**188/188/187**	**160/160/159**	**94/94/94**	**62/62/61**
Glidden Name	**Snowfield**	**Universal Grey**	**Veil**	**Granite Grey**	**Obsidian Glass**	**Dark Secret**
Glidden Code	**00NN 72/000**	**00NN 62/000**	**00NN 53/000**	**00NN 37/000**	**00NN 13/000**	**00NN 05/000**

Gray / Brown

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**231/228/219**	**221/215/205**	**203/196/185**	**182/171/157**	**125/115/104**	**91/80/69**
Glidden Name	**Kitten White**	**Carolina Strand**	**Fossil Grey**	**Scroll Beige**	**Fauna**	**Pebble Mosaic**
Glidden Code	**30YY 78/035**	**30YY 69/048**	**30YY 56/060**	**20YY 43/083**	**10YY 18/074**	**10YY 08/093**

Gray/Green

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell	**5Y/8.5/2**	**5Y/8/2**	**7.5Y/7/2**	**2.5Y/6/4**	**5Y/4/4**	**5Y/3/4**
RGB	**222/214/183**	**208/201/171**	**179/174/146**	**166/145/100**	**110/96/52**	**85/72/35**
Glidden Name	**Wishes**	**Autumn Haze**	**Chatham Green**	**Surrey Beige**	**Calm Water**	**Oak Alley**
Glidden Code	**45YY 75/110**	**45YY 67/120**	**40YY53/119**	**30YY 36/185**	**30YY 20/193**	**30YY/09/175**

Green scale

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell	**10Y/9/2**	**10Y/8.5/2**	**10Y/8/4**	**2.5GY/7/4**	**10Y/5/4**	**10Y/4/2**
RGB	**231/230/194**	**217/216/182**	**206/203/144**	**139/184/151**	**126/124/73**	**99/98/75**
Glidden Name	**Brocade Cream**	**Hint of Gold**	**Mount Olive**	**Pennyroyal**	**Retro Green**	**Laurentian**
Glidden Code	**60YY 70/189**	**60YY 64/211**	**60YY 54/255**	**60YY 40/243**	**60YY23/227**	**70YY15/160**

Emerald Green

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**228/236/223**	**212/228/205**	**199/222/190**	**154/185/141**	**108/140/96**	**86/117/74**
Glidden Name	**Boudoir**	**Nature Mist**	**Sea Scent**	**Summer Picnic**	**Frog Pad**	**Splendor**
Glidden Code	**50GY 83/060**	**50GY 75/122**	**50GY 69/165**	**50GY 44/248**	**50GY 23/280**	**50GY 15/289**

Blue/Green (Teal)

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**221/237/230**	**206/228/221**	**189/220/211**	**160/199/189**	**91/149/136**	**13/113/99**
Glidden Name	**Bubbling Brook**	**Aquabell**	**Warm Meadow**	**Country Cottage**	**Kelly's Island**	**Forest Hush**
Glidden Code	**50GG 83/057**	**50GG 74/077**	**50GY 69/165**	**50GG 53/144**	**50GG 26/228**	**50GG 13/314**

Maroon

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**217/207/210**	**196/180/185**	**165/142/151**	**135/107/117**	**108/83/93**	**88/71/77**
Glidden Name	**Whisper**	**Soft Wine**	**Sonata**	**Mystic**	**Alakazam**	**Black Currant**
Glidden Code	**30RR 64/043**	**30RR 49/067**	**30RR 30/103**	**30RR 17/140**	**30RR 10/131**	**30RR 07/094**

Purple

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell						
RGB	**224/222/228**	**215/211/226**	**165/142/151**	**159/154/184**	**126/119/153**	**92/86/121**
Glidden Name	**Mystic Purple**	**Touch of Violet**	**Giggles**	**Elevator**	**Coat of Arms**	**Purple Polka**
Glidden Code	**10RB 74/038**	**10RB 68/081**	**30RR 30/103**	**10RB 35/167**	**30RR 10/131**	**10RB 10/219**

