Non Thermal Food Processing in view of Food Safety Considerations

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11th Food Safety & Quality Summit
Food Safety, Quality and Regulatory Xchange
Agenda for discussion

• Food processing - why
• Integrated food safety measures
• Non-thermal food processing techniques
  – HPP
  – Cold plasma
  – Ozone
  – Pulsed Light
  – UV
  – Sanitizers
  – Super Critical Fluid Extraction
  – E beam
  – Gamma
  – Ultrasonic
• Conclusion
Why food processing?

- Enhance shelf life of produce, Sale in the region it’s not available— Fresh Milk
- Convert produce for ready to use or enhance ease of use [Remove husk/stalks, cut, slice, dice] – Fruits, vegetables, Fish, poultry etc
- Destroy pathogenic organisms – Many foods
- Minimize/destroy anti-nutritional factors - Beans
- Enhance flavours. Colours, taste – Caramels, Milk products
- Improve nutrition – fermentation
- Economic reasons

Heat is commonly used to achieve many of these. However it also leads to nutrient loss and may be sensory impact - hence non-thermal processing.
Techniques of non-thermal processing

- MAP/CAP
- Waxing
- Reducing water activity
- Altering pH
- Antimicrobial agents and preservatives
- Emulsification
- Microwave – Thermal/Non-thermal
- High Pressure Processing (HPP)
- Gases (ozone, chlorine dioxide, cold plasma)
- Light (ultraviolet, pulsed light)
- Chemical (chlorine, surfactants)
- Ionizing radiation (gamma irradiation, electron beam)
- Combination of one or more above

Today’s scope is limited to Non-thermal processing
Integrated Food safety measures

- **Product Safety**
  - Description: HACCP for product and process

- **People**
  - Description: Swab test, Plate count

- **Equipment**
  - Description: Sanitize/Sterilize

- **Packaging Materials**
  - Description: Surface swab, shelf life test

- **Environment**
  - Description: Air Quality, purity

**What**
- Use validated pathogen elimination techniques
- Entry, uniform, cleanliness, washrooms
- Sanitize/Sterilize
- Manufacture, storage, sterilize
- Clean
High Pressure Processing (HPP)

- The high pressure [600 MPa] causes the microorganisms membrane to be disrupted
- Target specific pathogens in specific food products such as *Vibrio spp* in oysters, and *Listeria spp* as post-process treatment on sliced deli meats and juices
- The food is largely protected from the damaging force of the pressure since pressure is uniformly distributed around and throughout the food.
- Pressure will depend on type of bacteria to be killed.
- Advantage: Commercially being used to treat Jams/Jellies in Japan and juices in the US
- Can be used in pre-packed food products
- Dis-advantage: Not proven to kill virus
HPP FREE

HPP is a form of pasteurization involving high pressure. Once juice is HPP’d, it is no longer considered fresh. Our juices are raw, fresh and free from any form of pasteurization.

SHAKE WELL. BE WELL.  
zulajuice.com
Cold Plasma Processing

- Cold plasma is generated by using electricity and a carrier gas, such as air, oxygen, nitrogen or helium.
- Ionization of atmospheric air/moisture.
- Generate – UV radiation, ozone, charged particles and “supercharged” oxygen and hydroxyl ions.
- All of these products work together to kill pathogens (bacteria, virus).
- Advantages: Water free, Chemical free. Can be used in surface treatment of fresh produce, Effective against Salmonella and E. Coli.
- Dis-advantage: Nutritional quality of products to be validated.
Plasma processing example
Ozone

- 10 to 30 PPB is good enough for a sanitizing action
- Ozone is a powerful sanitizer, similar to chlorine
- It kills pathogens and leaves no residues

- Advantages: Powerful sanitizing action, Decomposes to Oxygen hence does not get carried along with food.

- Dis-advantages: Human / workmen safety to be taken into consideration.
- Works mainly for surface treatment
Ozone Example

Ozone dozing in floatation bed
**Pulsed Light (PL) Processing**

- Pulsed light (PL) uses short, intense pulses of white light which includes ultraviolet, infrared and visible light.
- It is like a camera flash that is used to take pictures but far more intense.
- When this light is flashed on a food, it kills microorganisms but has minimal impact on the food.
- The UV light kills pathogens by disrupting the DNA.
- Advantages: Presently approved by FDA (21 CFR179.41), Helps in surface sterilization even for packaging materials.
Pulsed Light processing example

Ultra-Violet (UV) Light

• Radiation from UV range of spectrum 100 to 400 nm
• UV irradiation strength: 1800 to 2000mW
• At high levels, UV light causes damage to a microorganism’s DNA

• Advantages: UV processing is being used in the juice and cider industries for pasteurization without heat targeting *E. coli* O157:H7 and *Cryptosporidium parvum*. commonly employed for water treatment systems. It’s easy to use.
• Dis-advantages: People safety to be taken into consideration
UV Light example - Equipment & Product Sanitization
Sanitizers

- Sanitizers with surfactants are being found to be effective. Surfactant improves potency of the sanitizer by detaching microbial cell from food.
- Food grade surfactants are being worked upon.

