NON-THERMAL PROCESSINF OF MILK AND DAIRY PRODUCTS

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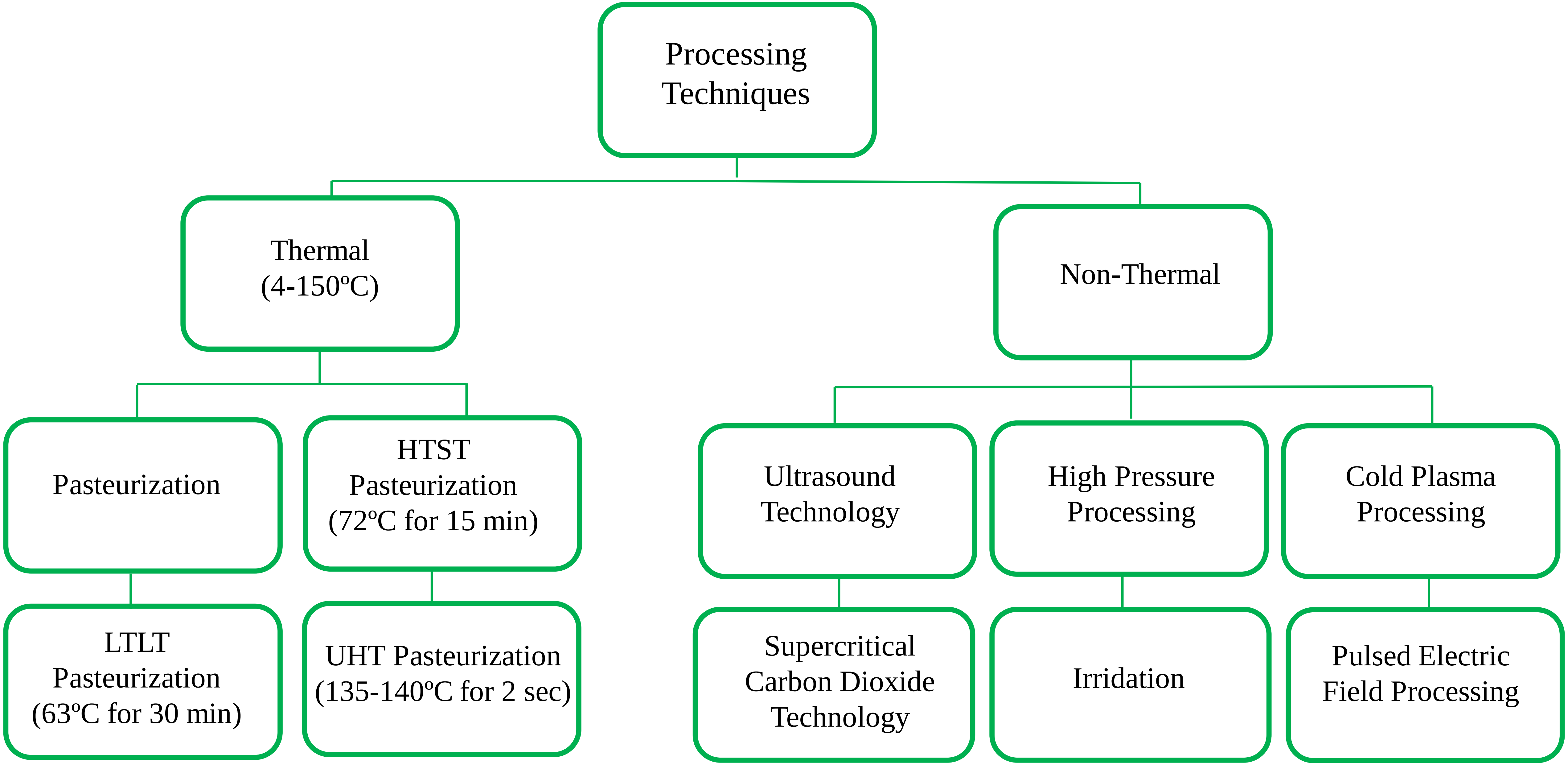
Increasing Consumer Expectation

Consumers Crave for Food



(Abbas Syed et al., 2021)

Thermal Processing Technology

- ✓ Effective Killing of Microorganisms
- ✓ Inactivating Active Enzymes
- ✗ Undesirable Physical or Chemical Changes
- ✗ Damage the Original Nutritional Value of Food
- ✗ High Energy Consumption
- ✗ More Pollution Emissions

(Abbas Syed et al., 2021)

