Expansion of HPP into New Product Categories Opportunities and Challenges

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JBT STRONGER TOGETHER AVURE

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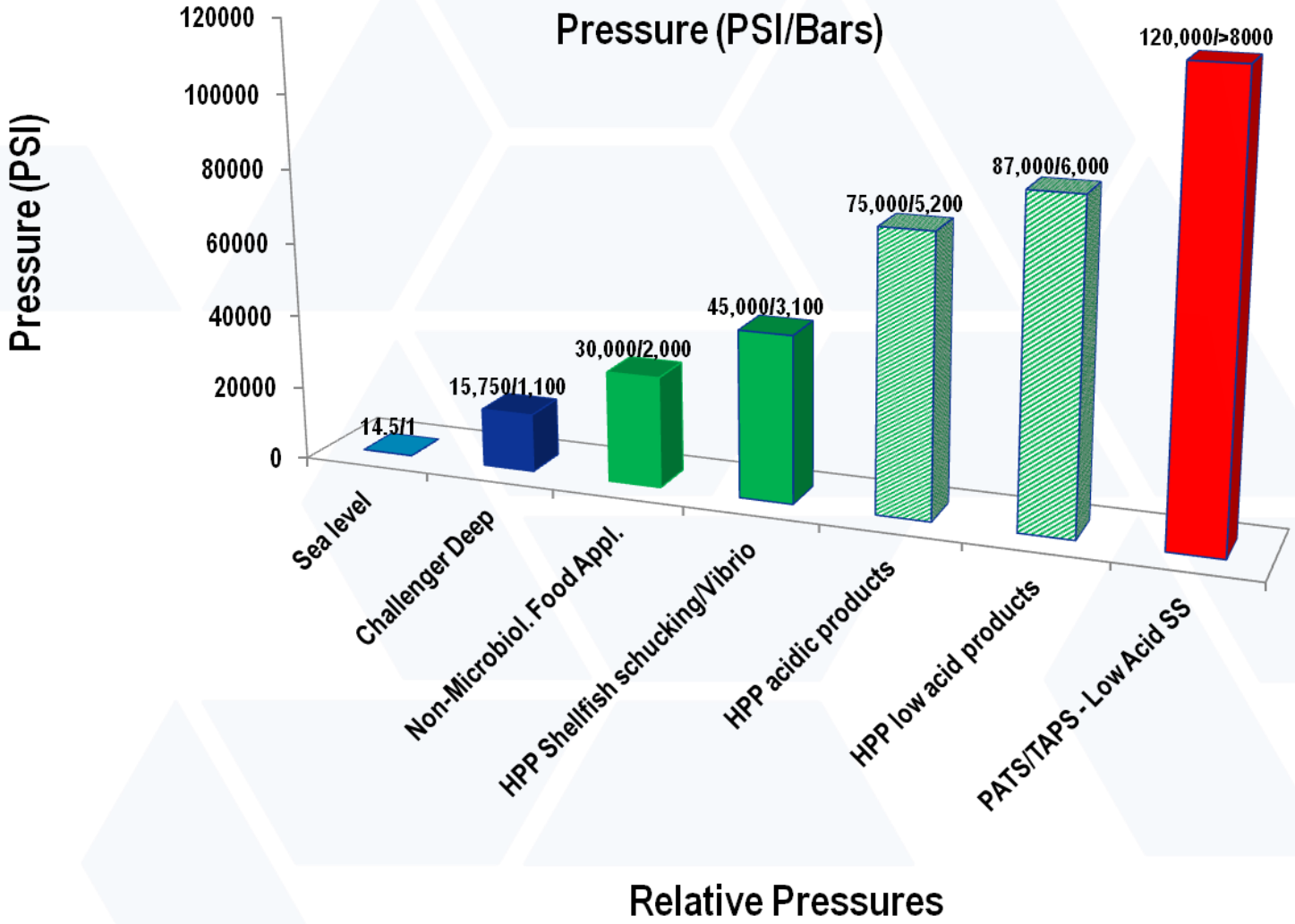
Discussion Topics

- 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



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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

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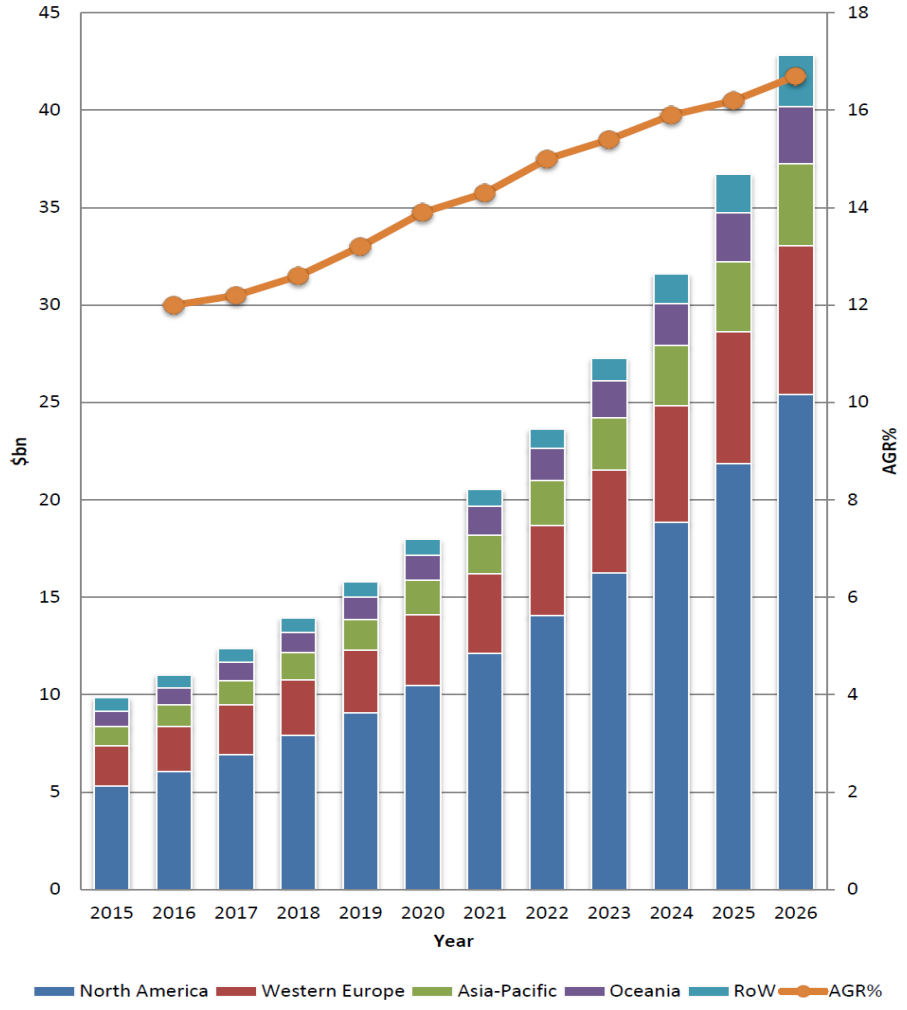
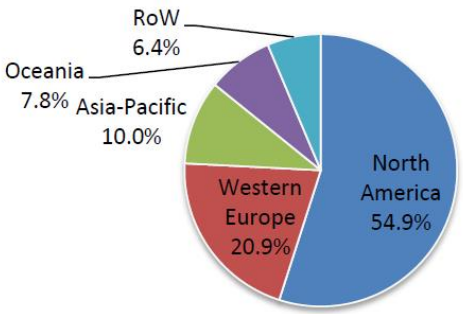
HPP Market – Geographies
~ 45 countries