Tan

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell	**2.5Y/9/2**	**2.5Y/8/4**	**10YR/8/6**	**10YR/7/8**	**10YR/6/10**	**10YR/6/8**
RGB	**240/227/198**	**220/198/148**	**236/194/129**	**216/165/81**	**194/137/24**	**188/139/57**
Glidden Name	**Lis Crème**	**Stucco**	**Light Topaz**	**Honeysweet**	**Golden Gate**	**Ovation**
Glidden Code	**30YY 77/169**	**20YY69/238**	**10YY58/295**	**10YY49/378**	**10YY 38/501**	**10YY 30/478**

Brown/Yellow

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell	**2.5Y/8.5/2**	**2.5Y/8/2**	**2.5Y/7/4**	**10YR/6/6**	**2.5Y/5/4**	**2.5Y/4/6**
RGB	**225/213/185**	**211/200/172**	**194/171/123**	**181/141/81**	**140/119/76**	**120/93/32**
Glidden Name	**Oyster White**	**Ivory Sampler**	**Cookie Crumb**	**First Anniversary**	**New Suede**	**American Bronze**
Glidden Code	**30YY 64/149**	**30YY 58/178**	**20YY 46/236**	**10YY34268**	**10YY 26/239**	**10YY 15/280**

Brown

	1 Lightest	***2***	***3***	***4***	***5***	***6 Darkest***
Colors						
Munsell	**10YR/9/2**	**10YR/8/2**	**10YR/7/4**	**10YR/6/4**	**10YR/4/4**	**10YR/3/6**
RGB	**242/22600**	**214/198/175**	**198/169/127**	**171/143/104**	**119/92/57**	**99/67/16**
Glidden Name	**Desert Floor**	**Dapper Tan**	**Family Legacy**	**Golden Pond**	**Side saddle**	**Timbre Trail**
Glidden Code	**20YY 69/120**	**10YY 55/163**	**00YY43/196**	**00YY 33/246**	**90YR 17/245**	**90YR 10/244**

Figure # 3

Standard for presence of milkiness (Std 10)

Figure 4. Standards for presence of bubbles

Presence

Figure 5. Standards for volume of liquor

Low (2)

High (10)

