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Bev Trend
& Tech Edition

QUENCHING INNOVATION:
THE EVOLUTION OF BEVERAGES

Thrive on Tech: เทคโนโลยีการผลิตเครื่องดื่มแห่งอนาคต และการประยุกต์ใช้ในเชิงพาณิชย์

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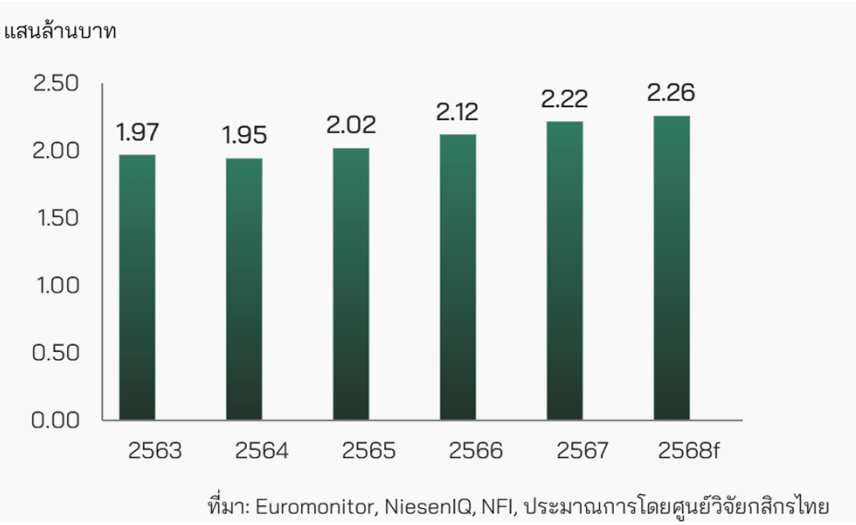
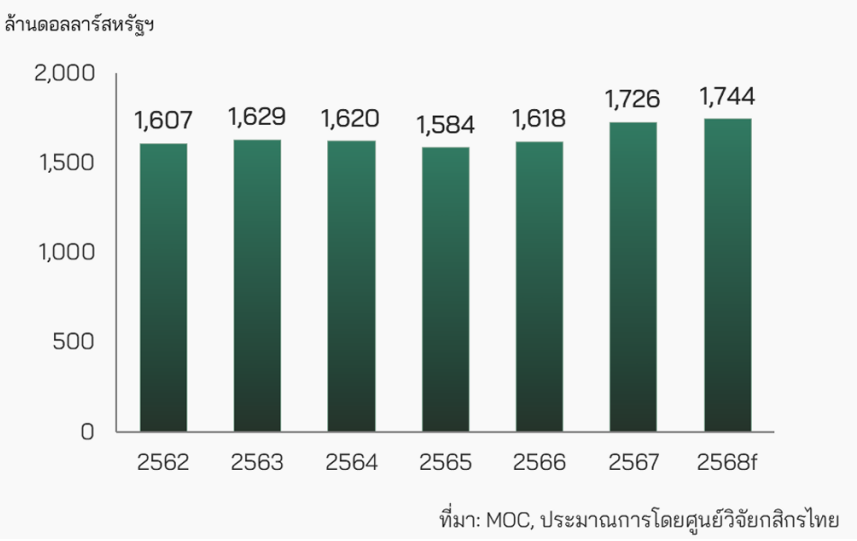
แนวโน้มตลาดเครื่องดื่ม ปี 2568

แนวโน้มตลาดเครื่องดื่มไม่มีแอลกอฮอล์ในประเทศ



แนวโน้มการส่งออกเครื่องดื่มไม่มีแอลกอฮอล์ของไทย



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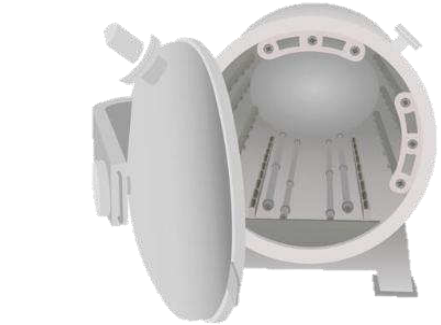
แนวโน้มอุตสาหกรรมเครื่องดื่มไม่มีแอลกอฮอล์ไทย-(ฉบับ-update).pdf

Thermal or Non-thermal technologies?