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



Source: *visiongain 2016*

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



Source: *visiongain 2016*

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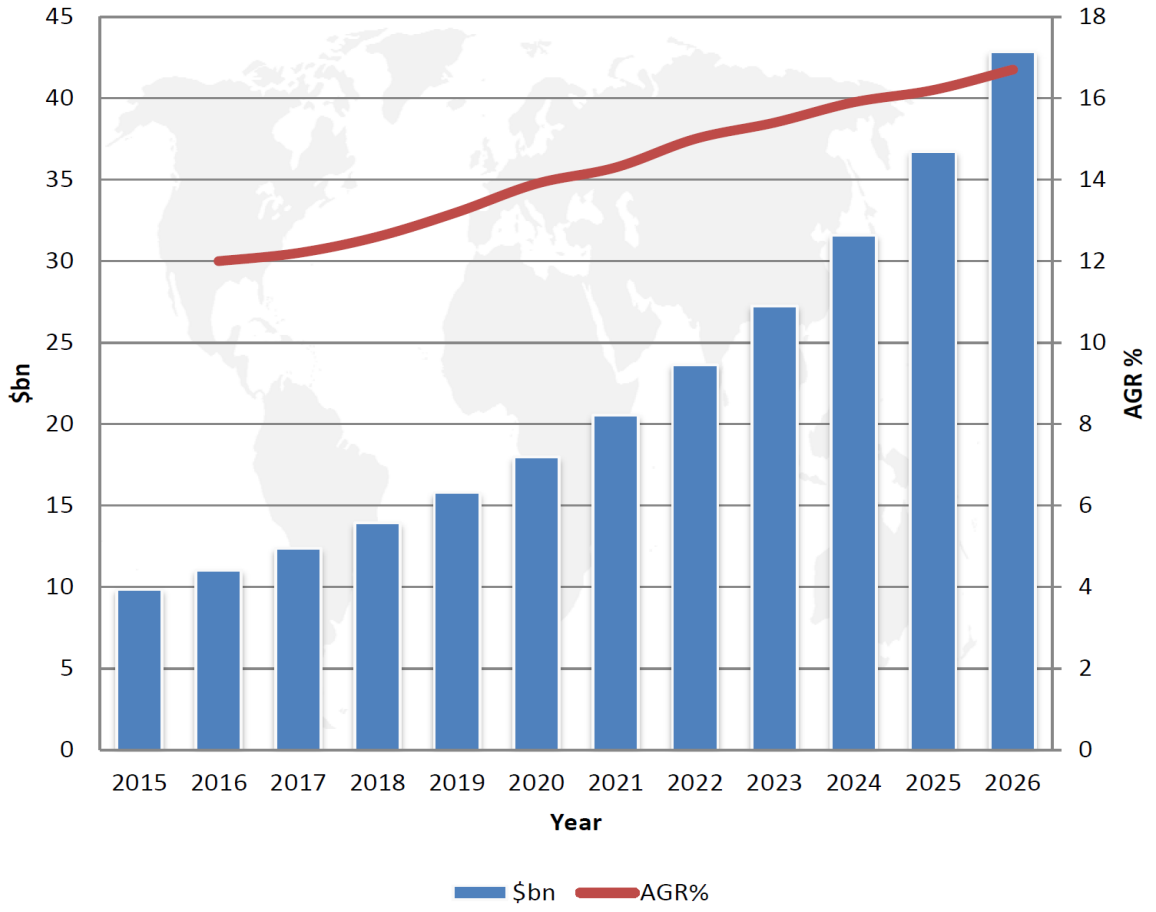
Major Product Category using HPP (%) Through November, 2016 (Global)

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



Source: *visiongain 2016*

Continued growth that is expected to accelerate

Driven by new applications, new categories, and extension of existing HPP applications.

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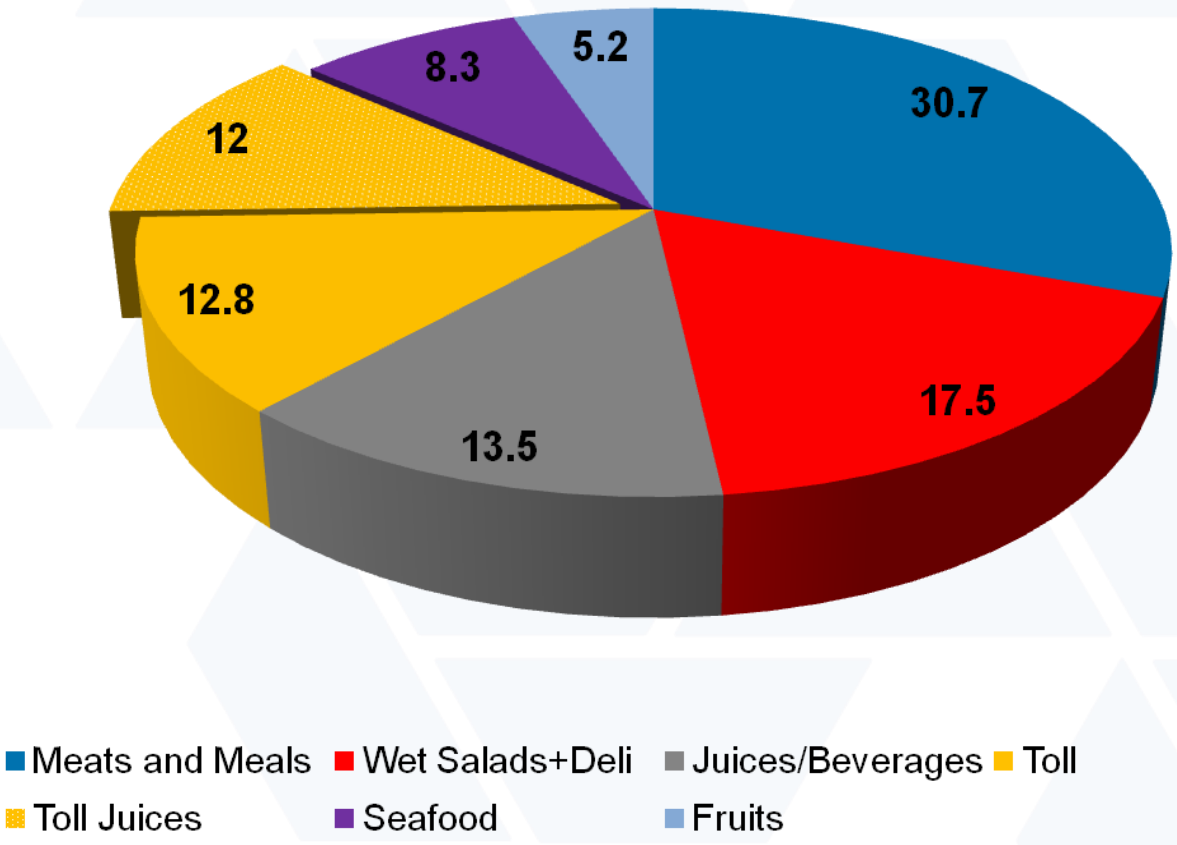
Major Product Category using HPP (%) Through November, 2016 (Global)



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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

