Building A Safe Food System: The Role of Cold Chain Logistics in Food Safety of Perishable Food

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Date:  
September 30, 2020
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Dr. Lourdes Martinez Romero is an agricultural economist in the Bureau for Resilience and Food Security, Food Safety Division. She specializes in market and food system development. Currently, Dr. Martinez Romero works on low-income consumers and micro, small and medium enterprises access to safe, nutritious food systems in local and international markets.
Building A Safe Food System: The Role of Cold Chain Logistics in Food Safety of Perishable Food
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Food Safety and Nutrition within a Food System
FIGURE 2-2 The components of a food system.

SOURCES: Presented by Kate Clancy on August 7, 2019, from IOM and NRC, 2015.
Effects of Electromagnetic Radiation (Light)

1. Quality Effects: Odors, Flavors, Discoloration
2. Nutritional Effects: Loss of Nutritional Value
3. Human Health Risk Effects
Electromagnetic Radiation (Light) and Nutrients

Light, especially UV light leads to the creation of free radicals that react with chemicals, especially those with double-bonds in the molecular structure.

**Nutrients**
- Riboflavin - Vitamin B2,
- Pyridoxine - Vitamin B6
- Cobalamin - Vitamin B12
- Folate - Vitamin B9
- Ascorbate - Vitamin C
- Retinol - Vitamin A
- Ergocalciferol - Vitamin D2
- Cholecalciferol, Vitamin D3
- Tocopherols - Vitamin E
- Fatty Acids
- Proteins and Amino Acids

**Other Food Compounds**
- Carotenoids
- Chlorophyll
- Flavanoids
- Anthocyanins
- Quercetin
- Myoglobin (UV & Visible)

Duncan & Chang *Advances in Food Science*, 2012.
## Pasteurization vs. Light

<table>
<thead>
<tr>
<th>Treatment</th>
<th>A: Loss of vitamin (%)</th>
<th>B: Loss of vitamin (%)</th>
<th>C: Loss of vitamin (%)</th>
<th>E: Loss of vitamin (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cow milk</td>
<td>Goat milk</td>
<td>Cow milk</td>
<td>Goat milk</td>
</tr>
<tr>
<td>Pasteurization</td>
<td>0–17</td>
<td>0–8.8</td>
<td>1–10</td>
<td>1.8–4.0</td>
</tr>
<tr>
<td>UV, 1 pass</td>
<td>8.0–13</td>
<td>1.0–9.0</td>
<td>3.0–10</td>
<td>1.0–2.0</td>
</tr>
<tr>
<td>UV, 3 passes</td>
<td>12–20</td>
<td>2.85–20</td>
<td>10.9–17.2</td>
<td>11–11.3</td>
</tr>
<tr>
<td>UV, 5 passes</td>
<td>20–27.5</td>
<td>12.8–28.9</td>
<td>14.1–26.9</td>
<td>11.9–15.1</td>
</tr>
<tr>
<td>UV, 7 passes</td>
<td>30–32</td>
<td>18.6–42.2</td>
<td>20.3–31.2</td>
<td>17.8–22.6</td>
</tr>
</tbody>
</table>

1 The milk samples are cow milk (C1, C2, and C3) and goat milk (G1, G2, and G3) samples.

<table>
<thead>
<tr>
<th>Food product</th>
<th>Optimal storage temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deep-frozen food</td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>$-25 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Poultry</td>
<td>$-24 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Fish</td>
<td>$-29 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Fruits and concentrated juices</td>
<td>$-18 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Vegetables</td>
<td>$-18 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Frozen food</td>
<td></td>
</tr>
<tr>
<td>Frozen butter</td>
<td>$-20 , ^\circ C$ or colder</td>
</tr>
<tr>
<td>Chilled food</td>
<td></td>
</tr>
<tr>
<td>Fresh meat</td>
<td>$-1.5 , ^\circ C$</td>
</tr>
<tr>
<td>Meat products</td>
<td>$-2 , ^\circ C$</td>
</tr>
<tr>
<td>Manufacturing meat</td>
<td>$-2 , ^\circ C$</td>
</tr>
<tr>
<td>Poultry</td>
<td>$-1.5 , ^\circ C$</td>
</tr>
<tr>
<td>Fish</td>
<td>in melting ice ($0 , ^\circ C$ to $-0.5 , ^\circ C$)</td>
</tr>
<tr>
<td>Dairy products</td>
<td>$0 , ^\circ C$ to $2 , ^\circ C$</td>
</tr>
<tr>
<td>Fruits and vegetables</td>
<td></td>
</tr>
<tr>
<td>Low temperature (apple, blueberry,</td>
<td>$0 , ^\circ C$ to $2 , ^\circ C$</td>
</tr>
<tr>
<td>carrot, lettuce, etc.)</td>
<td></td>
</tr>
<tr>
<td>Moderate temperature (carambola,</td>
<td>$6 , ^\circ C$ to $9 , ^\circ C$</td>
</tr>
<tr>
<td>melon, pumpkin, etc.)</td>
<td></td>
</tr>
<tr>
<td>High temperature (banana, cucumber,</td>
<td>$12 , ^\circ C$ to $16 , ^\circ C$</td>
</tr>
<tr>
<td>grapefruit, etc.)</td>
<td></td>
</tr>
</tbody>
</table>
FIG. 1. EFFECT OF STORAGE TIME AND TEMPERATURE ON BROWNING INDEX OF ORANGE (A), PEAR (B) AND GRAPE NECTARS (C)

**FIG. 2.** EFFECT OF STORAGE TIME AND TEMPERATURE ON TOTAL PHENOLIC COMPOUNDS (IN ORANGE (A), PEAR (B) AND GRAPE NECTARS (C)), ASCORBIC ACID (IN ORANGE (D) AND PEAR NECTARS (E)), TOTAL CAROTENOID (IN ORANGE NECTAR (F)) AND TOTAL ANTHOCYANINS (IN GRAPE NECTAR (G))
Let’s Talk About A Dry Heat
I Do Not Mean Tucson

Does Dehydrated Food Retain Nutrients
Issues Related To Drying Food

• Nutritive value, as well as flavor and appearance, is best protected by low temperature and low humidity during storage.