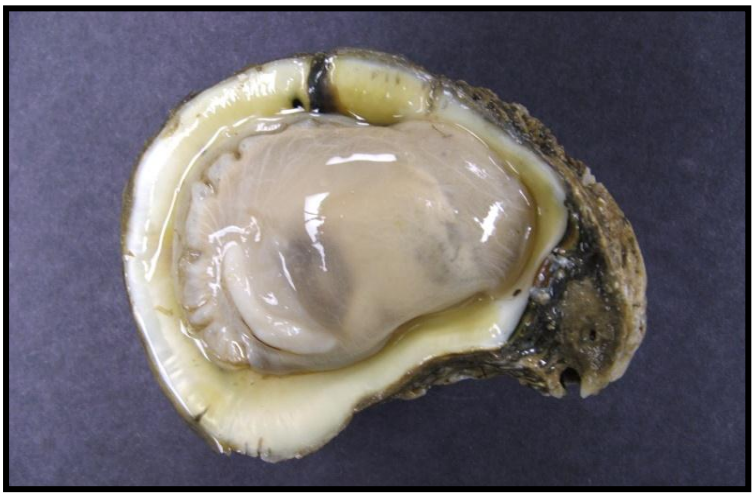


Figure 6. Standards for liquor opacity

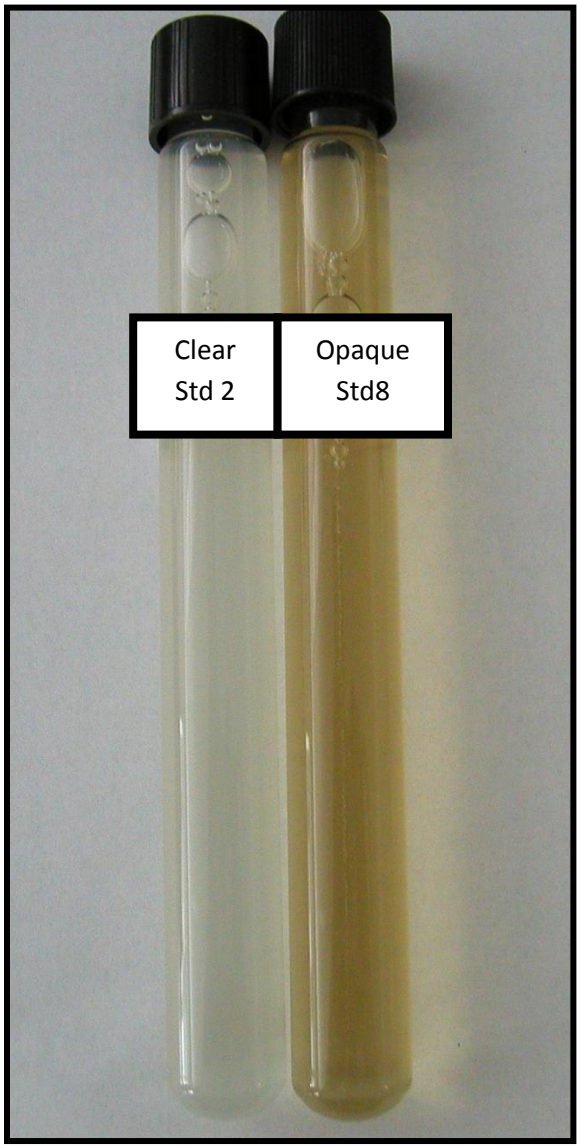


Figure 7. Standards for volume of meat

Hardly Covered (Std 2)

Fully Covered (Std 10)

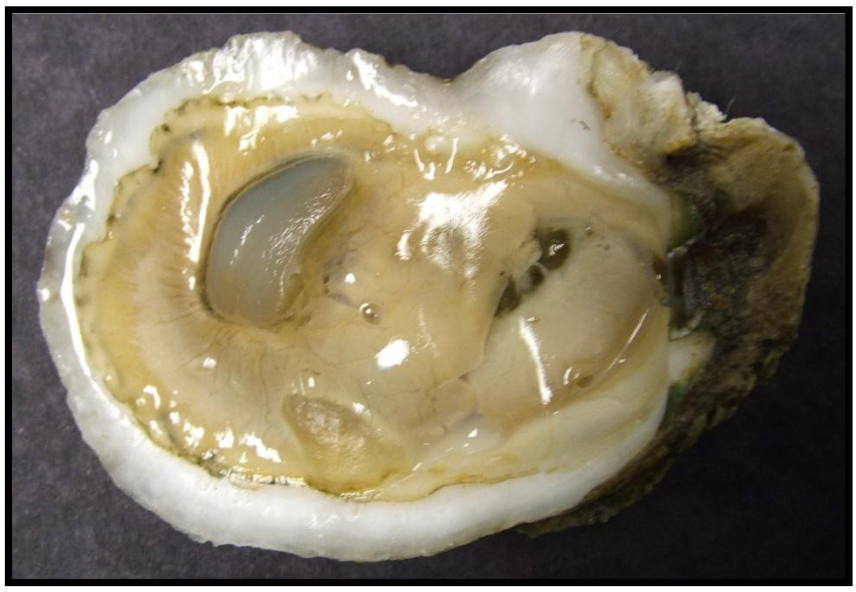
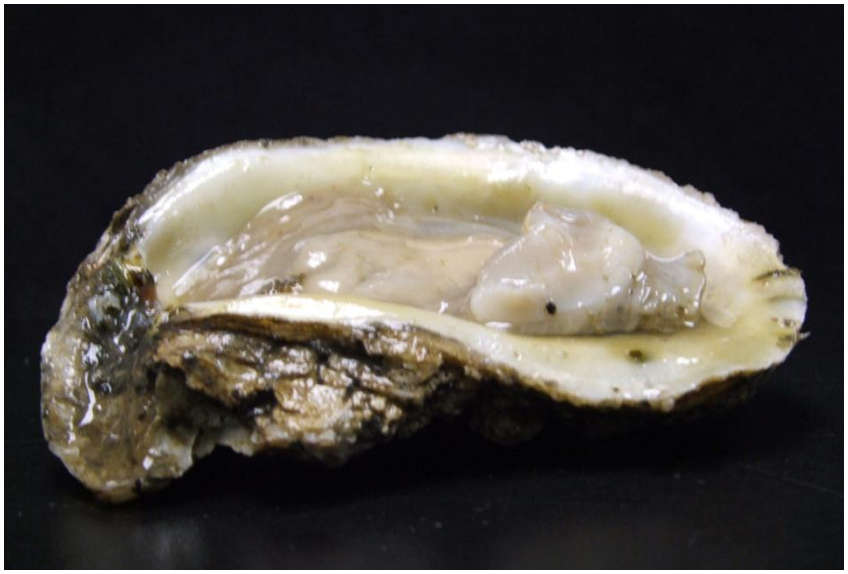