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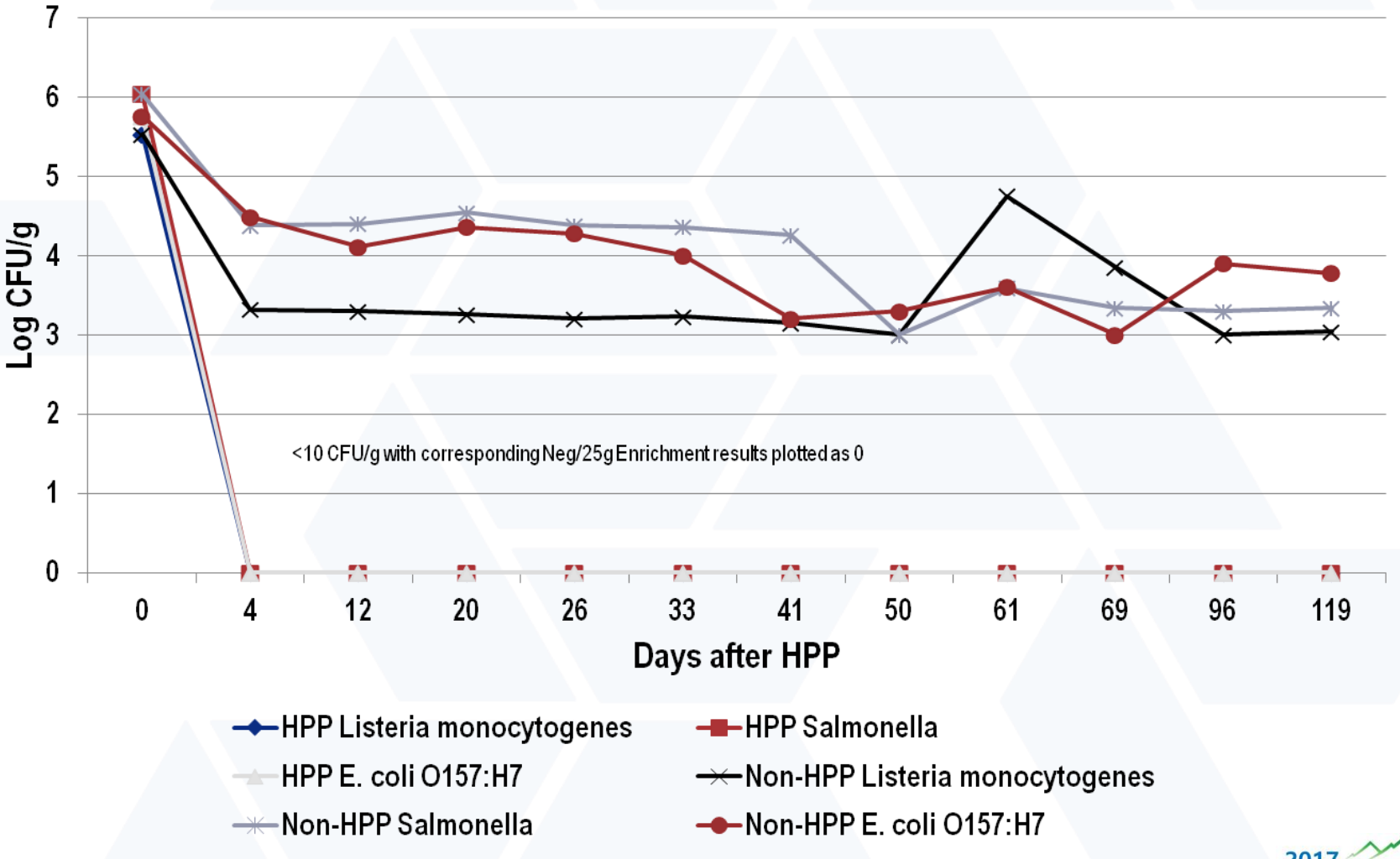
Effects of HPP on inoculated pathogens in sliced Roast Beef



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