Innovative processing technologies for preserving polyphenols in fruit products

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Ancient food processing

Almost 2 million years ago humanity was launched when we discovered cooking

(Richard Wrangham, Biological Anthropologist, Harvard University)

History of Food Processing

“Study of every ancient civilization clearly shows that throughout history humans overcame hunger and disease, not only by harvesting food from a cultivated land, but also by processing it with sophisticated methods”

(Floros, et al. 2010, Feeding the World Today and Tomorrow, Comprehensive Reviews in Food Science and Food Safety, 9:572-599)

History of Food Processing

“... the three most important foods in Ancient Greece — bread, olive oil, and wine — were all products of complicated processing that transformed perishable, unpalatable, or hardly edible raw materials into safe, tasty, nutritious, stable, and enjoyable foods”

(Floros, et al. 2010, Comprehensive Rev Food Sci Food Safety)
History of Food Preservation Processes

- Drying
- Smoking
- Salting
- Fermentation
- Thermal Irradiation
- High Pressure PEF

Year:
- 3000 BC
- 1800 AC
- 1900 AC
- 2000 AC

Consumer Dichotomies

- Consumer demanding miracle foods:
  - All Year
  - New and Improved
  - Good For You
  - Safe
  - Ready-to-Eat
  - Low Price
  - Convenient
  - Local
  - Traditional
  - High Touch
  - All-Natural
  - “Green” packaging
  - Eco-friendly
  - Organic

Megashock: Food Security

The challenge to produce enough food will be greater over the next 50 years than in all human history.

Importance of Processed Food

- Trade in processed food products is now 75% of global agricultural trade and growing twice as fast as raw commodity trade due to

  - Why Food Processing?
    - Preservation
    - Safety
    - Quality
    - Nutrition
    - Availability
    - Price
    - Sustainability
    - Convenience
    - Food Waste Management

  - Food Processing Offers Numerous Benefits

Source: Brian Keating, CSIRO
Emerging food processing technologies - innovative and potentially sustainable approaches

- **High Pressure Processing**
  - **Features**
    - Inactivation of microorganisms and viruses at room temperature
    - High retention of nutrients and flavour
    - Can texturize specific foods (e.g. meat or starch)
    - Instantaneous and uniform treatment
    - Compression fully reversible
    - Good consumer perception
  - **Challenges**
    - Cost intensive due to high capital costs and batch processing
    - Some enzymes and bacterial spores are pressure resistant
    - Regulatory approval required

**Effect of Thermal or HP Processing on Phenols**

Example: Strawberry / apple / banana / oranges mix
- Heat treatment: 72°C for 1 min, HPP: 450 or 600 MPa for 5 min at 20°C

Pressure treatment at 450 MPa increase and retain more apparent total polyphenols than thermal processing

Keenan et al. (2012) LWT
Effects of thermal and HPP on anthocyanins

Example: Strawberry puree
- HPP (600 MPa, 20°C, 5 min) TP: thermal processing (88°C/2 min)

Retention of anthocyanins in strawberry puree is similar after heat or HPP treatments.

Anthocyanin Degradation in Blueberry Juice During Storage
- Rate of anthocyanin degradation in blueberry juice can be reduced by HPP but relative retention is higher in thermally treated juice
- In contrast to heat, HPP can only partially inactivate polyphenol oxidase in fruit juice
- HPP assists saturation of juice with oxygen whereas heat treatment reduces oxygen levels

Buckow et al. 2010, J Agric Food Chem

Pulsed Electric Field Processing

Features
- Can inactivate vegetative cells of bacteria at mild temperatures (<50°C)
- Can enhance extraction processes
- Does not affect flavours & nutrients
- Treatment times in micro seconds
- Commercial systems (~10 t/h) available

Challenges
- Mainly suitable for pumpable products
- Some bacteria (eg Listeria) relative PEF resistant
- Energy intensive
- Regulatory approval case by case

PEF assisted extraction of grape phenols

Inactivation of Salmonella Senftenberg in apple juice subjected to PEF treatments (13 to 25 kV/cm electric field strength) at 45°C.

Evolution of anthocyanin (A) and polyphenolic content (B) during the maceration process in the Cabernet Sauvignon vinifications

Enhanced pigment and phenol extraction from grape must after PEF-treatment
Effects of Anthocyanin Storage Stability

- Moderate PEF treatments have little effect on grape juice anthocyanins.
- PEF processing can retain anthocyanins in grape juice better than conventional heat pasteurisation during storage.
- PEF anthocyanin degradation is not only due to heat but possibly also due to electrochemical reactions (e.g. pH).

Grape anthocyanin degradation at 25°C of untreated juice, heat treatment at 83°C for 20 min, PEF treatment at 25 kV/cm and 300 kJ/kg at 40°C.

Conclusions

- Food processing is needed to meet the demand of consumers and regulators for healthier, safe and better quality products.
- New, nonthermal food preservation technologies can retain more (or even increase) polyphenols in fruit products than conventional heat treatments.
- However, polyphenols can degrade faster in fruit products preserved by nonthermal processes due to the presence of native enzymes and oxygen.

International Nonthermal Food Processing Workshop – FIESTA 2012

16-17 October 2012, Melbourne Australia

Innovative Processes for Sustainable, Safe and Healthy Foods

www.innovativefoods2012.com

Supported by IFT’s Nonthermal Processing Division and EFFoST
Presented by the Food Innovation Emerging Science and Technology Applications (FIESTA) Conference series

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Thank you