Expansion of HPP into New Product Categories Opportunities and Challenges

2017 HPP SUMMIT
Hosted by Universal Pure

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Discussion Topics

- Pressure levels in food applications
  - Keys to commercial adoption
  - Global usage
  - HPP market value
- Factors that determine HPP conditions & efficacy
- Typical commercial processing conditions
- HPP science & technology overview
  - Microbiology
  - Chemistry
    - Covalent bonds
    - Hydrocolloids (starches/gums), proteins
    - Product formulations
- Growth in common applications
- Expansion into new product categories
- Packaging
HPP food applications

Pressure (PSI/Bars)

Relative Pressures

- Sea level: 14.571
- Challenger Deep: 15,750/11,100
- Non-Microbiol. Food Appl.: 30,000/2,000
- HPP Shellfish: 45,000/3,100
- HPP acidic products: 75,000/5,200
- HPP low acid products: 87,000/6,000
- PATS/TAPS - Low Acid SS: 120,000+8,000
Key Factors for Adoption of HPP

1. Inactivation of pathogens
   - Meet global regulatory requirements
   - Ensures product safety

2. No heat or preservatives
   - Clean label
   - High consumer appeal
   - Fresh 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
   - Healthy formulations
   - Improved organoleptic properties
HPP Market – Geographies
~ 45 countries

Figure 6.1 Regional HPP Foods Markets Forecasts ($bn, AGR%), 2016-2026

Figure 6.3 Regional HPP Foods Markets Share Forecast (% Share), 2016

Source: visionsain 2016
Major Product Category using HPP (%)
Through November, 2016 (Global)

Figure 4.1 Global HPP Food Market Forecast ($bn, AGR%), 2016-2026

- Continued growth that is expected to accelerate
- Driven by new applications, new categories, and extension of existing HPP applications.

Source: visiongain 2016
Major Product Category using HPP (%) Through November, 2016 (Global)

- Meats and Meals: 30.7%
- Wet Salads+Deli: 17.5%
- Juices/Beverages: 13.5%
- Toll: 12.8%
- Toll Juices: 12%
- Seafood: 8.3%
- Fruits: 5.2%
Overview of HPP Science & Technology

- Microbiology
- Chemistry
- Product Development
Important Microorganisms for HPP Pasteurization

- **Vegetative pathogens**
  - *Salmonella*
  - *E. coli* O157:H7
  - *E. coli* STEC 6 (proposed new Regulatory requirements)
  - *Listeria monocytogenes*
  - *Campylobacter*
  - *Vibrio* spp.

- **Other pathogens:** Viruses (product/regulation dependent); Parasites

- **Spoilage microorganisms**
  - Lactic acid bacteria: most critical for HPP
  - Aerobic and anaerobic plate count (APC/TPC/SPC)
  - Yeast
  - Mold
  - Total coliform bacteria

- **Bacterial spores are not affected in current applications**
Important Facts to Note - Chemistry

• HPP does not affect covalent bonds
  ➢ In current HPP application
  ➢ Can have disruption >150,000 psi

• Vitamins and other bioactive compounds are largely unaffected
  ➢ Enzymes

• Proteins unfold with pressure
  ➢ Water molecules are forced into hydrophobic core of protein
  ➢ Disruption of ionic bonds
  ➢ Hydration forces unfolding
  ➢ Leads to protein denaturation

• Gelatinization starches
  ➢ Effects on hydrocolloids
  ➢ Increased viscosity
  ➢ Adjust formulation to compensate
Refrigerated Food Guidelines

FDA/FSIS guidelines to ensure product safety

*Clostridium botulinum*: Non-proteolytic and proteolytic strains

- Temperature
- pH
- Water activity
- Water-phase salt content
- Additive
- Storage/distribution temperature
Factors that affect efficacy of HPP on Microorganisms
Determines HPP conditions

- pH
- Acidulant
- Water activity (A_w)/Brix
- Ingredients
- Nutrient content
- Antimicrobial constituents
  ➢ Naturally present
  ➢ Added
Typical processing conditions for food beverage pasteurization

- **Pressure**
  - Microbial inactivation
  - 4,500 to 6,000 bars (70,000 to 87,000 psi)
- **Hold Time**
  - Generally 1 to 3+ minutes
  - pH, Brix ($A_w$), Ingredients
- **Process Temperature**
  - 4 to 40 °C
  - Organoleptic, functionality
Continued growth in established categories

- Ready to eat (RTE) meat
- Avocado-based products
- Juice and beverages
- Seafood
Commercial HPP RTE Meat Products: Shelf-life 90 to >120 days
Effects of HPP on inoculated pathogens in sliced Roast Beef

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

<10 CFU/g with corresponding Neg/25g Enrichment results plotted as 0

Days after HPP

Log CFU/g
Effects of HPP on spoilage microorganisms in RTE meat: No spoilage after 6 months
Extension of Quality of RTE meats by HPP
Extended SL & Quality of HPP Meat

Non-HPP Control

HPP

Figure 6
Non-HPP Control Roast Beef

Figure 6
HPP Roast Beef
Microbiology

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

  **May need additional validation for “newer” formulations**

  (greater regulatory scrutiny)

- **Note:** Fruit juice with pH ≤4.6 (FDA Juice HACCP Regs. 2004). HPP approval by FDA 1999 – AVURE.
- Low acid juice: *C. botulinum* hazard – FDA guidance (CFSAN, 2007)

- Shelf-life
  - Spoilage bacteria
  - Yeast & molds
Effects of HPP on vegetative pathogens in Apple/vegetable juice blend: 5930 bars/2mins/4°C
Effects of HPP on pathogens in Nut Milk beverage: 5930 bars, 3 min

pH: 6.4
Effects of HPP on pathogens in coconut water
86,000 psi/3 minutes 4°C water
Shelf-life extension of raw coconut water, pH 5.2: 5930 bars, 3 min, 4° C

Update: Coconut water paper is under peer review for publication in the Journal of Food Protection as requested by the US FDA
Newer Products in Market - USA

Caribé Juices

Bringing you the exotic taste of the Caribbean in the healthiest way possible.