Different types of fruits

Pulp extraction and filtration

Conventional thermal processing techniques

Green non-thermal processing techniques

E.g. Pasteurisation, Sterilisation

E.g. Pulsed electric field, Pulsed light, Cold plasma, Hydrodynamic cavitation, UV light

- Extended shelf life
- Loss in bioactive compounds
- Change in sensory properties

- Extended shelf life
- Better retention of bioactive compounds
- High quality and stable product

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Emerging Green Processing Technologies for Beverages. DOI: https://doi.org/10.1016/B978-0-443-15732-5.00001-0

Thermal preservation processes

- **Pasteurization**
  - Mild temperature (~70-100°C)
  - Inactivation of disease-producing organisms
  - Destruction or reduction in the number of spoilage organisms in certain foods
  - No effect on spores
  - Short-term stability
  - Additional preserving factors such as refrigeration or low pH for long-term effectiveness.
  - Minimal changes of the sensory characteristics or nutritive value.

Process Controls

- ✓ HACCP plans → a minimum, a ***5 log reduction*** in a "pertinent microorganism."
- ✓ The "pertinent microorganism" is the ***most resistant microorganism of public health significance that is likely to occur in the juice***.
- ✓ LACF & ALACF exempt

Thermal preservation processes

pH	A_w>0.85	A_w<0.85
>4.6	High heat treatment to destroy spores	No heating required
<4.6	Mild heat treatment to destroy vegetative cells	No heating required

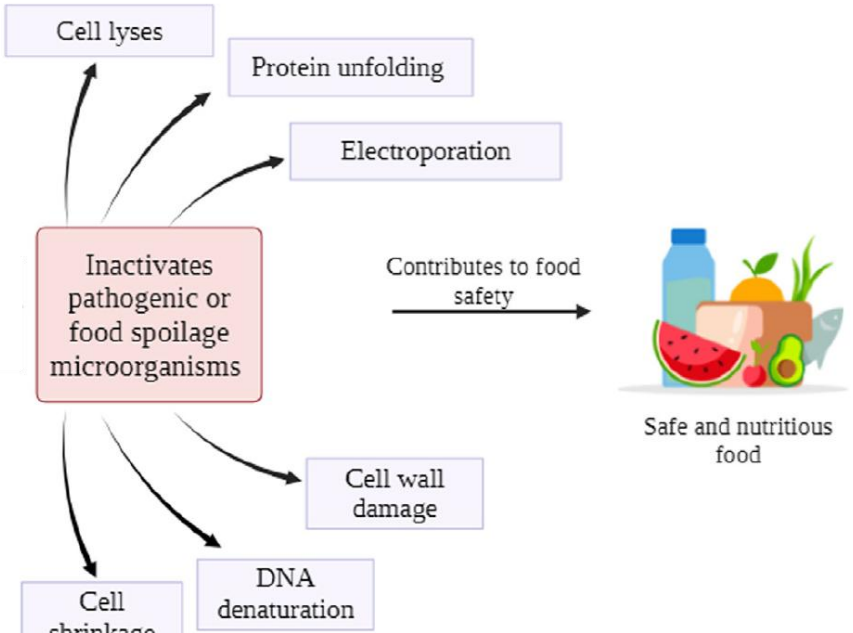
Sterilization

- High temperature (above 100°C)
- Inactivation of all forms of microorganisms including spores
- Long-term preservation