Figure 8. Standards for plumpness

Flaccid (Std 2)



Plump (Std 8)

Figure 9. Standards for adductor muscle

Level (Std 1)

Raised (Std 5)

Very Raised (Std 8)

ATTACHMENT #3

Score Sheet for Raw Oyster Products

Contains the score sheet use to profile the sensory attributes raw oysters by expert panel. This document aligns with the list of standards (Attachment 2).

Source:
http://fshn.ifas.ufl.edu/seafood/oysters/sensory%20school/services.shtml#tools

Contact: **Laura Garrido**
University of Florida
shrimp@ufl.edu

Oyster Product Characterization Form

Sample Code: _____
Date: _____
Panelist: _____

Appearance

Color Break-down - Circle all that apply

Oyster Meat:

1. White		1	2	3	4	5	
2. Pink		1	2	3	4	5	
		Light					*Dark*
3. Gray to Black		1	2	3	4	5	6
4. Gray/Brown		1	2	3	4	5	6
5. Grey/Green	1	2	3	4	5	6	
6. Green		1	2	3	4	5	6
7. Emerald Green		1	2	3	4	5	6
8. Blue/Green (Teal)		1	2	3	4	5	6
9. Maroon		1	2	3	4	5	6
10. Purple		1	2	3	4	5	6
11. Tan		1	2	3	4	5	6
12. Brow/Yellow		1	2	3	4	5	6
14. Brown		1	2	3	4	5	6

Edges:

1. White		1	2	3	4	5	
2. Pink		1	2	3	4	5	
		Light					*Dark*
3. Gray to Black		1	2	3	4	5	6
4. Gray/Brown		1	2	3	4	5	6
5. Grey/Green	1	2	3	4	5	6	
6. Green		1	2	3	4	5	6
7. Emerald Green		1	2	3	4	5	6
8. Blue/Green (Teal)		1	2	3	4	5	6
9. Maroon		1	2	3	4	5	6
10. Purple		1	2	3	4	5	6
11. Tan		1	2	3	4	5	6
12. Brow/Yellow		1	2	3	4	5	6
14. Brown		1	2	3	4	5	6

Inner Rim of Shell:

1. White		1	2	3	4	5	
2. Pink		1	2	3	4	5	
		Light					*Dark*
3. Gray to Black		1	2	3	4	5	6
4. Gray/Brown		1	2	3	4	5	6
5. Grey/Green	1	2	3	4	5	6	
6. Green		1	2	3	4	5	6
7. Emerald Green		1	2	3	4	5	6
8. Blue/Green (Teal)		1	2	3	4	5	6
9. Maroon		1	2	3	4	5	6
10. Purple		1	2	3	4	5	6
11. Tan		1	2	3	4	5	6
12. Brow/Yellow		1	2	3	4	5	6
14. Brown		1	2	3	4	5	6

