Post Harvest Processing
Post Harvest Processing (PHP) for Oysters

**WHY ?**

Because consumers prefer to eat them raw!

Limited illnesses occur but they are persistent.
Despite an extensive safety record, oyster consumption still requires special food safety attention ...

... the real issue is the recipe (raw) and the health of the consumer.
The primary food safety concern is certain naturally occurring bacteria that if present in certain amounts and certain types, it could present potential health problems for certain consumers …

… the primary bacteria of concern are certain types of *Vibrios*. 
Post Harvest Processing (PHP) for Oysters

Processing designed to retain raw product characteristics while reducing certain bacterial loads to acceptable levels

1. Reception of shellfish
2. Cold storage
3. Wash & cull
4. Post Harvest Processing
5. Finished product storage

Key Bacteria:
- *V. vulnificus*
- *V. parahaemolyticus*
Post Harvest Processing (PHP) for Oysters

Current PHP methods approved and have been used in USA commerce

- Freezing
- Hydrostatic High Pressure
- Low Temperature Pasteurization
- Irradiation
- Others
- Nitrogen
- Carbon Dioxide
- Blast
- Standard Freezer

**PHP - FREEZING**

1. Whole oyster
2. Remove top shell
   - Whole Shellstock
3. Freeze
4. Glaze
5. Pack

**Frozen storage**
PHP - Freezing

Key to effective freezing in terms of bacterial reduction

- Rate of freeze
- Duration for frozen storage
PHP - Freezing

Pros:
• Market acceptance noted & acceptable in restricted markets (CA)
• Low initial cost – facility, equipment ($300,000+)
• Long shelf-life and inventory control
• Product available during harvest closures
• Variable product forms – whole, half-shell, shucked, value-added
• No royalty fees for new processors (?)

Cons:
• Market acceptance limited, not preferred
• Requires high product cost vs. profit margins?
• Delay in returns on investments
• Entry and maintenance costs
• Lack of available validations and periodic verifications
High Pressure

Whole oyster

Banding

High Pressure

Shuck, grade & wash

Pack → Refrig. storage
PHP – High Pressure

Vibrio reduction
3 min @ 40,000 psi.
PHP – High Pressure

Pros:
• Reduces labor to shuck shellstock for processors thru food service
• High product quality – product appearance excellent
• Market acceptance noted & acceptable in restricted markets (CA)

Cons:
• High initial cost – facilities, equipment and spare parts ($1.7M+)
• Needs trained maintenance personnel on-site
• Higher sale price for oysters when compared to traditional
• Royalty fees for new processors
• Market acceptance limited, not preferred
PHP - Cool Pasteurization

Patented process with required royalty fees

Whole oyster

Banding

Heat – Cool Treatments

Shuck, grade & wash

Pack → Refrig. storage
PHP – Cool Pasteurization

Processing parameters  24 min. @ 128° F
PHP – Cool Pasteurization

Pros:
• Moderate initial cost – facility, equipment ($500,000)
• Higher yields than traditional (company claims)
• Market acceptance noted & acceptable in restricted markets (CA)

Cons:
• High initial cost – facilities, equipment ($500,000+)
• Needs trained maintenance personnel on-site
• Higher sale price for oysters when compared to traditional
• Royalty fees for new processors
• Market acceptance limited, not preferred
PHP - Irradiation

• Gamma
• X- Rays
• E-beam

Whole oyster

Remove top shell  Whole Shellstock

Irradiate

Pack  →  Refrig. storage
FDA issues new rule effective Aug 16, 2005 recognizing safe use of ionizing radiation for the control of *Vibrio* species and other foodborne pathogens in fresh or frozen molluscan shellfish (e.g., oysters, mussels, clams, etc.)

http://a257.g.akamaitech.net/7/257/2422/01jan20051800/edocket.access.gpo.gov/2005/05-16279.htm
PHP – Irradiation

Truck unloading
Oyster pallet used for dose mapping
Metal carriers for pallets
Loading pallets on carriers

Irradiation 0.82 kGy minimum absorbed dose

Oyster box with dosimeters

Unloading carriers and loading the truck
PHP – Irradiation

Pros:
• Proven effective with Gamma and X-rays
• Moderate initial cost – facility, equipment, ‘dual trucking’
• Market acceptance noted

Cons:
• Availability of facilities and use of contracted services
• Higher sale price for oysters when compared to traditional
• Market acceptance limited, lacks experience
• Linger consumer concern for irradiated products vs. labeling
PHP – Status in USA

• Currently 5-6 freezing plants (CO2 and N2)
• Blast freezing has shown Vv reductions to non-detectable levels, but hesitant to use relative to cash flow and need for verification services
• One pasteurization plant with patent
• Three high pressure plants
• Limited irradiation plants available for shellfish
• Average cost of PHP product $0.25 – $0.50 per oyster (wholesale)
• Markets and Consumers will accept PHP, but prefer traditional
PHP Concerns?