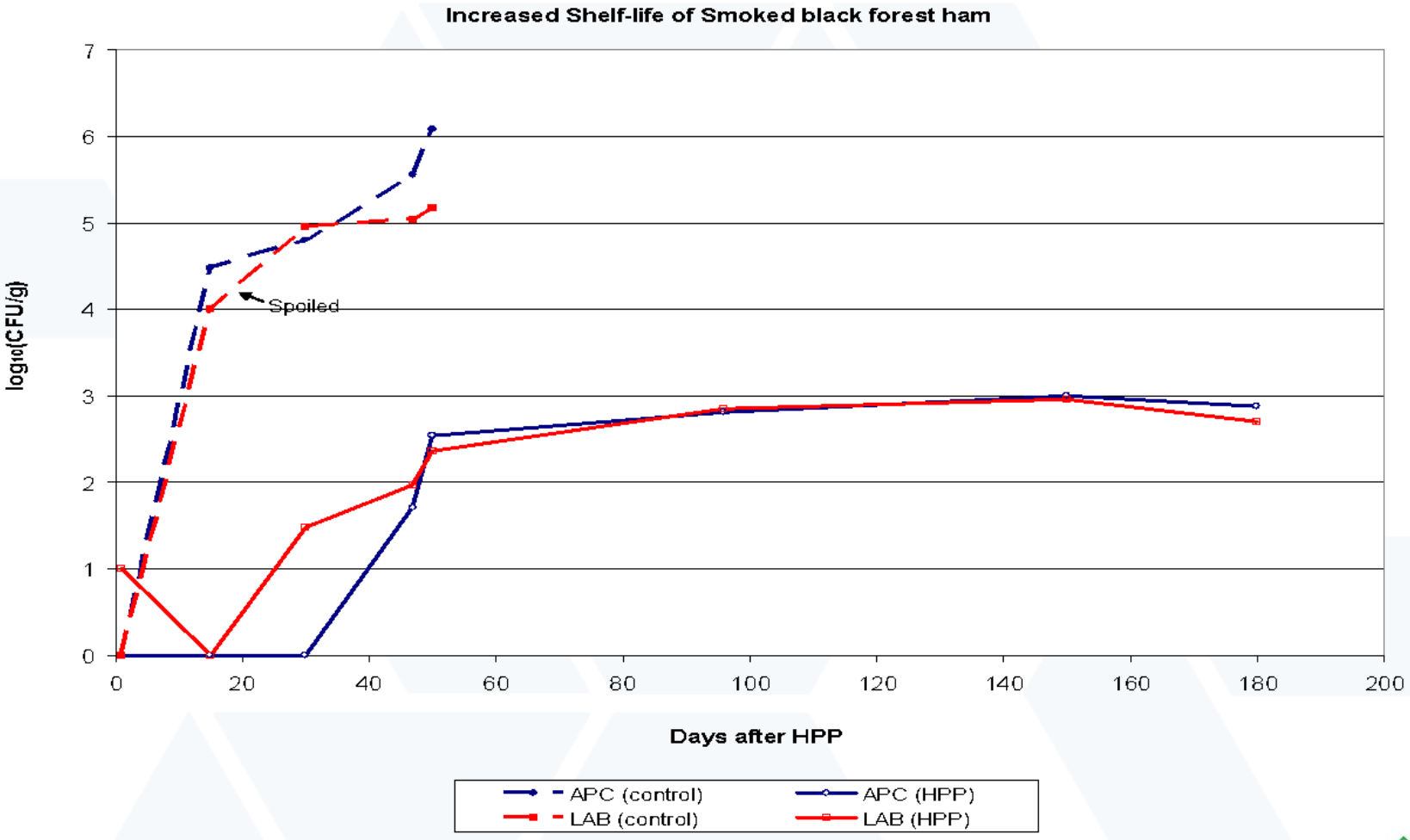
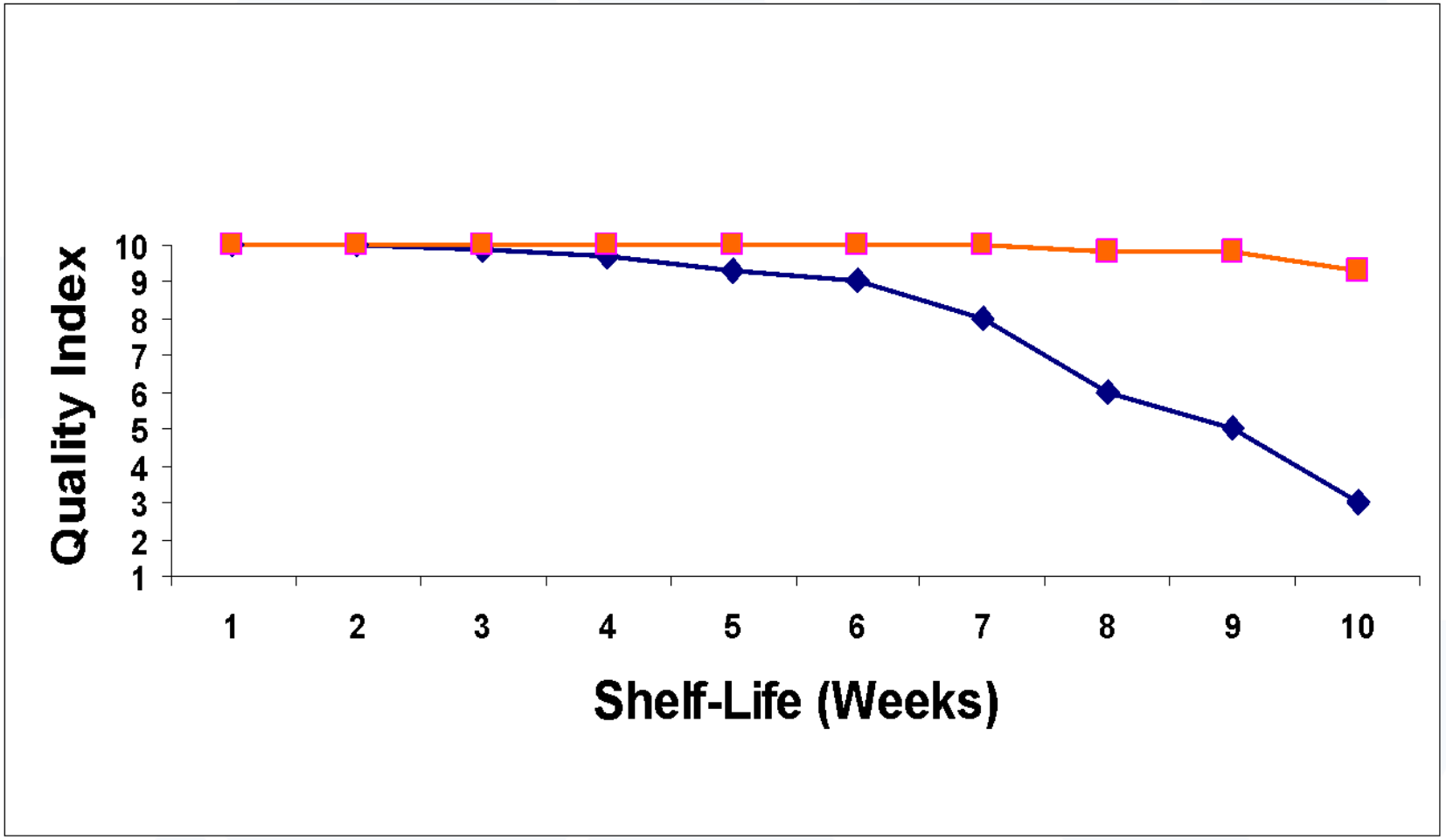
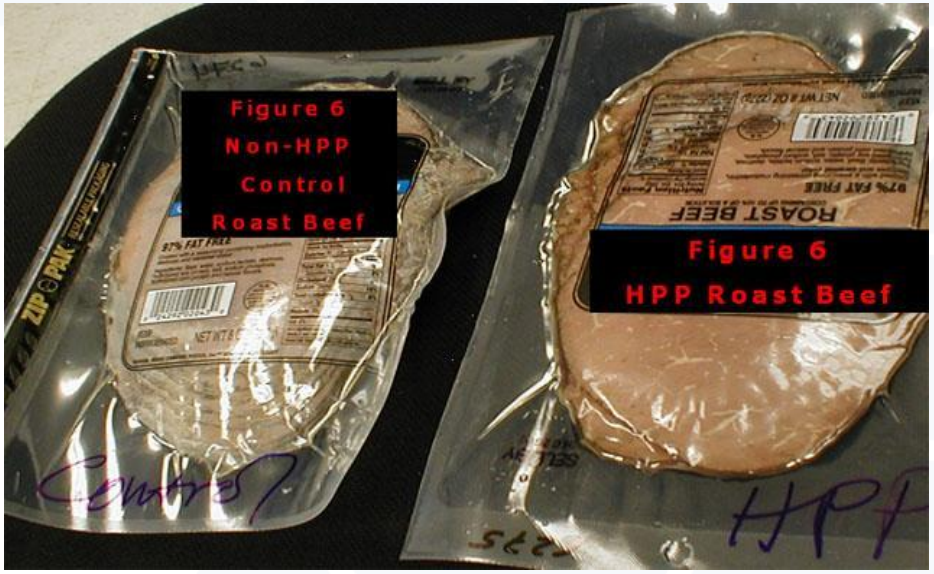
Effects of HPP on spoilage microorganisms in RTE meat: No spoilage after 6 months