Ultrasound Technology

Ultrasound Technology

Eco-friendly

Rapid

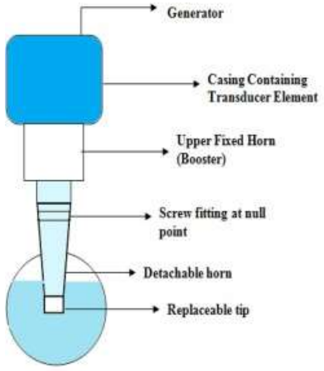
Inexpensive

Uses Less Energy

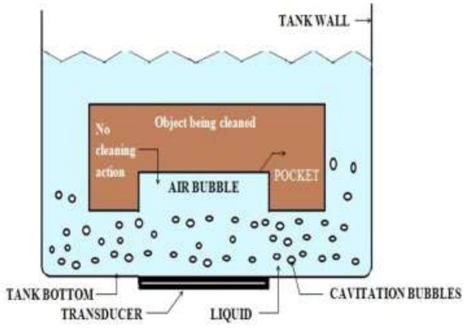
Simple

Harmless

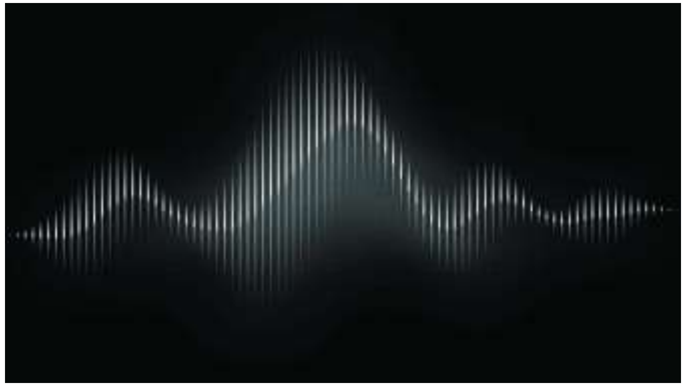
20 Hz-20 kHz



SONOTRODE



ULTRASONIC WATER BATH



Advantages

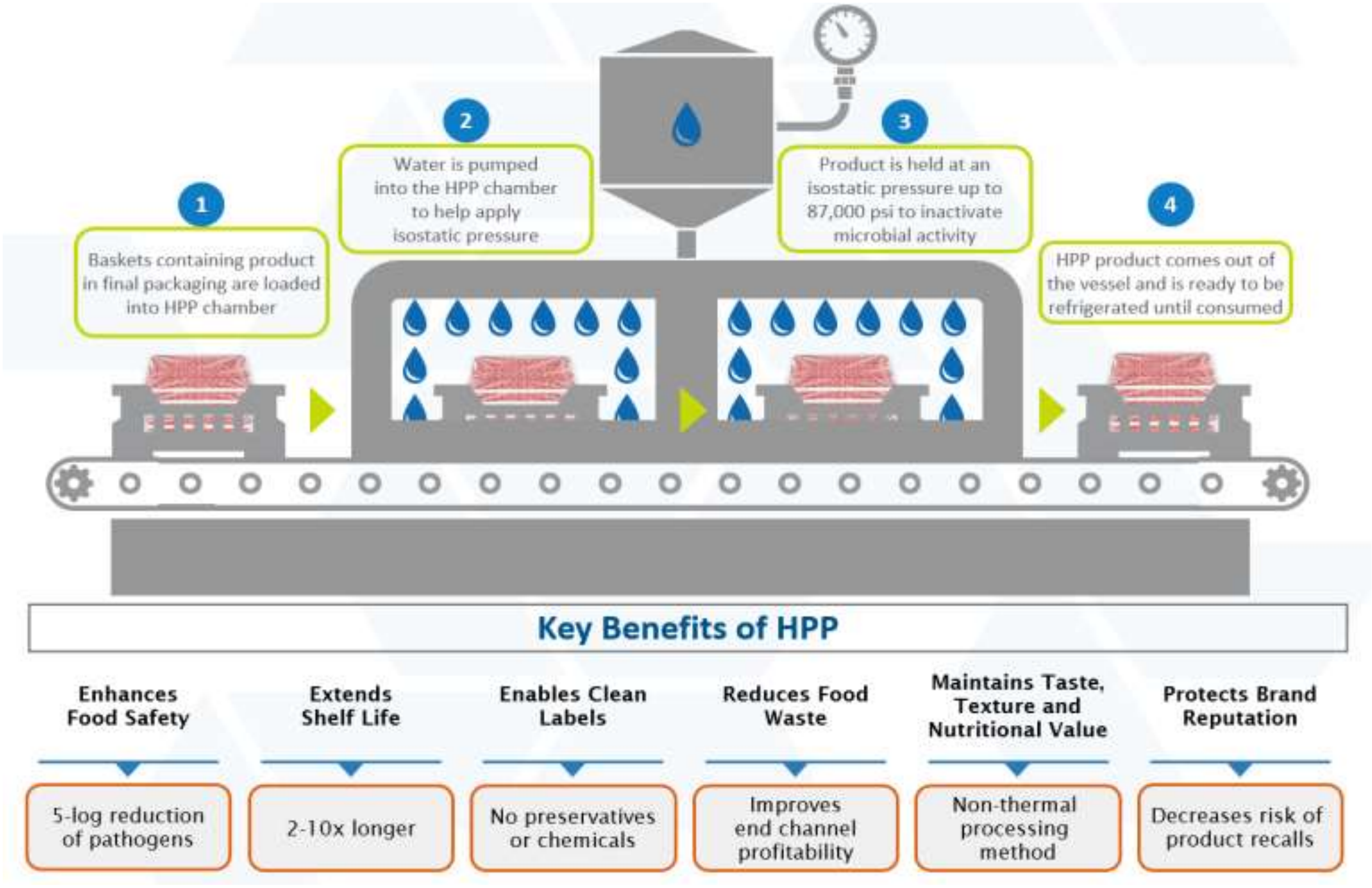
- Low running cost
- Energy efficient
- Environment friendly
- Improved mass transfer
- Limited chemical changes
- Non-thermal process with numerous applications