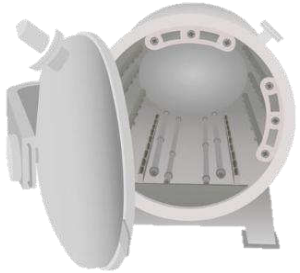
Novel Non-thermal Processing

- High pressure processing [a] (HPP)
- Pulsed electric field [a] (PEF)
- Ultraviolet light [a]
- Ultrasound (US)
- Cold or non-thermal plasma (NTP)
- High pressure homogenization [a] (HPH)
- Membrane filtration [a]
- Ozone [a]

[a] In use by the Food Industry



Source: modified from Khan et al. (2017)
Barbosa-Ca´novas (2022)
Source: modified from Khan et al. (2017)

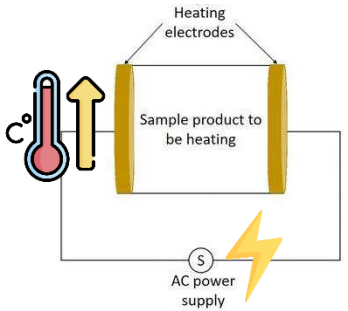


- Mild temperature short time (MTST)
- Mild temperature long time (MTLT)
- High temperature short time (HTST)
- High temperature long time (HTLT)

Conventional Thermal Processing

Novel Thermal Processing

- Ohmic heating (OH) [a]
- Microwave heating [a]



NEW

Legislative consideration

Novel nonthermal processing (NTP)	Novel Foods EU Regulation 258/97 EU Regulation 2015/2283	European Union https://food.ec.europa.eu/safety/novel-food_en Great Britain, Canada, Australia, New Zealand and China
HPP	Since 2018, at the EU level, HPP is no longer considered a novel process. EU Regulation 2073/2005	European Union
HPP/PEF/Ultrasound	Pasteurization	USA
Irradiation, UV radiation and pulsed light (US FDA 2021).	Food additive UV radiation: 21 CFR 179.39 Pulsed UV light: 21CFR179.41	USA
Cold plasma	No approved legislation or regulatory guidance	USA