- Advantages: Lower cost in use

- Dis-advantages: Chemicals - Human / workmen safety to be taken into consideration
Super Critical Fluid Extraction

• Super critical Cardon Dioxide is used to deactivate Bacteria and enzymes

• Advantages: Used in Bio-active compounds like Carotenoids, Flavonoids and fruits and vegetables

• Dis-advantages: Chemicals - Human / workmen safety to be taken into consideration
E-Beam?

- Electron beam irradiation (E-beam)
- High energy accelerated electrons (close to the speed of light) are aimed at solid or liquid foods, reducing the number of or eliminating pathogens, pests or insects.
- An electron beam generator uses electricity as the energy source and can be turned on and off.
- E-beam work against pathogens such as viruses and bacteria by breaking the linkages in DNA or RNA.

Advantages: Tried on packaged dry meat to kill E. coli.
Dis-advantages: Limited penetration depth, High initial cost.
Gamma Irradiation

- Cobalt 60, properly shielded, is primarily used as the gamma irradiation source
- Doses used must be established for each specific food product taking into account product composition, texture, density and impacts on quality
- Advantages: Used in lettuce, spinach, mushrooms, fresh fish and Spices
- Food is safer without compromising texture, taste and nutrition and can be used effectively on frozen products
- Dis-advantages: Irradiation labeling, safety considerations.
Ultrasonic treatment

- High frequencies in the range of 0.1 to 20 MHz, pulsed operation and low power levels (100 mW)

- Ultrasonic treatment is a sterilization method that uses alternating high-frequency electric currents, amplified and applied via an ultrasonic probe, to produce cavitation and shear forces.

- When sonicating liquids at high intensities and amplitudes, the sound waves that propagate into the liquid media result in alternating high-pressure (compression) and low-pressure (rarefaction) cycles, with rates dependent on the frequency – Disrupt cellular structure

- Advantages: Suitable for liquid, slurry or paste products

- Dis-advantages: Technology cost is high
Conclusion

• There are variety of non-thermal processing methods available. One has to choose a method suitable to the product type under consideration.

• Considering it’s benefit in retaining nutritional and sensory quality, they may be adapted for future use.

• A combination of processing methods along with an Integrated Food Safety Measures will help in delivering a safe product to consumers.

• Choose a method that guarantees food safety. Even 99.999% confidence indicates we are putting 1 consumer in 1 lakh products sold at risk....
References

- http://certified-laboratories.com/contact-us/
Master Class 1 – Best practices in FSQ – Farm to Fork

Infrastructure Design for food safety and quality

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- What are we trying to achieve?
- Quality Assurance protocols
- Infrastructure Design
- Conclusion
What are we trying to achieve

• Food safety:
  – Pathogenic and non pathogenic microorganisms
  – Insect pests and rodents
  – Contaminants
  – Toxic substances
  – Pesticide residues

• Quality:
  – Assured product experience – Condition, appearance, taste, texture etc.
  – Compliance to weight and quantity
  – Compliance to claimed attribute delivery
  – Seal integrity/ originality without chances of tamper
Quality Assurance Protocols

- Recipe design and control
- Raw materials specifications and vendor management procedures
- Sampling and analysis manual
- Equipment calibration plan
- Sensory evaluation procedure
- In-process quality control procedures
- CCP validation protocols
- Net contents control
- Claims and declarations validation protocols
- Internal audit procedures
- Training and learning program
- People hygiene and sanitization protocols
Quality Assurance Protocols

- Finished product specs covering Regulatory and product claims requirements
- Traceability
- Crisis Management and product recall procedures
- Out of specification product handling procedures
- Waste generation, collection and disposal procedures
- Policy manual on usage of glass, Jewelry, and foreign matter
- Cleaning and sanitation procedures
- Hygiene and housekeeping manual
- Integrated pest management
- Keeping quality/Shelf life tests
- Packaging material specs and vendor management
Quality Assurance Protocols

• Finished product release protocol
• Product storage, transit and point of sale instructions
• Method of preparation by consumers
• Corrective and preventive actions procedure
• Consumer and customer complaint handling
How to achieve?

• Building and process design
• Organization and responsibility matrix
• Providing adequate tools and methods
Conclusion

- Food business operator’s responsibility to deliver a safe and quality food to consumers.
- Establishing Quality by design programs is very important
- The infrastructure design should support this objective of total quality assurance