High Pressure Processing of Food and Beverage

What’s New?

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Today’s Discussion

• HPP Overview
• Category growth
  – Key drivers
• New products
• Application in major food categories
  – Juice/beverages
  • Products for children
  – Prepared foods
  – Raw pet food
• Commercial HPP equipment
HPP food applications

Pressure (PSI/Bars)

<table>
<thead>
<tr>
<th>Relative Pressures</th>
<th>Pressure (PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea level</td>
<td>14.5/1</td>
</tr>
<tr>
<td>Challenger Deep</td>
<td>15,750/1,100</td>
</tr>
<tr>
<td>Non-Microbial Food Appl.</td>
<td>30,000/2,000</td>
</tr>
<tr>
<td>HPP Shellfish shucking/Vibrio</td>
<td>45,000/3,100</td>
</tr>
<tr>
<td>HPP acidic products</td>
<td>75,000/5,200</td>
</tr>
<tr>
<td>HPP low acid products</td>
<td>87,000/6,000</td>
</tr>
<tr>
<td>PATSTAPS - Low Acid SS</td>
<td>120,000/&gt;8000</td>
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</tbody>
</table>
How HPP Works

**Baskets loaded on conveyor**

- **Water Storage Tank**
- **Pre-fill Pump**
- **Intensifier Pumps**
- **Frame/yoke**
- **Product in baskets**
- **Conveyor**
- **Vessel**
- **To Pack Off**

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Growth of commercial HPP application
$12B US

HPP COMMERCIAL INSTALLED (LITERS)

YEAR

LITERS


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Commercial application of HPP by product category

Food production volumes

- RTE Meat/Poultry
- Dips/spreads/wet salads
- TOLL
- Juice/Beverages
- AVACADO Products
- Fruit based products
- SEAFOOD
- Vegetables
- Dairy/tofu
Continued HPP Growth category

- Continued global growth in beverage industry
  - Larger beverage companies involvement
- Coconut Water – pure and blends
- Prepared foods category expanding
  - Soups, dips, salad dressings, wet salads, condiments, ready meals
  - Greater selections in refrigerated section
    - Movement away from frozen
- Raw pet food
  - Regulation driven
New categories of HPP products

• High protein
  – Beverages
  – Puddings
  – Dips and salads
• Ready meals (refrigerator)
  – Complete meals
  – Soups
• Baby foods
  – Fruit based purees
  – Fruit-Vegetable based
• Raw Protein
  – Pet foods
  – Raw poultry products
  – Meat tenderization
Key factors for adoption of HPP in food and beverage

1. **Inactivation of pathogens**
   - Meet regulatory requirements
   - Avoid food safety recalls
   - Brand protection

2. **No heat or preservatives**
   - Clean label
   - High consumer appeal
   - Fresh/natural taste

3. **Maintains nutrition**
   - No damage to vitamins
   - No damage to bioactive compounds
   - Raw Quality

4. **Increased Shelf-life**
   - Reach wider markets
   - Juice products >4 months
   - Extends quality

5. **New products**
   - Value added refrigerated products
   - Health formulations
   - Better sensory properties

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Fruit juice & vegetable beverages
Market drivers

- Food safety (FDA 5-log Pathogen Rule) for fruit juice:
  - *Salmonella*
  - *E.coli O157:H7*
  - *Listeria monocytogenes*
  - *Cryptosporidium parvum*

- Nutrition
  - No damage to vitamins and bioactive compounds

- Shelf-life

- Freshness – “raw” taste
5-Log pathogen reduction in apple - vegetable juice beverage: 5,450 bars 2 min
Effects of HPP on pathogens in almond milk beverage: 5930 bars, 3 min

Log CFU/mL

Days after HPP

pH: 6.4

E. coli O157:H7 Non-HPP
E. coli O157:H7 HPP
Salmonella Non-HPP
Salmonella HPP
L. monocytogenes Non-HPP
L. monocytogenes HPP

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Nutrition
Largely unaffected

- Vitamins
- Minerals
- Bioactive compounds
  - Antioxidants, etc.
- Enzymes
Nutrition
- Vitamins and antioxidants

### Effects of Pressure on Vitamin C

- **Study (9/2001): Flow International Corporation & Medallion Laboratories.**

### Effects of Pressure on Folic Acid

- **Study (9/2001): Flow International Corporation & Medallion Laboratories.**

### Effects of Pressure on Niacin

- **Study (9/2001): Flow International Corporation & Medallion Laboratories.**

### Chlorophyll

- **Process conditions**

### Lutein
Fresh/Raw taste

- Fresh Orange
- Bitter
- Sweet
- Tangy/Juicy
- Acid
- Pithy/Rindy
- Processed

Lines indicate:
- **Blue** Fresh
- **Green** HPP
- **Red** Heat Pasteurized
Orange and apple juice loading in HPP vessel
Holland and Brazil
Cut fruit in juice, fruit purees, jams
Examples of beverages in the US
Natural One HPP juices in Brazil

“HPP technology that keeps our pure Natural One juices fresh and nutritious.”
HPP beverage products
-Larger companies are in...
New HPP Kids’ products

SMOOTHIES
An easy way for kids to get their servings of fruit

FRUIT TUBES
A fun fruit snack moms can feel good about

Vegesentials
The Fresh Generation

BEST OF 2014 AWARDS

BEST KIDS' BEVERAGE

Ingredients: Carrot*, Orange*, Filtered Water, Almonds*, Dates*, Vanilla Bean*
* = Organic.
Never heated, never frozen.
High Pressure Processed for freshness.
Vital Juice Co. 1519 Elliott Ave. W.
Seattle, WA 98119
Certified Organic by
Washington State Dept. of Agriculture
New HPP Kids Snacks from Bolthouse - US

<table>
<thead>
<tr>
<th>SMOOTHIES</th>
<th>FRUIT TUBES</th>
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<td>An easy way for kids to get their servings of fruit</td>
<td>A fun fruit snack moms can feel good about</td>
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- **Smoothies**
  - 1½ servings of fruit per bottle!

- **Fruit Tubes**
  - No sugar added!* | see nutrition facts panel|

*Assuming the text is readable and not obscured by the image.
Coconut products

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Prepared/Manufactured Foods

- Refrigerated category growing
  - Value added
  - Home-made appeal
- Natural, clean label
  - Meets Natural/Organic market demand
  - No preservatives
  - Reduced Sodium
- Convenience
  - Heat and serve (entrées)
  - Ready to cook (marinated meats, fresh pasta)
- New products
  - Meet market demands for healthier foods
  - Positive effects on hydrocolloids, proteins
Shelf-life Hummus
With and without preservatives

Hummus Natural (No Preservatives)

Hummus with Preservatives

Days after HPP

log_{10}(CFU/g)

APC (non-HPP)  APC (HPP)
Yeast (non-HPP)  Yeast (HPP)
Lactics (non-HPP)  Lactics (HPP)
Avure – Applications (Ready Meals)
Dips, sauces, condiments, salad dressings, salsas.
“Soup will be a big category,” said Irwin Simon, CEO of Hain Celestial. “…….. I just see the opportunities in fresh, H.P.P. (high pressure pasteurization), which gives you a longer shelf-life, and that’s something we will continue to do.”
Raw Protein: Pet food, poultry market drivers

- Ground products
  - High interest recently
  - Several Major recalls
    - Salmonella, Listeria, E. coli
  - Regulatory requirements
Avure’s HPP Food Systems

10 MILLION
POUNDS PER YEAR

30 MILLION
POUNDS PER YEAR

60 MILLION
POUNDS PER YEAR

AV-S
Thank you

• Questions?