Novel food processing techniques

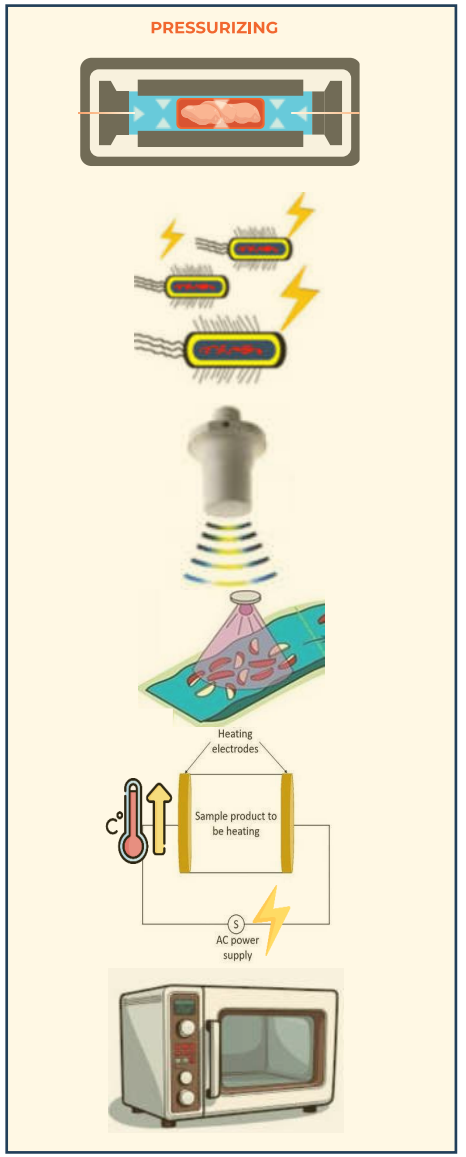
ผลิตภัณฑ์เครื่องดื่ม

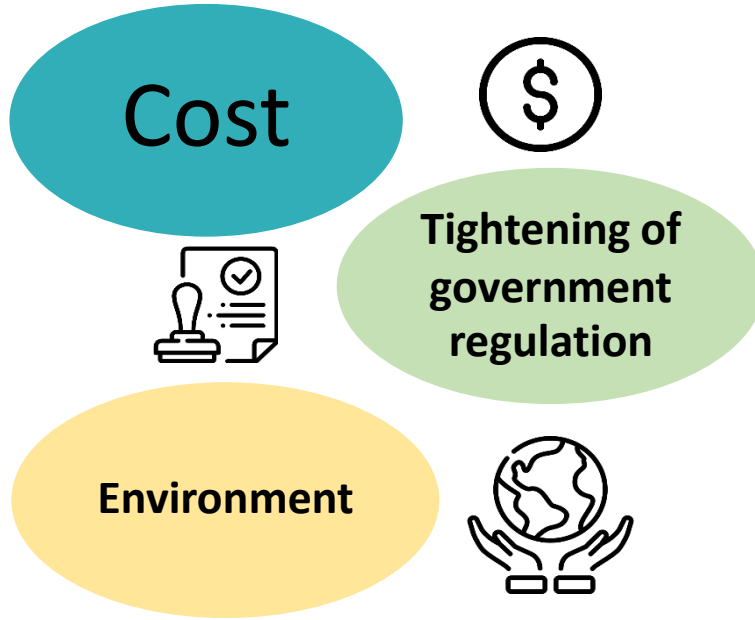
ลักษณะทั่วไปของอาหาร เช่น ลักษณะปรากฏ เนื้อสัมผัส pH