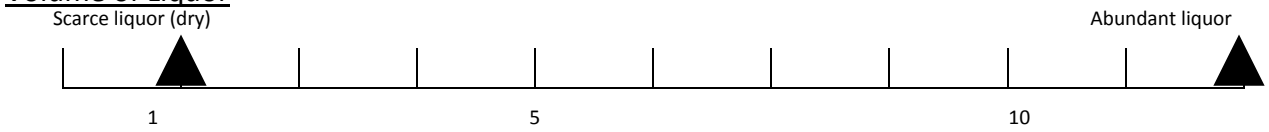
Oyster Liquor

Please circle appropriate descriptor(s):

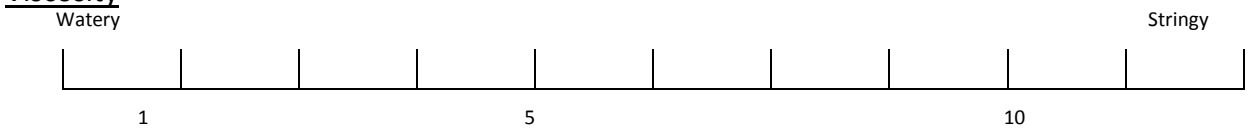
Milkiness: Not Milky Milky

Air Bubbles: Absent Present

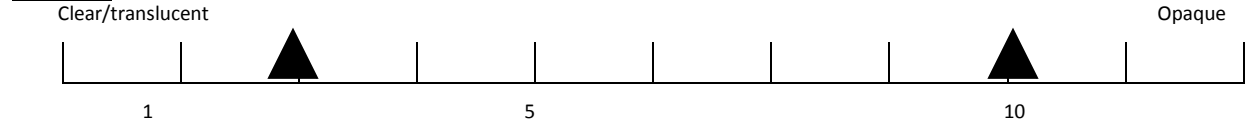
Volume of Liquor



Viscosity



Opacity

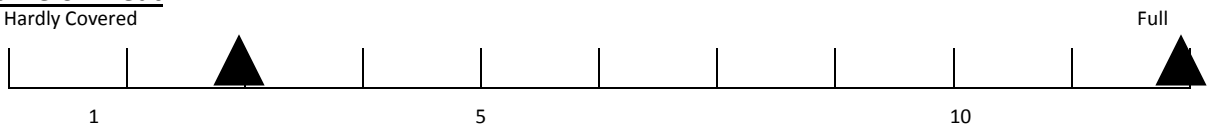


Oyster Meat

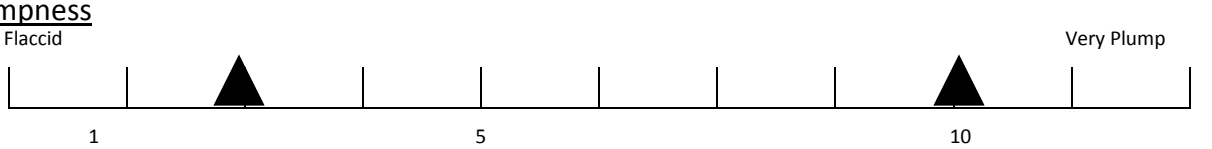
Please circle appropriate descriptor(s):