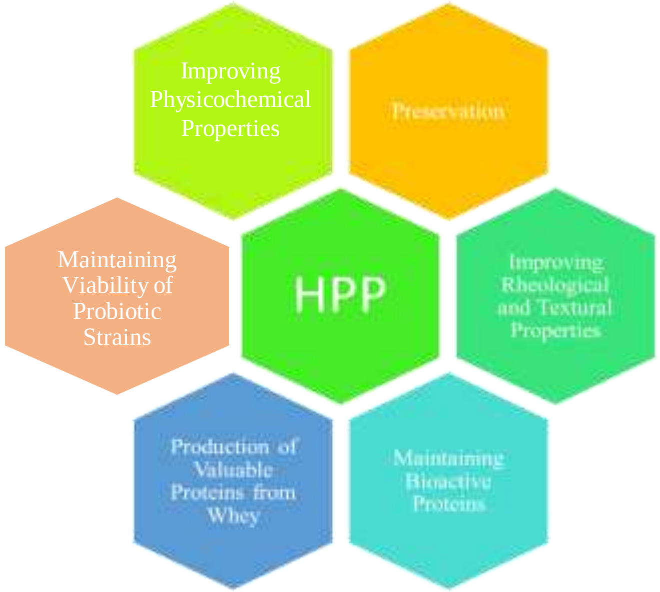
Limitations

- Apprehension regarding health effects of free radicals formed
- Equipment for industrial scale processing is not yet available
- Some food products develop off flavors/physicochemical defects