อุณหภูมิ และระยะเวลาในการเก็บรักษา

บรรจุภัณฑ์

ระดับการฆ่าเชื้อ: Pasteurization หรือ Sterilization



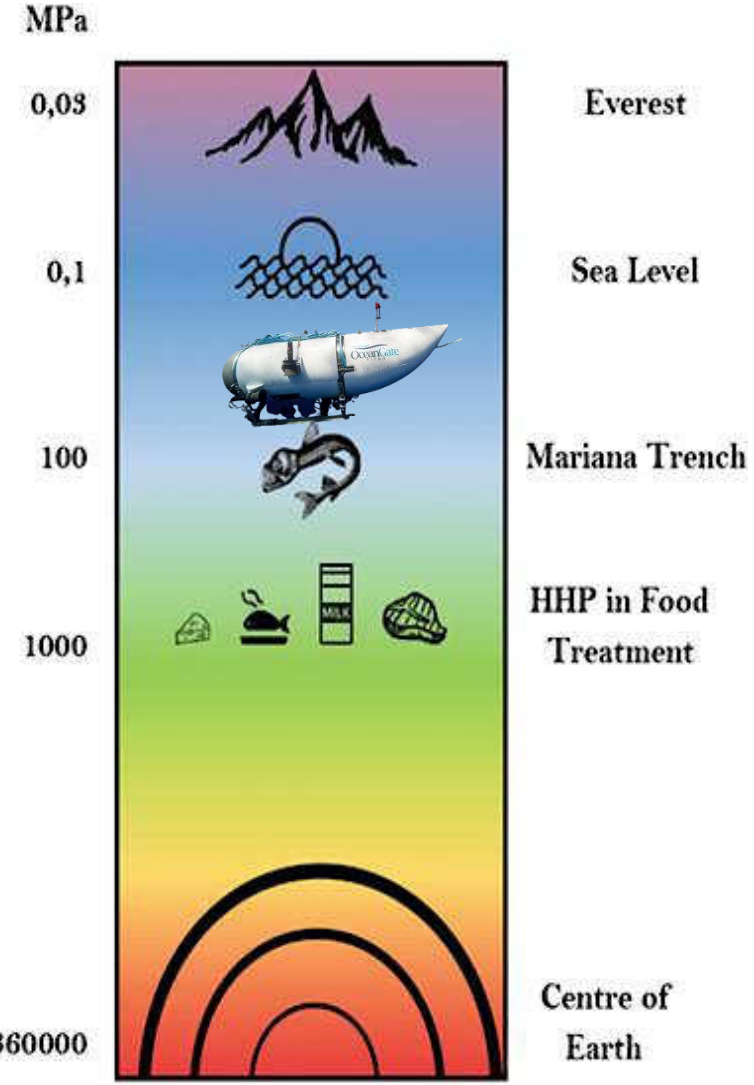


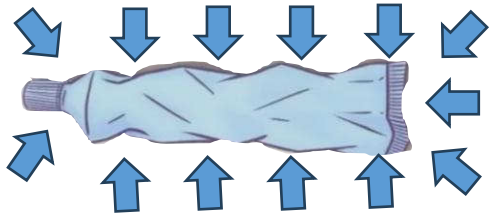
High-Pressure Processing (HPP)

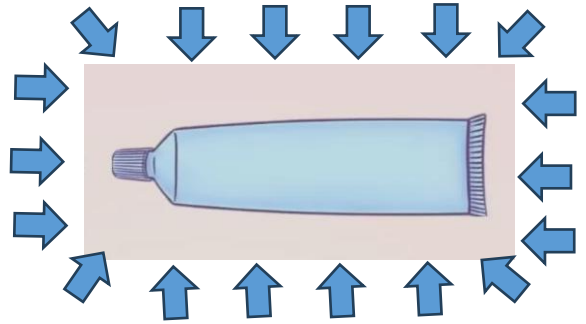
High Hydrostatic Pressure (HHP) Processing

Ultra-High Pressure (UHP) Processing)

High-Pressure Processing (HPP)
High Hydrostatic Pressure (HHP) Processing
Ultra-High Pressure (UHP) Processing







–Pressures between 100 and 800 MPa

–Short period, typically ranging from a millisecond pulse to several minutes (3-5 min)

–Temperature <45°C (Khaliq et al., 2021)