Shattered Meat: Yes No

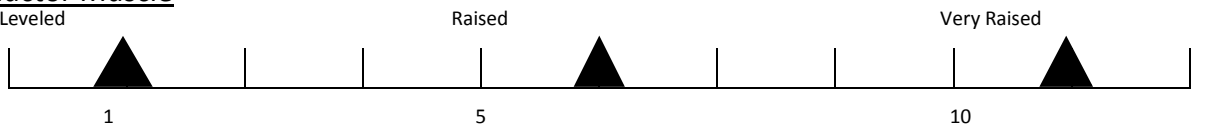
Volume of Meat



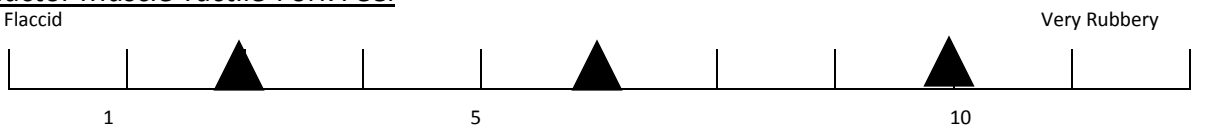
Plumpness



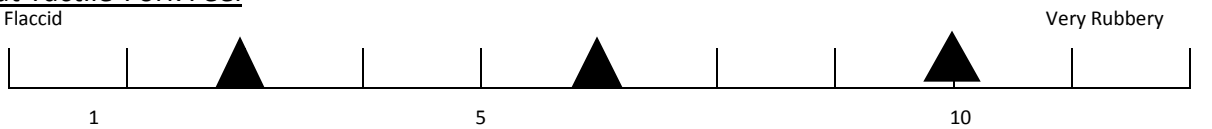
Adductor Muscle



Adductor Muscle Tactile-Fork Feel

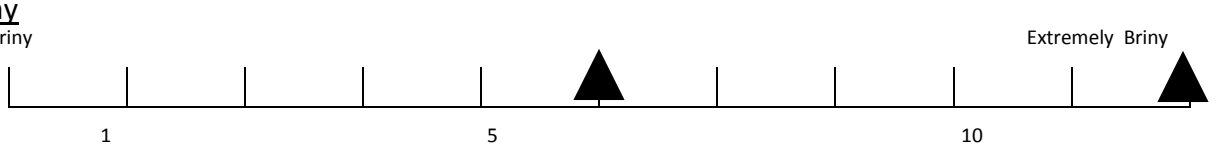


Meat Tactile-Fork Feel

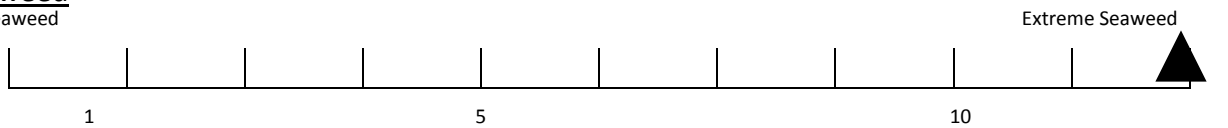


Aroma/Smell

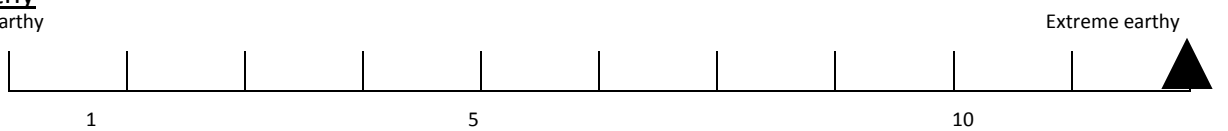
Briny



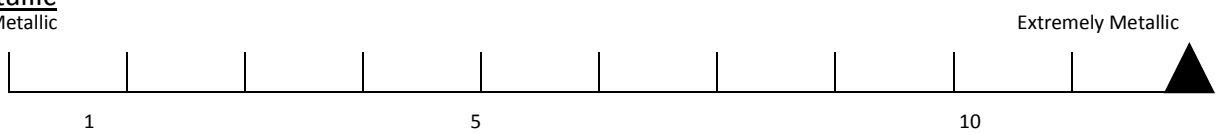
Seaweed



Earthy



Metallic

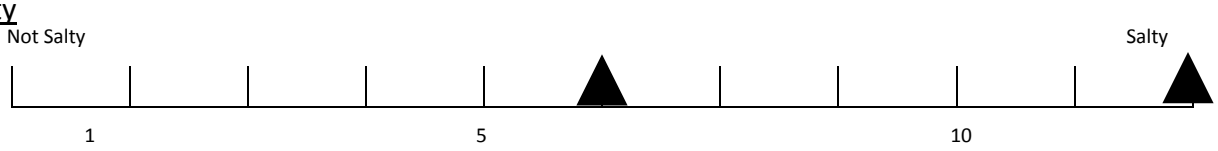


If any objectionable odors are detected, please circle the appropriate descriptor(s):