Extension of Quality of RTE meats by HPP



Extended SL & Quality of HPP Meat



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Microbiology

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

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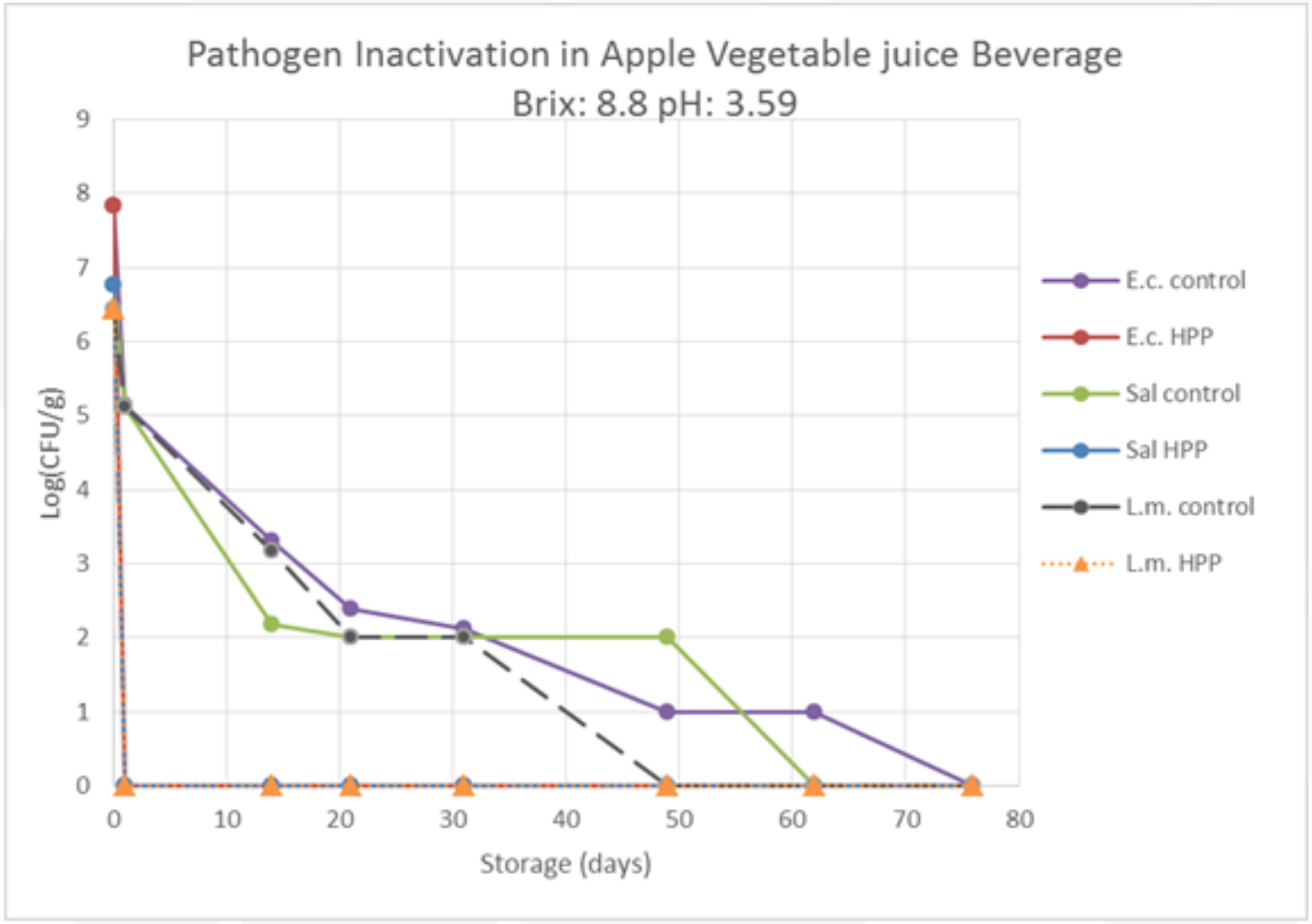
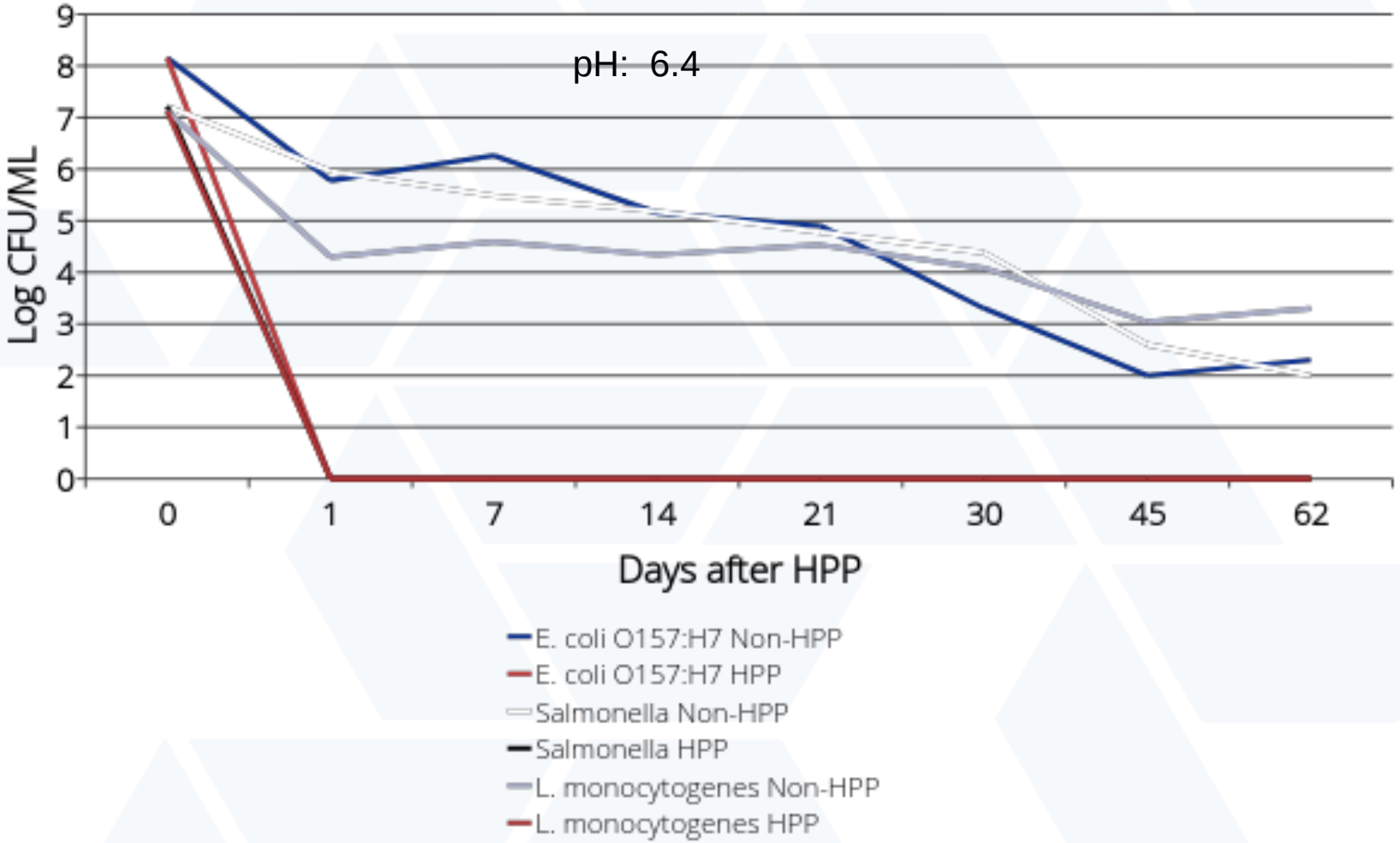
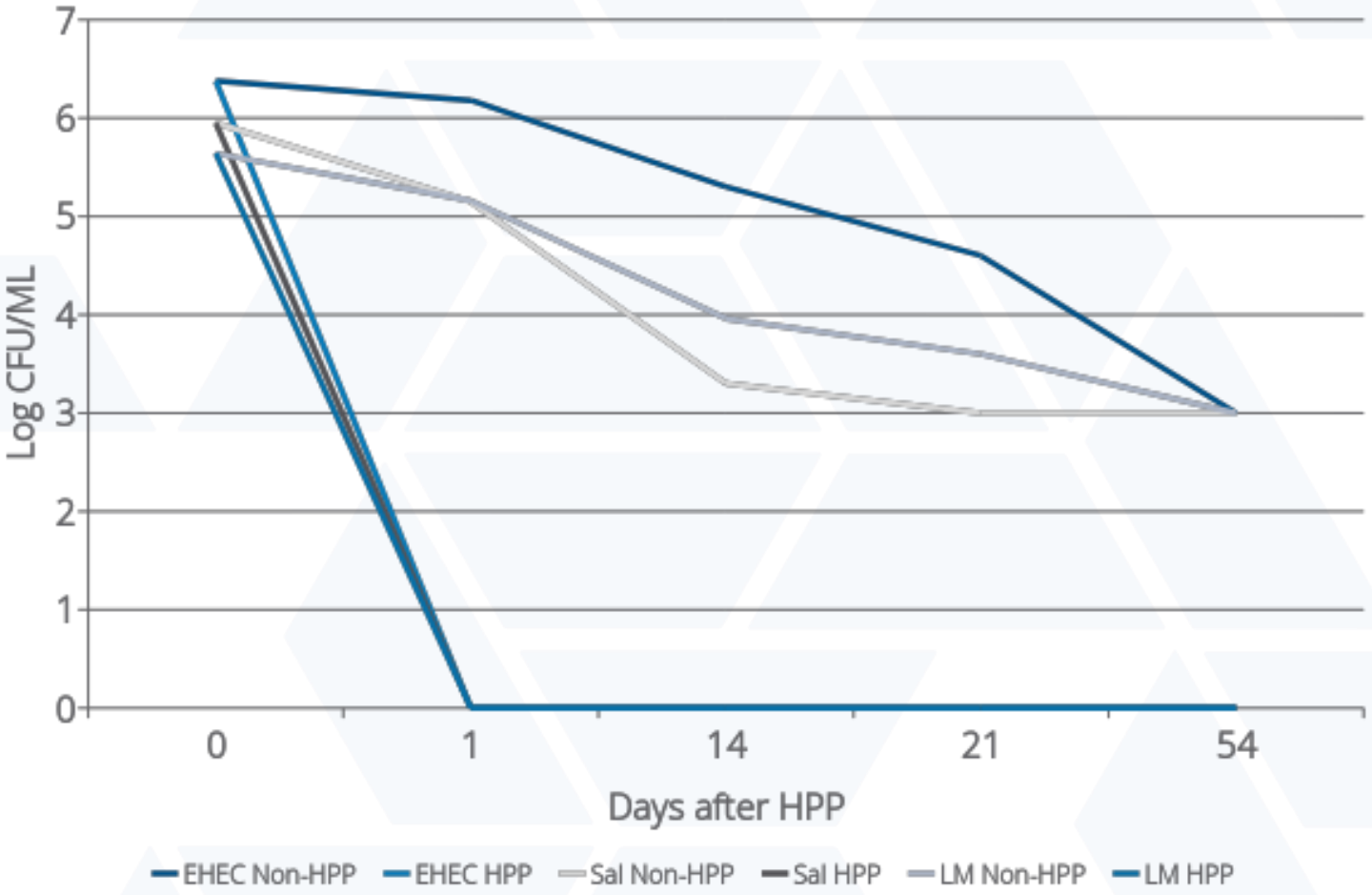
Effects of HPP on vegetative pathogens in Apple/vegetable juice blend:5930 bars/2mins/4°C