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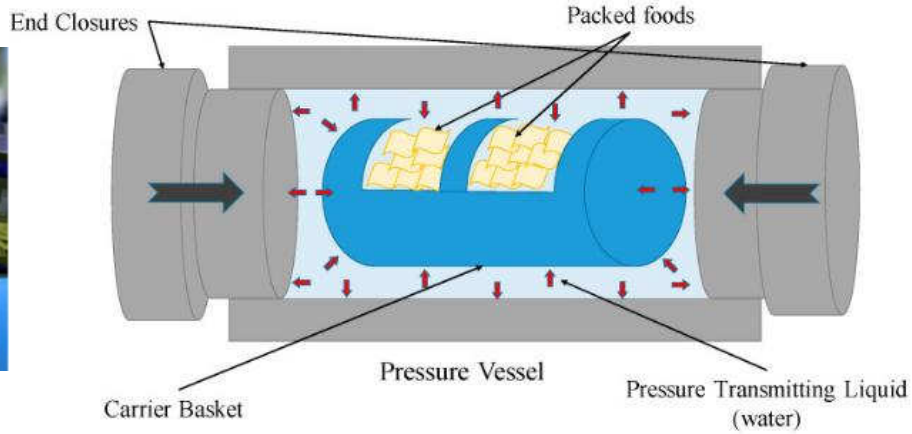
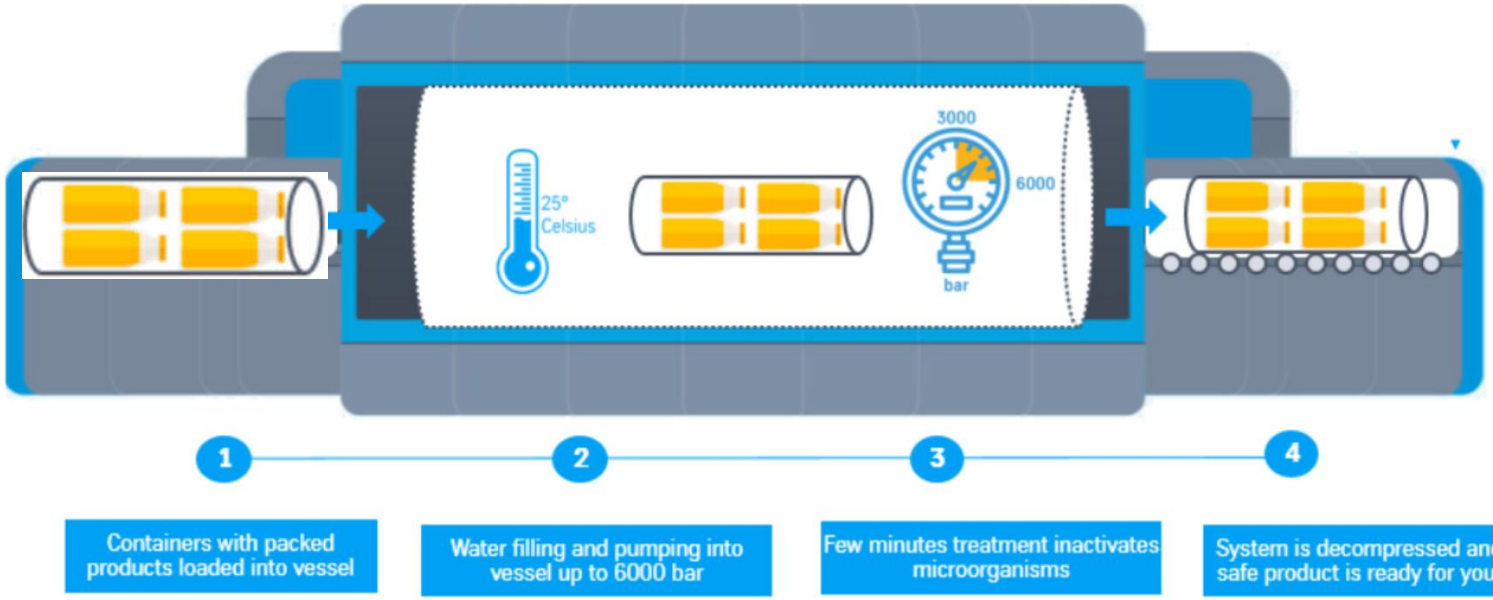
https://www.thyssenkrupp-industrial-solutions.com/high-pressure-processing/en/what-is-hpp

Go´mez et al. (2021)

HPP in-pack processing





Houska et al. (2022)

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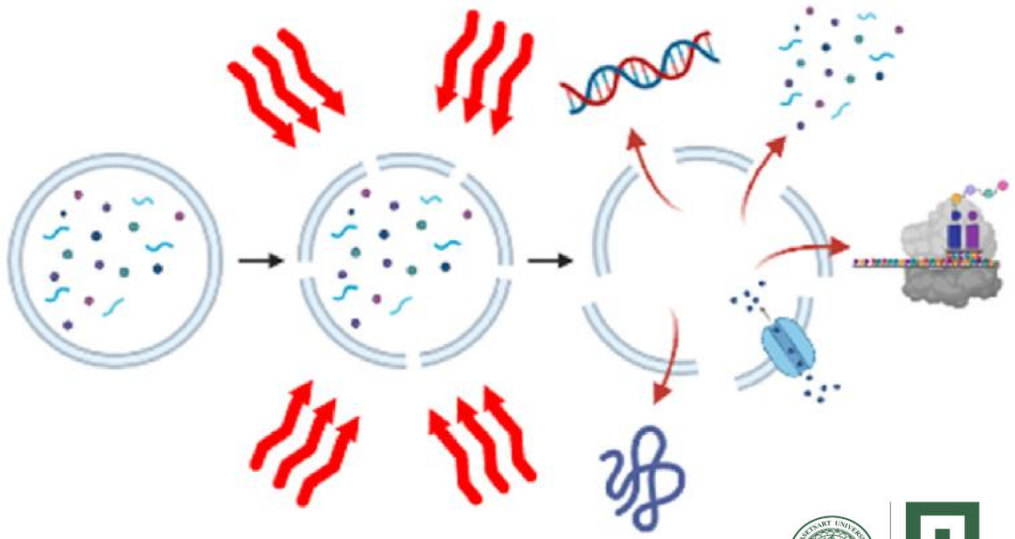
High-Pressure Processing (HPP)