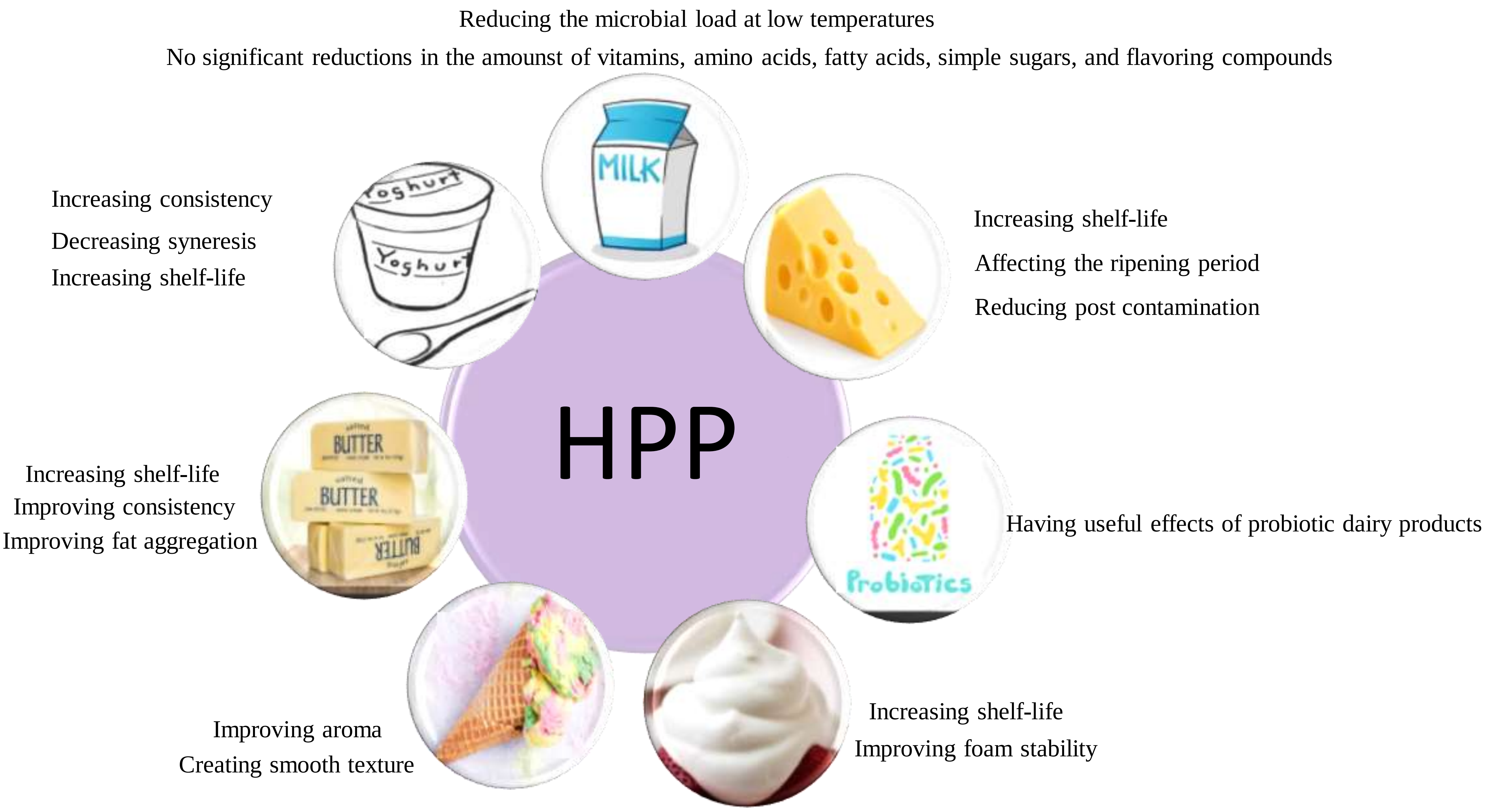
(Soni et al., 2021; Zhang et al., 2021)

High Pressure Processing





(Abbas Syed et al., 2021; Han et al., 2020; Ravash et al., 2020; Soni et al., 2021)



(Abbas Syed et al., 2021; Han et al., 2020; Ravash et al., 2020; Soni et al., 2021)

Advantages

- Improved shelf life
- Less thermal degradation
- Ability to manipulate the texture
- Non-thermal microbial destruction
- Ability to handle both particulate and liquid foods
- Homogeneity of treatment independent of mass and time
- Clean technology, flexible system for number of products and operation
- Ability to retain the freshness in flavor and nutrient content without using preservatives or other additives

Limitations

- Requirement of water for compression
- Pressure-induced denaturation of proteins
- Initial investment and maintenance costs are high
- Unavailability of industrial equipment for massive processing
- Destruction of spores is not ensured without thermal treatment

(Abbas Syed et al., 2021; Han et al., 2020; Ravash et al., 2020; Soni et al., 2021)