Effects of HPP on pathogens in Nut Milk beverage: 5930 bars, 3 min



Effects of HPP on pathogens in coconut water 86,000 psi/3 minutes 4° C water



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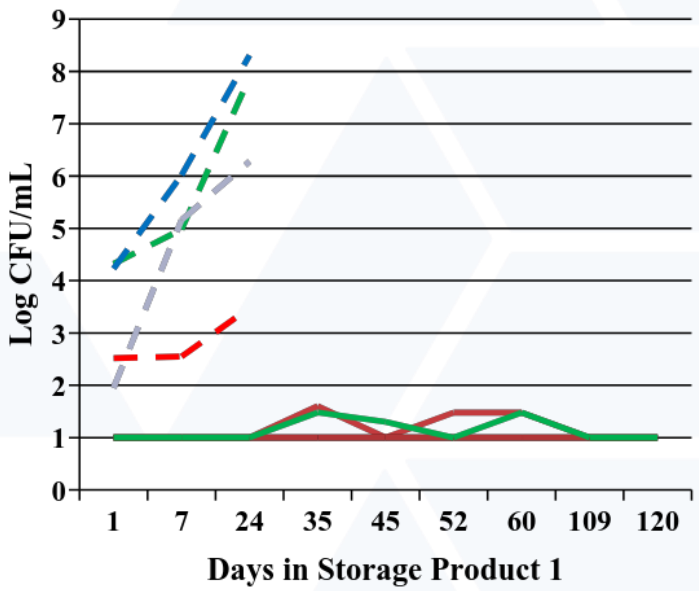
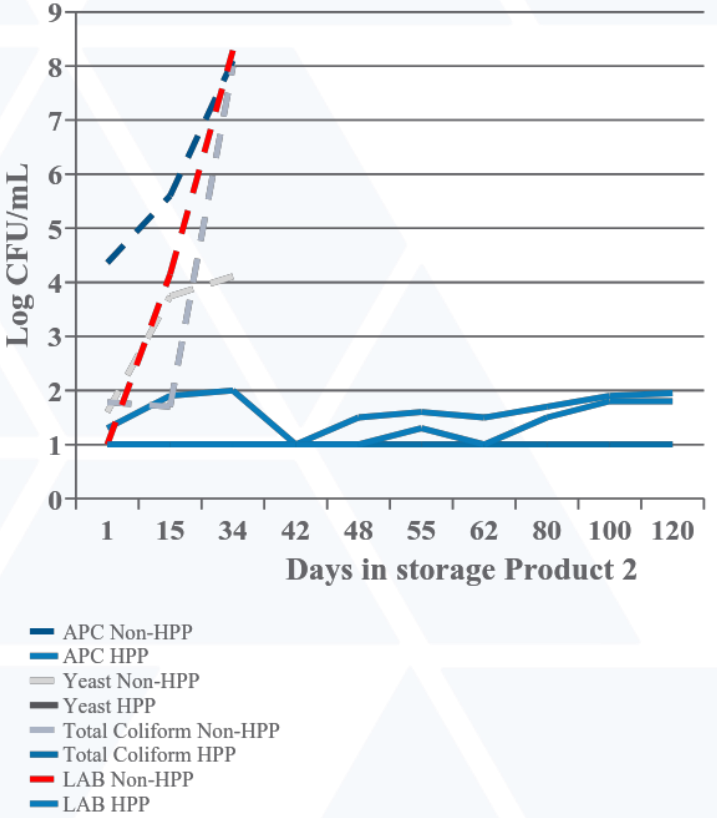
Shelf-life extension of raw coconut water, pH 5.2: 5930 bars, 3 min, 4° C





Update: Coconut water paper is under peer review for publication in *the Journal of Food Protection* as requested by the US FDA

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Applications - Juices

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Newer Products in Market - USA

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Large Companies involvement in HPP Beverage Market

Coca Cola

Starbucks/Evolution Fresh

Bolthouse Farms/Campbell's

Pepsi

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Avocado Products

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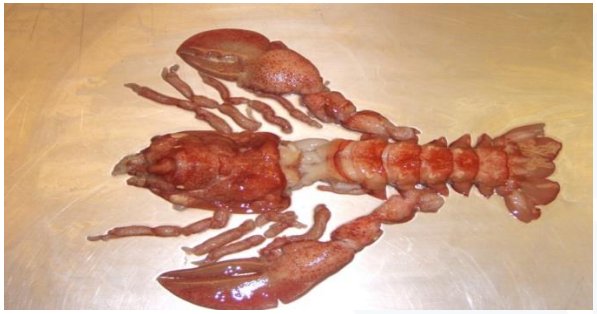
HPP – Seafood

- **Food safety**
- **Shelf-life extension**
- **Process enhancement**
  - Shucking of Crustaceans/shellfish



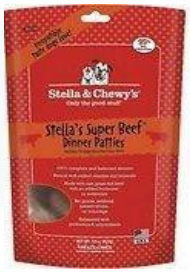
Fresh Fish

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**



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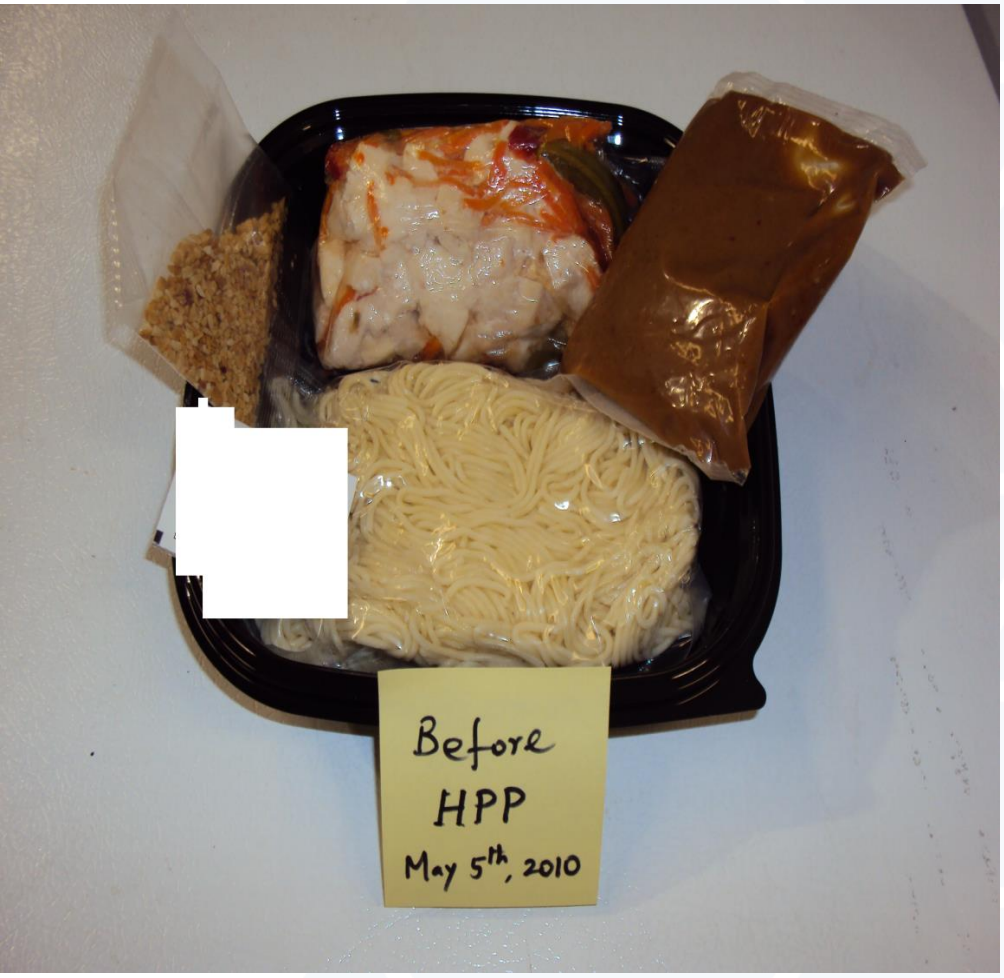
Ready Meals – Fastest growing category