Support for Validations & Verifications

*Vibrio vulnificu* levels

3 thru 100 MPN / g?
PHP Concerns?

Market and Consumer Preference vs. Acceptance
Proven approach:
Trained ‘food product profiling’ panels for sensory characterization of raw oysters

Product Characterization for Oysters

Sensory Profiling
Sensory Terminology

**APPEARANCE**
- Product Color - Meat; Edges; & Visible Inner Shell
- Oyster Liquor - Opacity; Milkiness; & Air Bubbles
- Oyster Meats - Volume (fill); Plumpness; & Adductor

**AROMA**
- Seaweed; Briny; Freshness; Metallic; Earthy; Iodine; Wet Burlap; Fecal & Shellfish

**FLAVOR**
- Seaweed; Salty; Sweet; Sour; Bitter; Earthy; Wet Burlap; Umami

**TEXTURE**
- Firmness; Chewiness

**AFTERTASTE**
- Astringency; Chalky; Metallic
Sensory Definitions

SEAWEED  Seaweed aroma or taste per Std SA10-wet seaweed

BRINY  Resembling saltiness or the sea per Std. B10-seawater, seaweed & oyster shell blend

SHELLFISH  Aroma similar to fresh shrimp per Sample Std. 10 (white shrimp from Gulf of Mexico)

UMAMI  Taste (savory) and mouthfeel produced by MSG
Sensory Standards

**Firmness (15 point scale):**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Jello 211 (Knox gelatine)</td>
</tr>
<tr>
<td>2.5</td>
<td>Canned peaches-diced-4oz. Del Monte</td>
</tr>
<tr>
<td>5.0</td>
<td>Yellow American cheese (wrapped) Kraft</td>
</tr>
<tr>
<td>7.5</td>
<td>Dried Apricots (Sun maid- Mediterran.)</td>
</tr>
<tr>
<td>10</td>
<td>Jello 121 (Knox gelatine)</td>
</tr>
<tr>
<td>15</td>
<td>Cooked Chicken Breast-salad top (Plain Purdue)</td>
</tr>
</tbody>
</table>

*Product temperature is essential!*
Oyster Color Scales
Fresh Oysters

FLAVOR

February

May

July
Fresh Oysters - Shelf-Life Study

Flavor

- Saltiness
- Sweetness
- Seaweed
- Wet Burlap
- Earthy
- Umami
- Bitter

Comparison of flavor intensity across different days:
- Day 2
- Day 4
- Day 8
- Day 10
- Day 14

The graph illustrates the relative intensity of various flavors over the span of 14 days, showing a decline in saltiness and sweetness, and an increase in umami and bitter notes as the shelf life progresses.
Frozen Shelf Life Study

Flavor

Saltiness, Sweetness, Seeweed, Wet Burlap, Earthy, Umami, Bitter

1 week, 2 months, 4 months, 6 months
Virtually Training and Product Characterization
Dolphin Bay Delights

Natural Sea Aroma
Salty Rating 6.5
Umami Scale ‘A’
Plump & Full Cups
Verified

$4.00 / dozen
Panorama of Oyster Options

Galveston Bay

SW Pass

Apalachi Bay’s
Florida – Taste a Difference

Monkey’s Elbows

Cat Point Delights

Fish Hawk’s

Apalachicola
'PHP' - COOKING

• D value – the decimal reduction time required at a certain temperature to kill 90% of the organisms

• Z value – the temperature required for one log reduction in the D-value

\[
z = \frac{T_2 - T_1}{\log D_1 - \log D_2}
\]

Whole or Half-Shell Oysters

Heating

The caveman was right!

Serving
What does “Cooked” actually mean
What does “Cooked” actually mean?