Cold Plasma Processing

Shelf-life extension

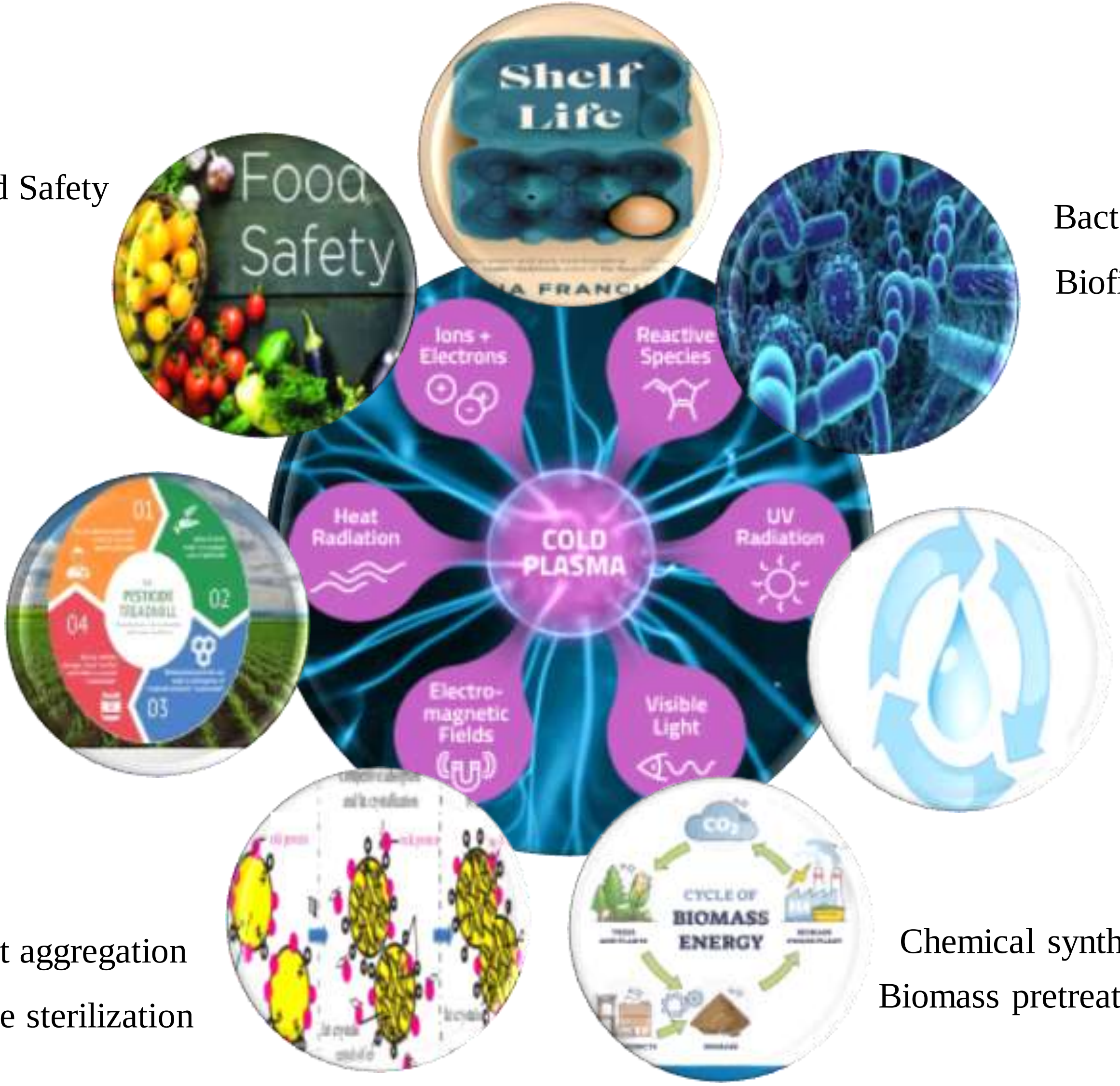
Toxin inactivation

Improvement in Food Safety

Disinfection

Bacteria Control

Biofilm Treatment



Pesticide degradation

Water treatment

Water re-use

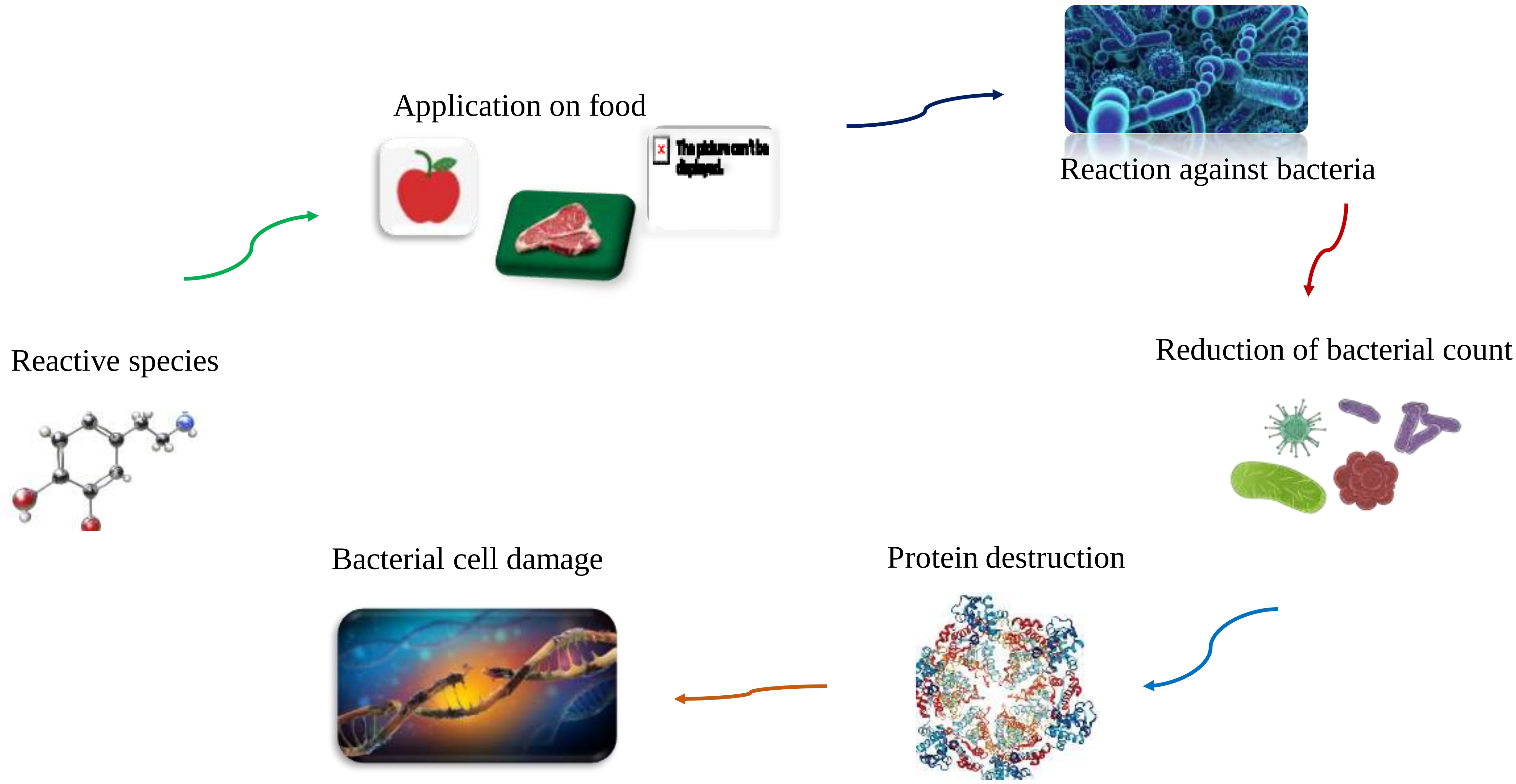
Improving fat aggregation

Device sterilization

Chemical synthesis

Biomass pretreatment