- **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

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HPP RTE “Ready” Meals

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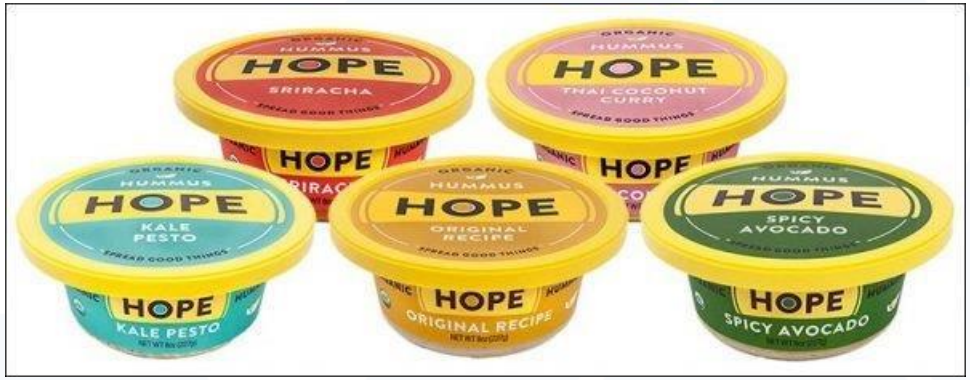
HPP Hummus – Commercial Examples



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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

Born Pu

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Baby Foods
- fruit based, pH ≤4.6

Bib & Spoon
EST. 2015
FRESH BABY FOOD

The Latin Baby

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HPP Soups

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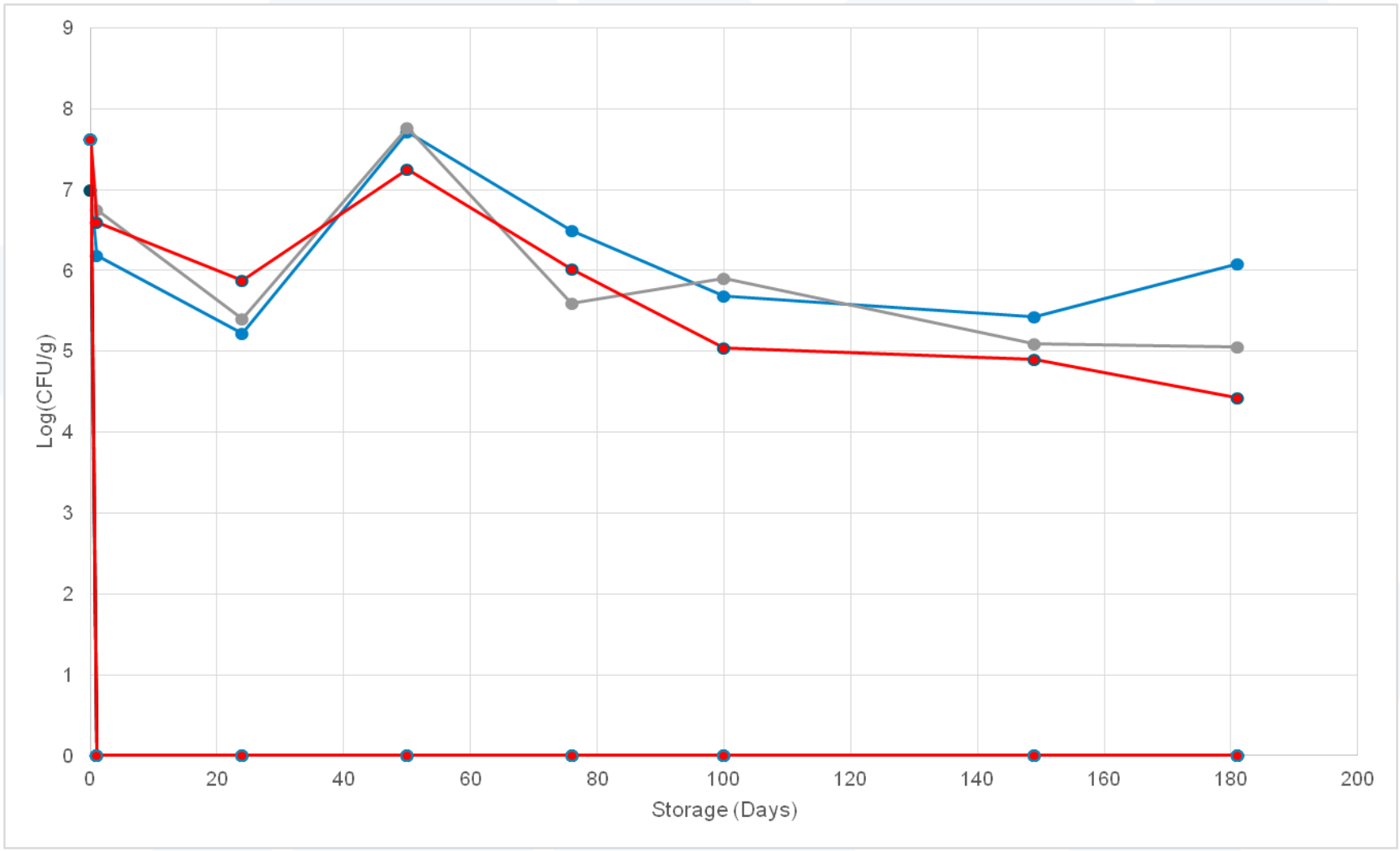
HPP RTE Sauces/Soups