Agar	Ammonia	Boiled Potato	Fecal	Fishy
Garlic	Sour	Wet Burlap Sac	Wet Dog	Other:_____

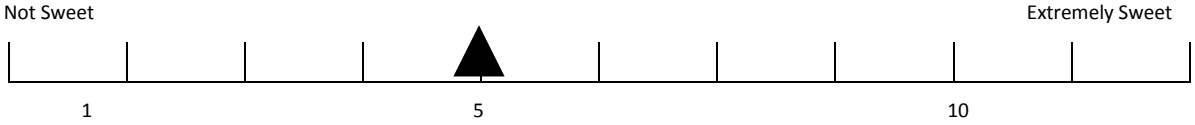
Basic Tastes

Salty

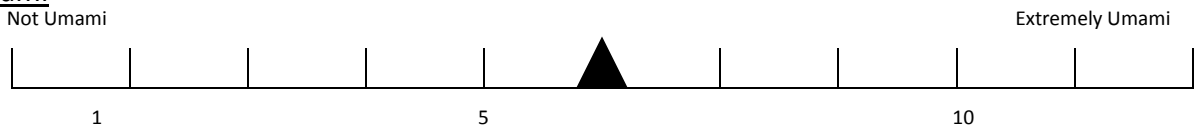


If saltiness is higher than 10, please specify:_____

Sweet



Umami

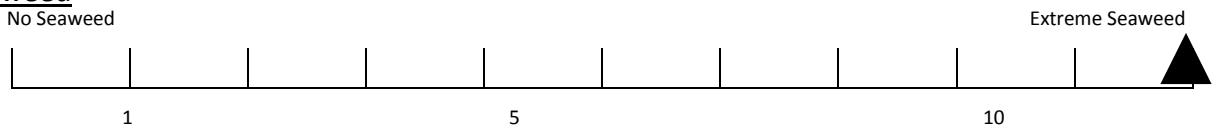


If any objectionable basic tastes are detected, please circle the appropriate descriptor(s):

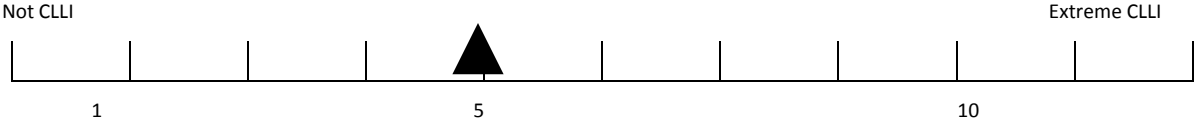
Sour Bitter

Flavor

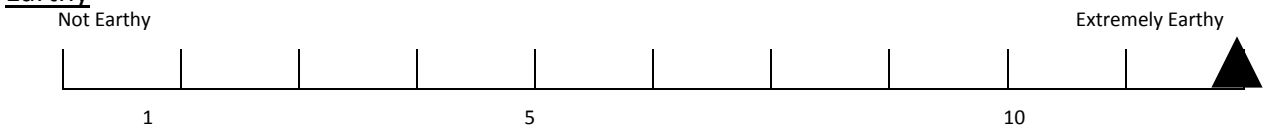
Seaweed



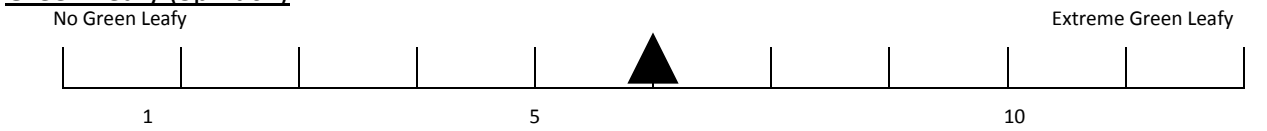
Chicken-Liver-Like/Iron(CLLI)