(Coutinho et al., 2018; Soni et al., 2021)



(Coutinho et al., 2018; Soni et al., 2021)

Advantages

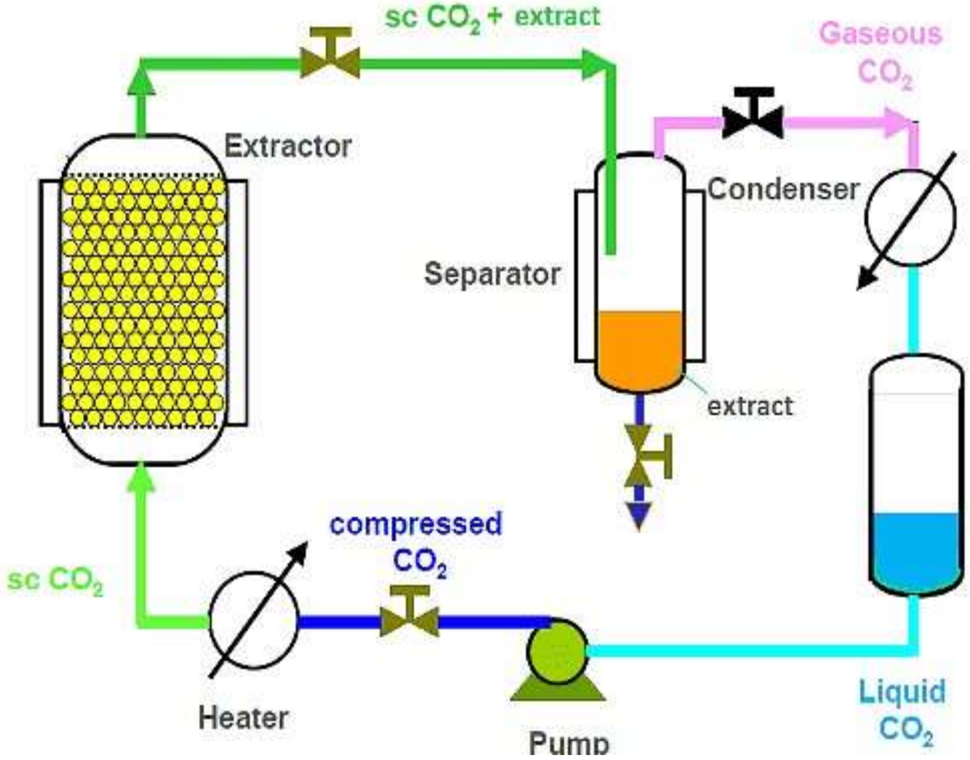
- Fast process
- Energy efficient technology
- Efficient antimicrobial action
- Limited structural changes
- Resource efficient technology
- Environmentally safe technology
- No damage to the quality of food products
- Sensory quality of the products are preserved