Bigi et al. (2023)

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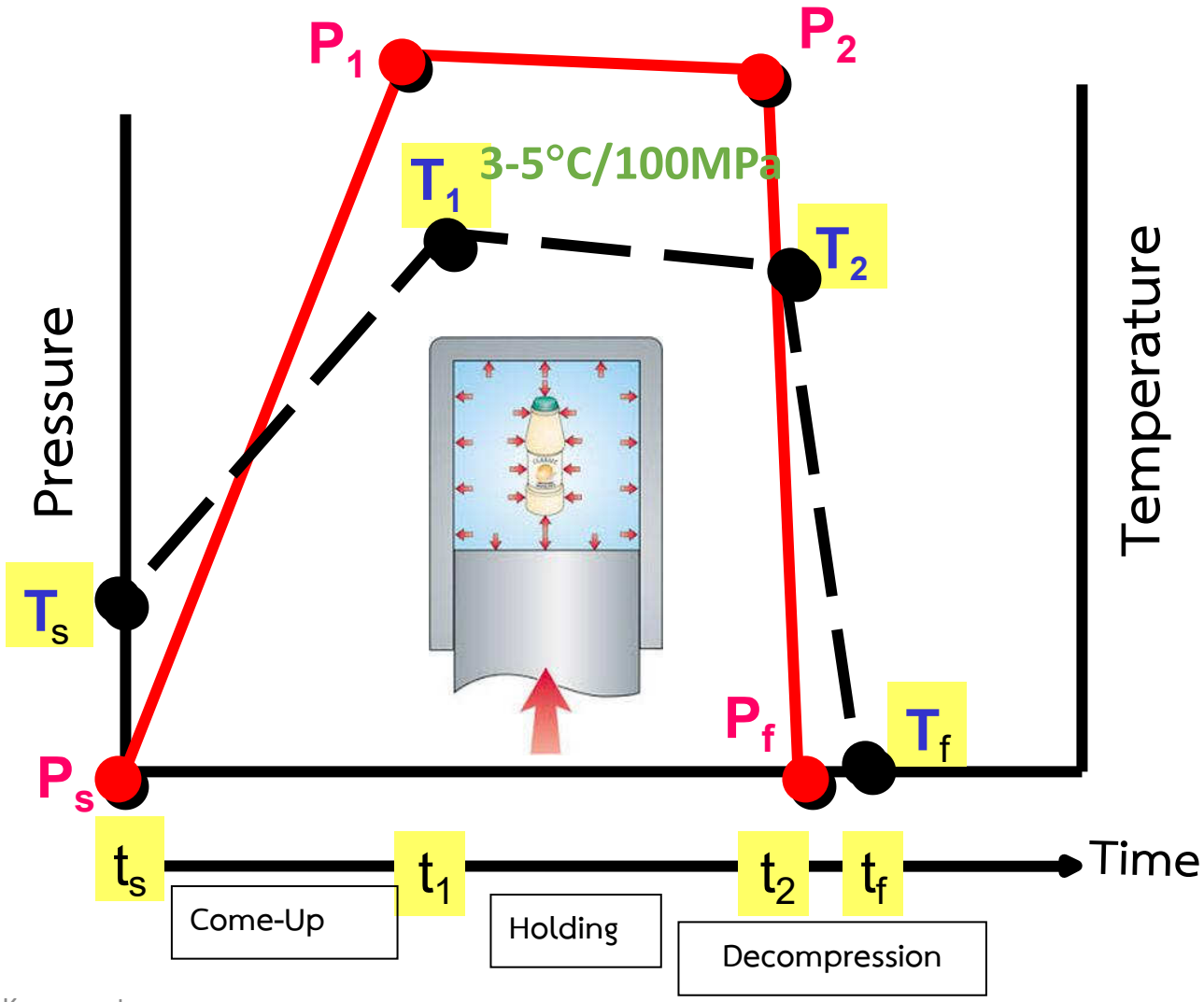
Adiabatic heating (compression heating)