• Sun-dried foods can be pasteurized by heating them in an oven at 175 degrees Fahrenheit (10 minutes for vegetables cut small, 15 minutes for fruits).
Issues Related To Drying Food

• Dried foods can be stored for a long period.

• Conventional methods (long time at elevated temperatures) lead to loss of nutritional value and sensory characteristics.

• Improper use of the preservation methods after dehydration may create food safety risks, quality deterioration, and a short product shelf life.
Nutritional Issues Related To Drying Food

- Vitamins A and C content decreased by heat and air.
- Sulfite treatment prevents the loss but causes the destruction of thiamin.
- Blanching reduces the loss of thiamin and vitamins A and C during dehydration and storage but results in some loss of vitamin C and B-complex vitamins as well as the loss of some minerals, because these are all water soluble.
- Dried foods have more calories on a weight-for-weight basis because of their nutrient concentration. For example, 100 grams of fresh apricots has 51 calories, whereas 100 grams of dried apricots has 260 calories.
The Market for Dry Fish

Figure 1. Export data (value wise) of dry fish from India.

The Market for Dry Fish

Figure 4. Market prices for different dry fishes in and around Kolkata (India).

Overall shell eggs lose very few nutrients when stored properly.

Quality of eggs stored at room temperature deteriorates at a much faster rate than does the nutritional value.

Thiamin can deteriorate over time.

Protein not affected by appropriate drying. Xanthophylls in yolk decrease with storage.

Drying with too much heat can lead to Maillard Reaction and decrease protein availability.
### Table 3: Microbial profile of eggs during storage

<table>
<thead>
<tr>
<th>Treatment</th>
<th>WK0 (CFU/ml)</th>
<th>WK2 (CFU/ml) TPC</th>
<th>WK4 (CFU/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>$5.0 \times 10^3$</td>
<td>$1.4 \times 10^5$</td>
<td>$2.8 \times 10^7$</td>
</tr>
<tr>
<td>Refrigerated</td>
<td>$5.0 \times 10^3$</td>
<td>$2.0 \times 10^4$</td>
<td>$1.1 \times 10^4$</td>
</tr>
<tr>
<td>Oiled</td>
<td>$5.0 \times 10^3$</td>
<td>$3.0 \times 10^3$</td>
<td>$7.2 \times 10^4$</td>
</tr>
<tr>
<td>Ambient</td>
<td>$9.0 \times 10^2$</td>
<td>$3.0 \times 10^5$</td>
<td>$1.2 \times 10^5$</td>
</tr>
<tr>
<td>Refrigerated</td>
<td>$9.0 \times 10^2$</td>
<td>$1.0 \times 10^4$</td>
<td></td>
</tr>
<tr>
<td>Oiled</td>
<td>$9.0 \times 10^2$</td>
<td>$9.0 \times 10^2$</td>
<td>$1.5 \times 10^3$</td>
</tr>
</tbody>
</table>

TPC = Total plate count, YMC = Yeast and Mould Count, CFU/ml = colony forming unit per ml.
Summary

- Food Processing Has Mixed Effects on the Nutritional Value of Food and Depends of Type of Processing and Food Components.

- Product Quality and Nutritional Status Are Intimately Associated with each other during Food Processing.
Thank You

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Food Safety and the Cold Chain
Introduction

The Cold Chain & Food Safety Meet

“WHO’s first ever global estimates of foodborne diseases find children under 5 account for almost one third of deaths (World Health Organization: WHO, 2015)”

Temperature Control is Critical in Food
Cold Chain
Cold chain is a temperature-controlled supply chain.

Cold Chain Starts on the Farm or Sea Harvest times

• Shading
• Plastic Crates for Air Circulation
• Precooling
• Blast Freezing
• Cold Storage
• Refrigerated Vehicles
Four Key Elements of Food Safety

• Quality-Safety Culture
  • Leadership is engaged in planning and monitoring the FSMS.
  • The company commits visible resources to quality and safety.
  • Employee perception surveys show genuine buy-in with safety and quality values.
  • People take ownership of quality and safety issues they see.

• Compliance
  • Regulatory Agencies Requirements
Four Key Elements of Food Safety Cont...

- **Traceability**
  - Link production, shipping and receiving data to trace food forward and backward in the food supply.
  - Connect Supplier Management tools to track and resolve supplier-related issues for improved supply chain visibility.
  - Record the history of compliance-related activities for better visibility into source and scope of potential problems.

- **The FSMS as the Foundation**
  - Documents
  - Employee training
  - Audits
  - Reporting
  - Corrective Action
Critical Areas for Contamination
Business Reason for Food Safety

- Safe & Quality Food - Extends life of Human
- Reduce Food Borne illness – Economically burdens many countries
- Market Access – Export Market Higher Return on product
- Brand Advantage – Over local competitor
Cold Chain Solutions

- Mobile Precooler & Mobile Blast Freezer
- Aldelano Solar Cold Box/Water Maker
- CloudTrack – Temperature Monitoring & Fleet Management Software
- GPS Tracking of Reefer Trucks
- Verizon Connect - GEOFENCE
Conclusion

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Thank You
THANK YOU!

Q & A
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