Limitations

- High cost
- Surface treatment with limited penetration depth
- Accelerated lipid oxidation in high fat products
- Difficulty to effectively treat foods having a rough or irregular surface
- Volume, size and shape of food determines the efficiency of treatment

(Coutinho et al., 2018; Soni et al., 2021)

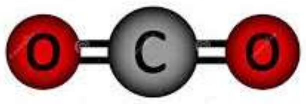
Supercritical Carbon Dioxide (SC-CO_2) Technology



Carbon dioxide (CO_2)

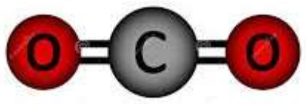
- Inert
- Non-corrosive
- Fireproof
- Nontoxic
- Easy Availabilite
- Low Price
- Safe for Consumption
- High Solubile
- Moderate Diffusivie
- Low Viscosity Values
- Residual CO_2 After Processing can be Effortlessly Removed

(Amaral et al., 2017; Deotale et al., 2021)



Advantages

- No thermal degradation
- Short processing time
- Environment friendly
- Easy removal of residual CO_2
- The fluids used are inexpensive
- High selectivity for extraction and fractionation
- Oxidation prevented due to lack of oxygen in system
- Low viscosity, high diffusion and lack of surface tension ensure increased penetration of the supercritical fluid



Limitations

- Real-time control is difficult
- High initial investment required
- Requires trained staff to reduce safety risk
- Changes in phase diagram, making it complicated to predict processing conditions

(Amaral et al., 2017; Deotale et al., 2021)

Irridation

Sprout Inhibition

Pathogen Reduction

Insect Disinfestation

Shelf-life Extension

Quarantine Fruits

(Abbas Syed et al., 2021; Han et al., 2020; Scudino et al., 2020; Soni et al., 2021)

Advantages

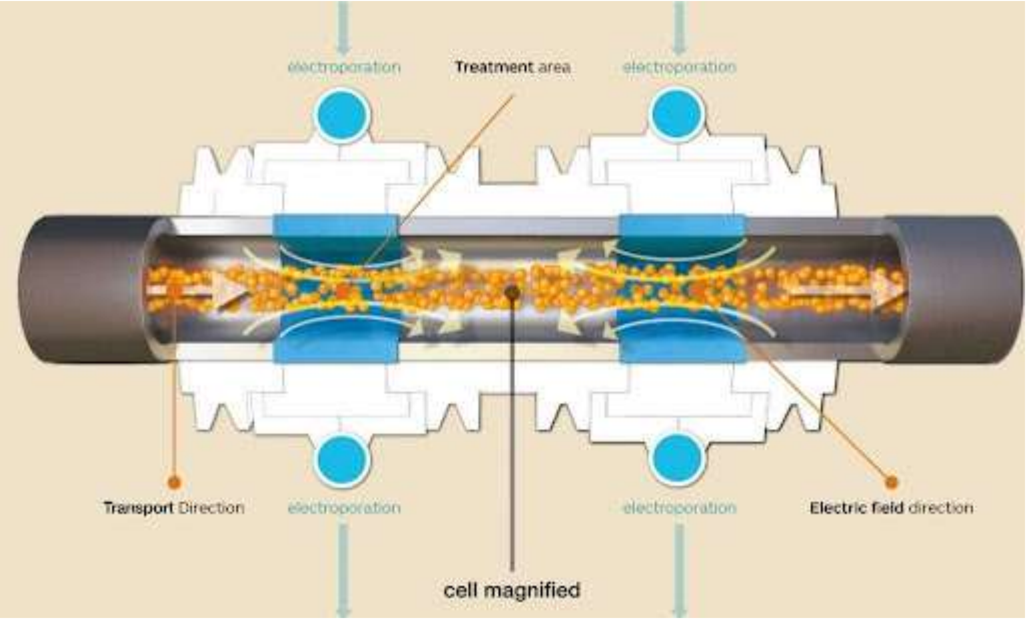
- Cold process
- Extended shelf life
- Environment friendly
- Effective in microbial destruction and disinfestation
- Reduced need of preservatives
- Due to high penetration depth, irradiation can be used for even packed foods
- Reduced risk of migration of pests across the borders throughagricultural produce