AVURE Confidential 2016
Large Companies involvement in HPP Beverage Market

Coca Cola

Starbucks/Evolution Fresh

Bolthouse Farms/Campbell’s

Pepsi
Avocado Products

NO PRESERVATIVES, ADDITIVES OR FLAVOURANTS
HPP – Seafood

- Food safety
- Shelf-life extension
- Process enhancement
  - Shucking of Crustaceans/shellfish
Growth in “newer” Product Categories

• Ready meals
• Soups
• Baby Foods/snacks
• Dips, sauces, salad dressings
• Fruit toppings
• Beverages, “waters”, tea, coffee
• Raw protein
  » Pet Foods
  » Marinated meat & poultry
• Meat protein replacement products
• Dairy
Key Factors for Expansion

- **Health & Nutrition**
  - Preservative free
  - Clean label
  - More protein in diet
  - Freshness

- **Convenience with freshness**
  - Greater urban population growth
  - Increased income
  - Fresh home made appeal

- **Food Safety**

- **Extended refrigerated shelf-life**
Ready Meals – Fastest growing category

- Food Safety
- Extended Refrigerated SL
- Clean Label
- Convenience
- Home cooked appeal

- Needs validation (FDA/FSIS)
  - Replication
  - Components/composite
  - Refrigerated Food Guidelines
  - Packaging
Thai Chicken Noodle Meal Kit
Ready Meals

Thai Chicken Noodles
HPP RTE “Ready” Meals

**Bunless Turkey Burger**
Savory, lean turkey burger with caramelized mushrooms and onions, served with a side of roasted cinnamon-chili sweet potatoes.

**Barbeque Chicken**
Grilled chicken breast brushed with sweet and tangy barbeque sauce, served with flame-roasted corn, peppers, and chili potatoes.

**Chicken Parmesan**
Parmesan cheese melted over an herb-crusted chicken breast, topped with pomodoro sauce and served with whole wheat pasta.
HPP Hummus – Commercial Examples
Hummus Production

- **Significant growth**
  - Preparation of beans
    - Raw peas, in house preparation: Soak, boil and “grind”
    - Raw Chick peas flour/grounds
    - Canned (retorted) chickpeas
    - Aseptic cooked, ground
  - Aseptic cooked, ground is becoming more popular
    - Custom prepared
    - More consistency as a raw material
    - FDA Refrigerated Food Guidelines
    - Mixing under vacuum is better
    - Reduce entrapped air
    - Package integrity
      - Entrapped air will cause damage to containers (cups)
      - Good OTR properties
  - 90 to 120 days of shelf-life
Baby Foods
- fruit based, pH ≤4.6
HPP Soups
Cucina Fresca™ Pasta Sauces are all-natural and contain no artificial ingredients. All of our sauces are manufactured with state-of-the-art High Pressure Processing (HPP) technology to deliver a product that stays fresh longer without preservatives, additives, or heat processing.
Effects of HPP on *L. monocytogenes* in vegetable-based “burger” and meals
HPP of Raw Proteins
Three Main Applications

- **Food Safety**
  - Beef, Pork, Turkey, Chicken
  - Raw pet food

- **Meat Tenderization & Yield Improvement**
  - Pre-rigor (AVURE/Hormel Project)
    - Beef
    - Pork
  - Post-rigor
    - Beef
    - Pork

- **Shelf-life**
  - Whole muscle
Raw Protein: Pet Food
Use of HPP in Pet Food Production

Raw Materials

- HPP
- Refrigerated 24 hours

- Clean Room
  - Freeze
  - Refrigerate

- Form

Freeze Dry

Heat Dry

- Market Frozen or Refrigerated

- Market RT

- Market RT/Ref

- Market Refer

- Market Frozen
HPP Dairy Applications

- Milk
- Soft Cheese
- Yogurt-based Products
- Cheese
Dairy Beverages

Mango and Passionfruit
Refreshing bottled breakfast
High in natural protein
Packaging

• Film Type
  ➢ High Barrier (Foil, KPET, EVOH)
  ➢ High Strength (Nylon)
  ➢ Biodegradable – Not suitable for HPP
    Organic e.g. sugarcane, corn

• Bottles and containers
  ➢ PP not appropriate due to high OTR
  ➢ PET most commonly used
  ➢ PET EVOH
  ➢ Bottle caps
    Double Seal: BERICAP and Silgan
    Bottle lip must be even
Note on Packaging

Good Oxygen barrier container is essential
PP; PE; PLA not appropriate

Closure
Induction seal OR
Double seal caps from Bericap or Triple (double) seal from Silgan

>90,000 psi
Hydraulic pressure will push past threads

Even if water is able to compromise outer seal; hydraulic pressure is diminished and cannot pass inner seal (BERICAP)
AVURE HPP laboratory support - supports our tollers’ customers
Thank You!