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



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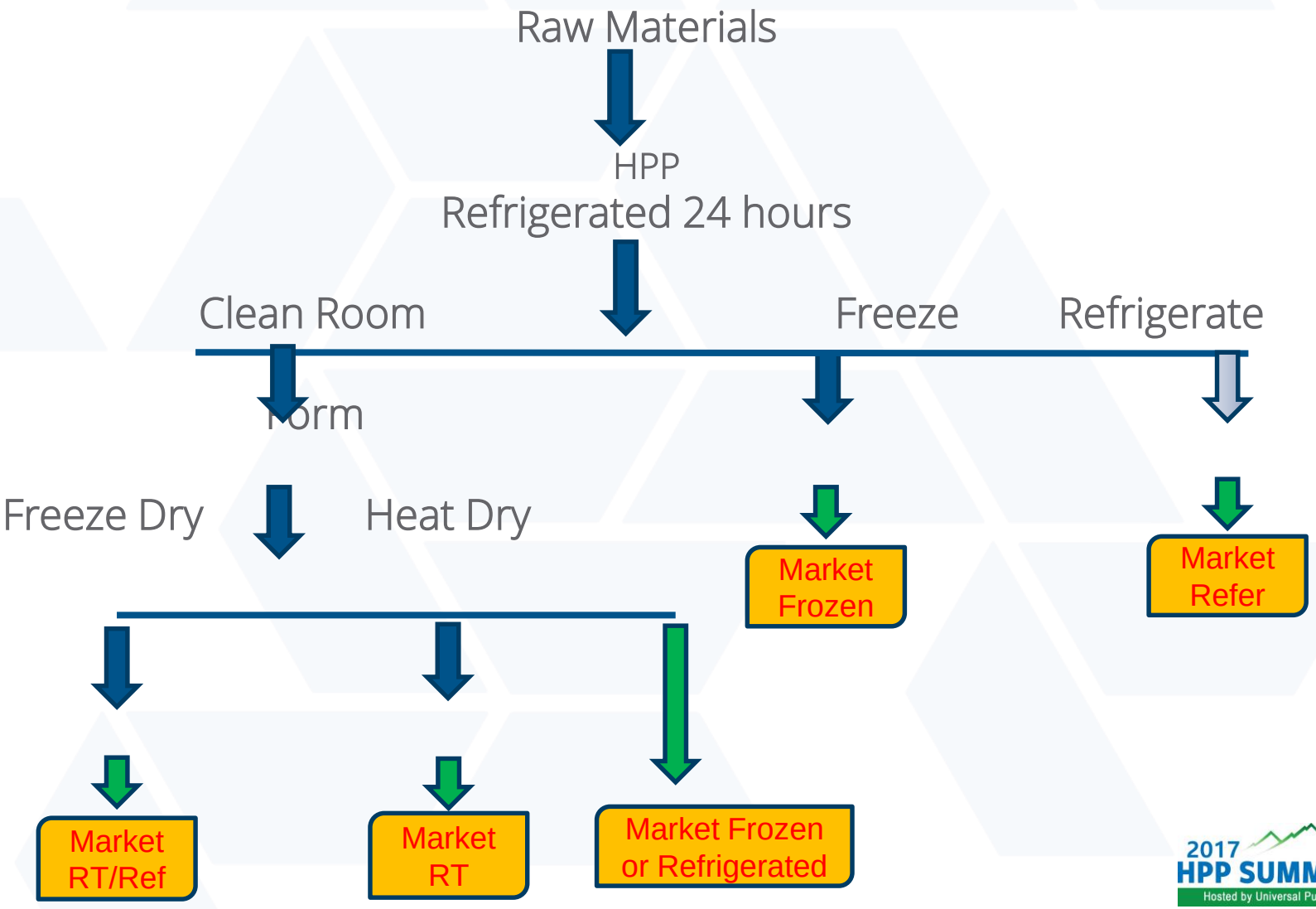
HPP of Raw Proteins
Three Main Applications

- **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



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HPP Pet Food

Made with

HPP

processed poultry

PRIMAL
PET FOODS INC.
SINCE 2001

Wholesome Raw Frozen Foods for
DOGS ★ CATS

STELLA & CHEWY'S
COLD PRESSED
FOR NUTRITION & SAFETY

Nature's Variety®

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Marinated Beef

HPP Dairy Applications

Milk	Soft Cheese	Yogurt-based Products	Cheese

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Dairy Beverages

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Packaging

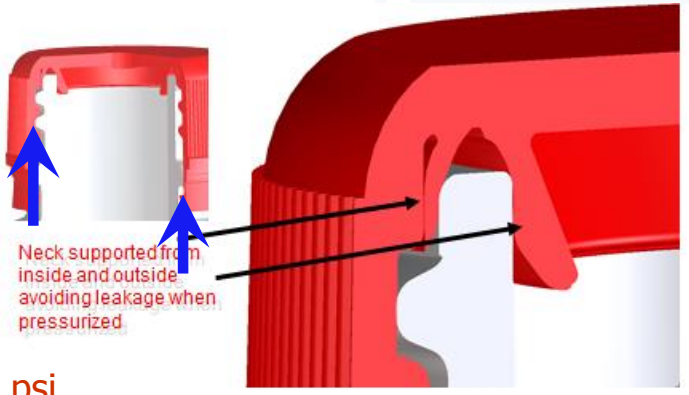
- **Film Type**
  - High Barrier (Foil, KPET, EVOH)
  - High Strength (Nylon)
  - Biodegradable – Not suitable for HPP
    Organic e.g. sugarcane, corn

- **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

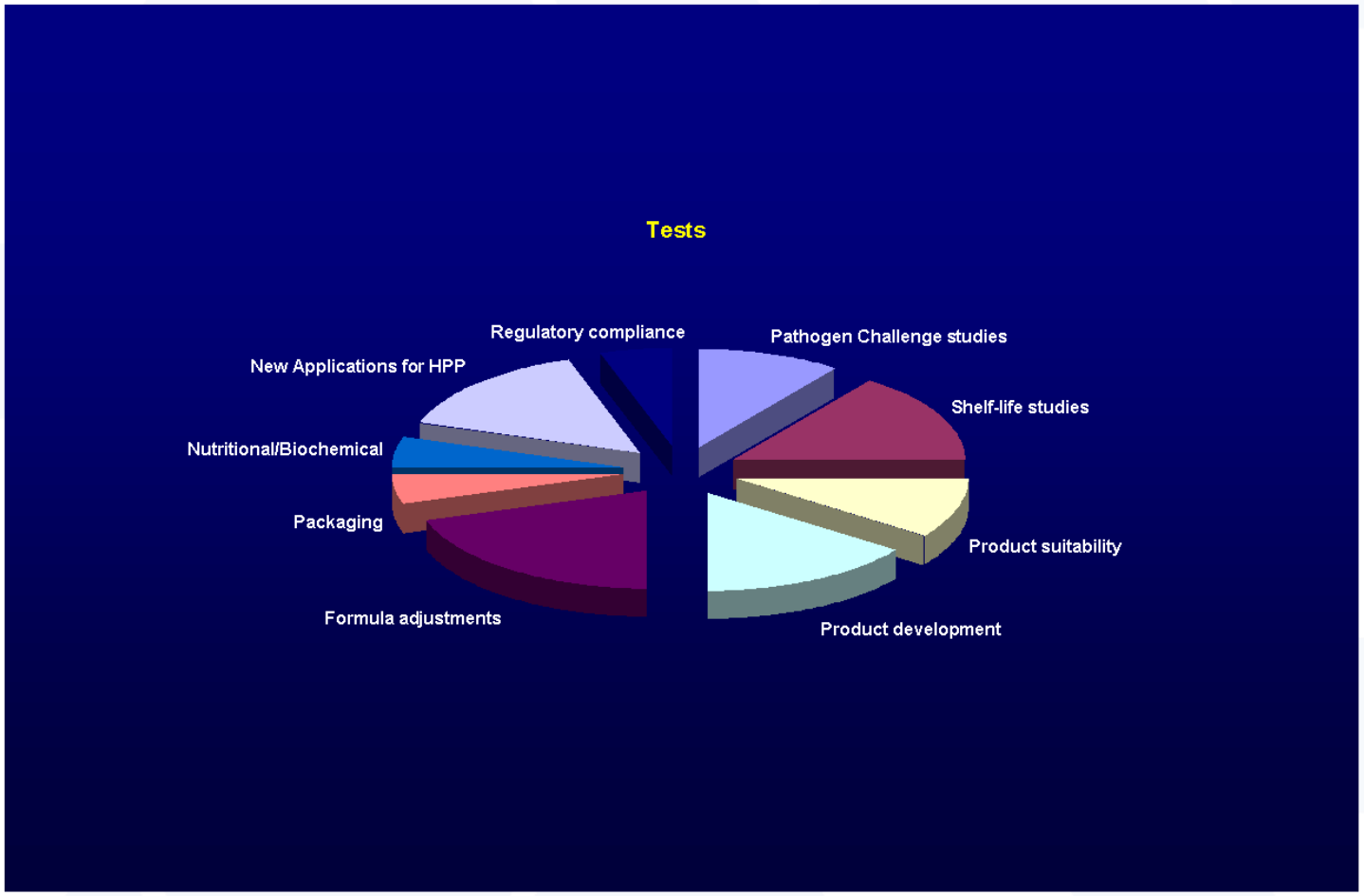
Closure
- Induction seal OR
- Double seal caps from Bericap or Triple (double) seal from Silgan



>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!