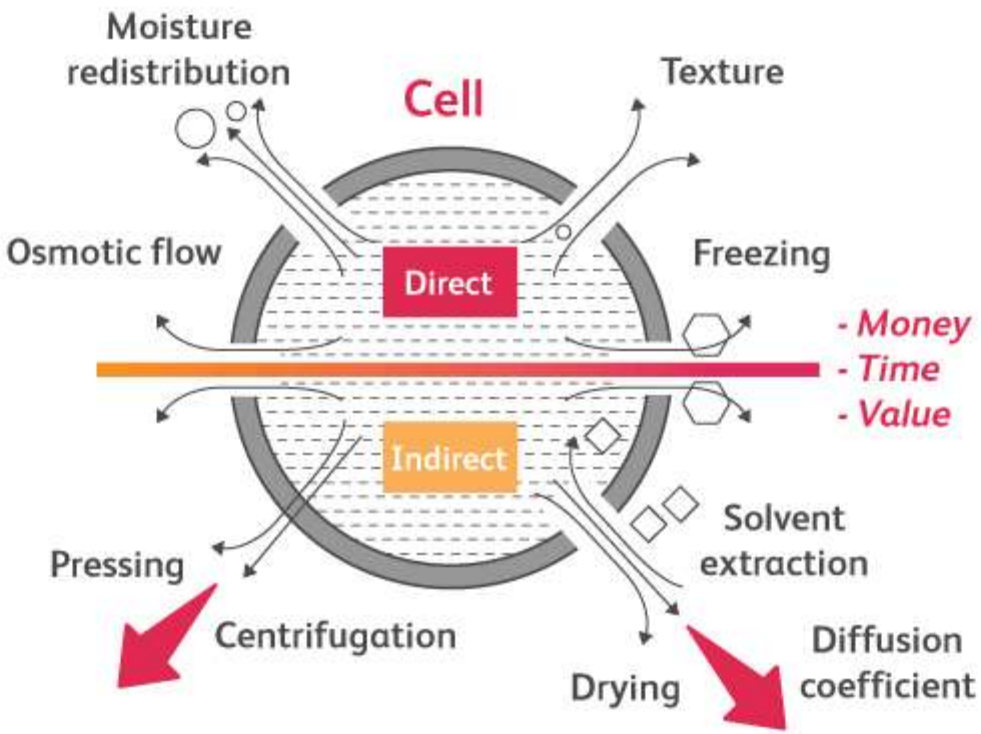
Limitations

- Negative consumer perception
- High capital investment required
- Not all foods are suitable for irradiation
- Apprehensions regarding radiolytic products and free radicals formed
- Some loss of nutrients like vitamins and minerals

(Abbas Syed et al., 2021; Han et al., 2020; Li et al., 2020; Scudino et al., 2020; Soni et al., 2021)

Pulsed Electric Field Processing





(Mosqueda-Melgar et al., 2008; Sharma et al., 2014; Soni et al., 2021)

Inactivate microorganisms

Save time, energy and water

Improve product quality

Improve biological activity

Enhance extraction process

Retain freshness and nutritional value

Enhance brining and marinating

Speed up drying process

Degrade pesticide residues

(Mosqueda-Melgar et al., 2008; Sharma et al., 2014; Soni et al., 2021)

Advantages

- Reduced fouling
- Less treatment time
- Minimal processing
- No chemical reactions
- Enhanced mass transfer
- Color, flavor, and nutritional retention
- Applicable as batch or continuous process

Limitations

- Cannot inactivate enzymes
- High initial investment required
- Not very effective against spores
- Presence of bubbles reduces the efficiency
- Treatment is applicable only to specific food types

(Mosqueda-Melgar et al., 2008; Sharma et al., 2014; Soni et al., 2021)

CONCLUSION

Microbial safety and retention of nutritional compounds are two parallel and essential requirements for consumer acceptability and safety. Nutritional compounds can be significantly retained by reducing thermal exposure so novel technologies in the food industry can produce food products with minimal changes in quality characteristics. Also combining more than one technology to impart physiological stress on the microbial contaminants leading to the better desired level of reduction in numbers. The use of these processes is expected to have a rising trend as an alternative or complementary technology to conventional thermal processes by conducting further research to identify the benefits and limitations of these processes.

Finally, in an economic perspective, feasibility studies of the process in order to enable the implementation of this technology at industrial scale are also welcome and compulsory.

THANK YOU FOR YOUR ATTENTION

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