### Heat Resistance

#### Heat resistance of *V. cholerae*.

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>Temp. (°F)</th>
<th>D-Value (min.)</th>
<th>Medium</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>48.9</td>
<td>120</td>
<td>9.17</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>49</td>
<td>120.2</td>
<td>8.15</td>
<td>Crabmeat</td>
<td>Shultz et al., 1984</td>
</tr>
<tr>
<td>54</td>
<td>129.2</td>
<td>5.02</td>
<td>Crabmeat</td>
<td>Shultz et al., 1984</td>
</tr>
<tr>
<td>54.4</td>
<td>129.9</td>
<td>0.43</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>60</td>
<td>140</td>
<td>2.65</td>
<td>Crabmeat</td>
<td>Shultz et al., 1984</td>
</tr>
<tr>
<td>60</td>
<td>140</td>
<td>0.39</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>65.5</td>
<td>149.9</td>
<td>0.32</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>66</td>
<td>150.8</td>
<td>1.60</td>
<td>Crabmeat</td>
<td>Shultz et al., 1984</td>
</tr>
<tr>
<td>66</td>
<td>150.8</td>
<td>1.22</td>
<td>Crayfish homogenate</td>
<td>Groder and Hinton, 1985</td>
</tr>
<tr>
<td>71</td>
<td>159.8</td>
<td>0.30</td>
<td>Crabmeat</td>
<td>Shultz et al., 1984</td>
</tr>
<tr>
<td>71</td>
<td>159.8</td>
<td>0.30</td>
<td>Crayfish homogenate</td>
<td>Groder and Hinton, 1985</td>
</tr>
<tr>
<td>71.1</td>
<td>160</td>
<td>0.31</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>76.7</td>
<td>170.1</td>
<td>0.30</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
<tr>
<td>77</td>
<td>170.6</td>
<td>0.27</td>
<td>Crayfish homogenate</td>
<td>Groder and Hinton, 1985</td>
</tr>
<tr>
<td>82</td>
<td>179.6</td>
<td>0.27</td>
<td>Crayfish homogenate</td>
<td>Groder and Hinton, 1985</td>
</tr>
<tr>
<td>82.2</td>
<td>180</td>
<td>0.28</td>
<td>Shrimp homogenate</td>
<td>Hinton and Grodner, 1985</td>
</tr>
</tbody>
</table>

#### Heat resistance of *V. parahaemolyticus*.

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>Temp. (°F)</th>
<th>D-Value (min.)</th>
<th>Medium</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>116.6</td>
<td>65.1</td>
<td>7.5% NaCl</td>
<td>Deuchat and Worthington, 1976</td>
</tr>
<tr>
<td>49</td>
<td>120.0</td>
<td>0.82</td>
<td>Clam homogenate</td>
<td>Delmore and Chrisley, 1979</td>
</tr>
<tr>
<td>51</td>
<td>123.8</td>
<td>0.66</td>
<td>Clam homogenate</td>
<td>Delmore and Chrisley, 1979</td>
</tr>
<tr>
<td>53</td>
<td>127.4</td>
<td>0.40</td>
<td>Clam homogenate</td>
<td>Delmore and Chrisley, 1979</td>
</tr>
<tr>
<td>55</td>
<td>131</td>
<td>0.29</td>
<td>Clam homogenate</td>
<td>Delmore and Chrisley, 1979</td>
</tr>
</tbody>
</table>

#### Heat resistance of *V. vulnificus*.

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th>Temp. (°F)</th>
<th>D-Value (min.)</th>
<th>Medium</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>116.6</td>
<td>2.40</td>
<td>Buffered saline</td>
<td>Cook and Ruple, 1992</td>
</tr>
<tr>
<td>50</td>
<td>122</td>
<td>1.15</td>
<td>Buffered saline</td>
<td>Cook and Ruple, 1992</td>
</tr>
</tbody>
</table>
Restaurant Settings

- Asked to cook normally
- Insert temperature probe
- Recorded thermal consequences
Conclusions

• All trials over 145°F for 15 sec
• Many over 200°F internal temperature
• More likely “over done” for micro purposes
Serving Heating Whole or Half-Shell Oysters

‘PHP’ - COOKING

HACCP Controls for Food Service

KEY DRIVER is SOURCE
Summary

• At least four PHP options developed
• PHP methods with validations and verifications
• PHP encouraged and recognized by prevailing governance
• Commercial experience proves PHP product acceptance
• Challenge remains regarding PHP product preference
• Concerns hampering commercial adoption
Thank You