Earthy



Green Leafy (Spinach)



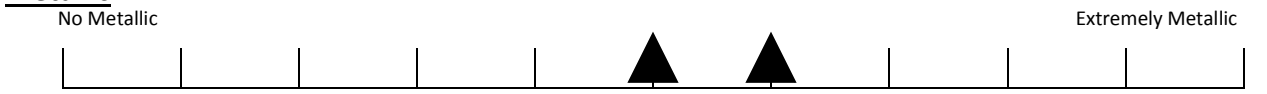
If any objectionable flavors are detected, please circle the appropriate descriptor(s):

Boiled Potato-Like Fishy Garlic (Oil) Raw Cabbage

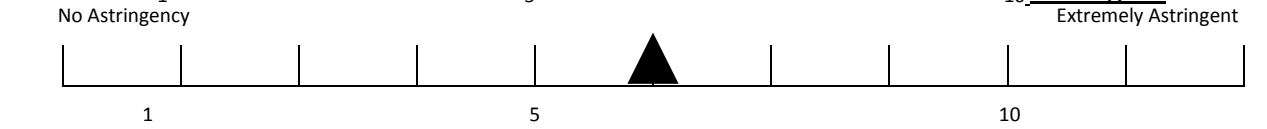
Wet Burlap Sac Other:_____

Aftertastes

Metallic



Astringent



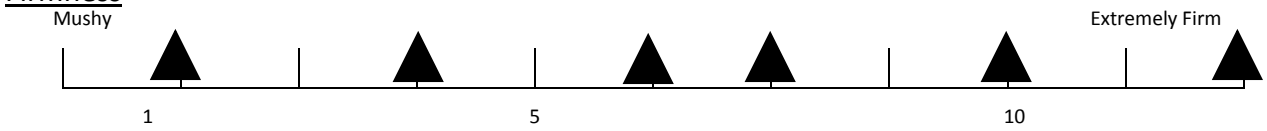
If any objectionable aftertastes are detected, please circle the appropriate descriptor(s):

Chalky Other:_____

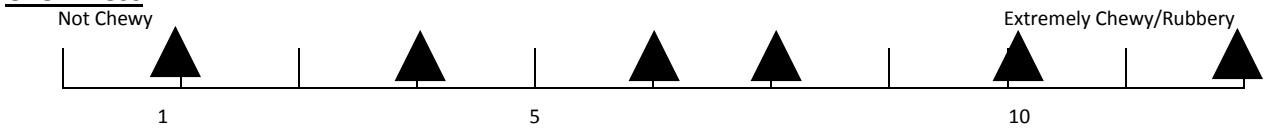
Texture & Mouth feels

Adductor Muscle

Firmness

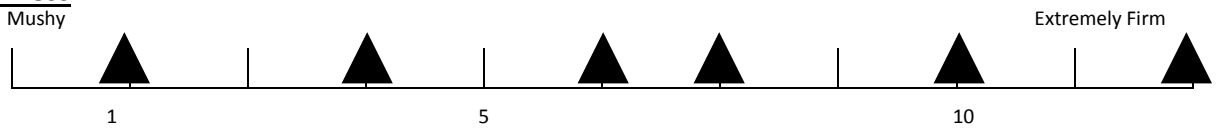


Chewiness

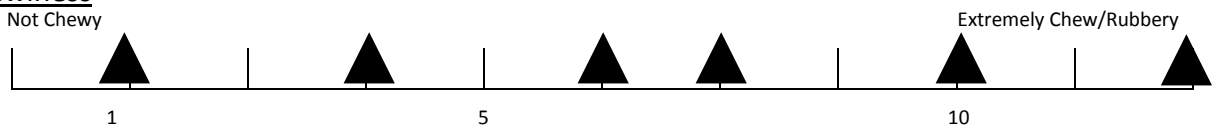


Body

Firmness



Chewiness



If any objectionable mouth feels are detected, please circle the appropriate descriptor(s):

Grittiness from sand Grittiness from shell

Other:_____