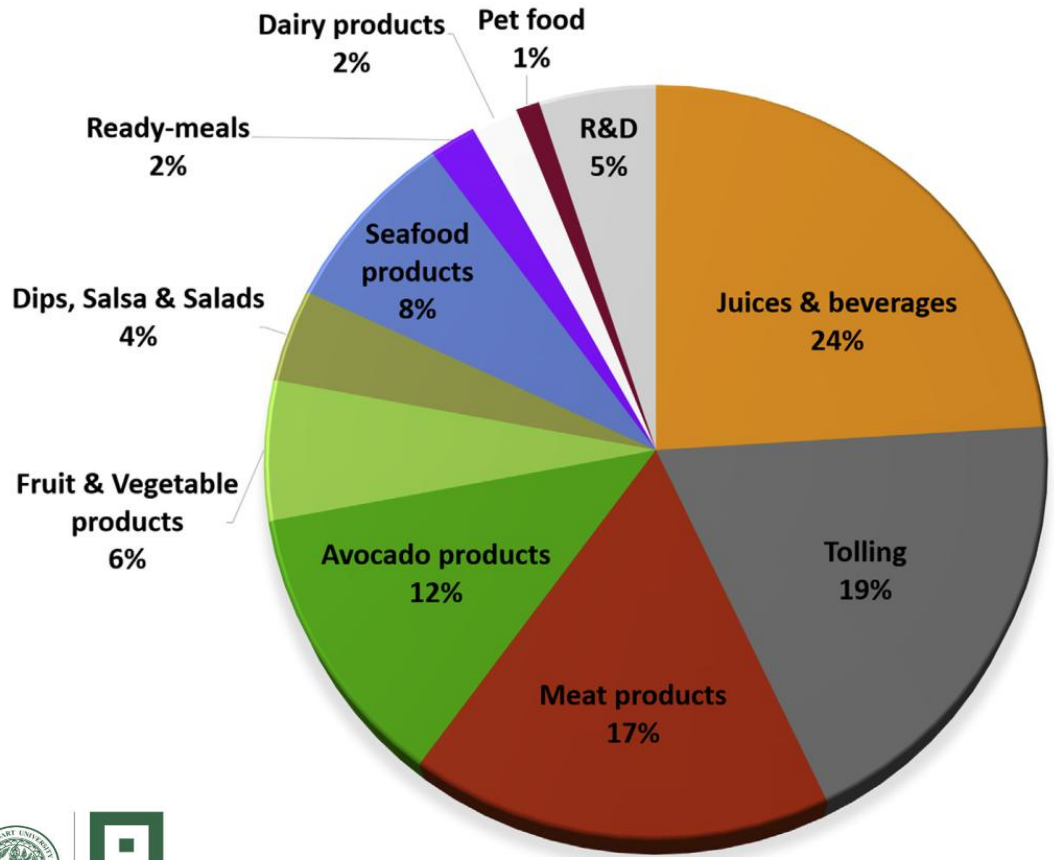


https://foodsafetytech.com/feature_article/hpp-achieve-high-standards-food-safety-without-compromising-food-quality/
https://apfoodonline.com/industry/high-pressure-processing-a-powerful-tool-for-the-food-beverage-industry/
https://www.profoodworld.com/home/article/21114106/juice-maker-expands-with-high-pressure-processing
https://www.intechopen.com/books/fuel-ethanol-production-from-sugarcane/high-hydrostatic-pressure-process-to-improve-ethanol-production

HPP food products

What is HPP? | manufactor | thyssenkrupp (thyssenkrupp-industrial-solutions.com)

Worldwide distribution of industrial HPP machines by food sectors (updated: 2020)



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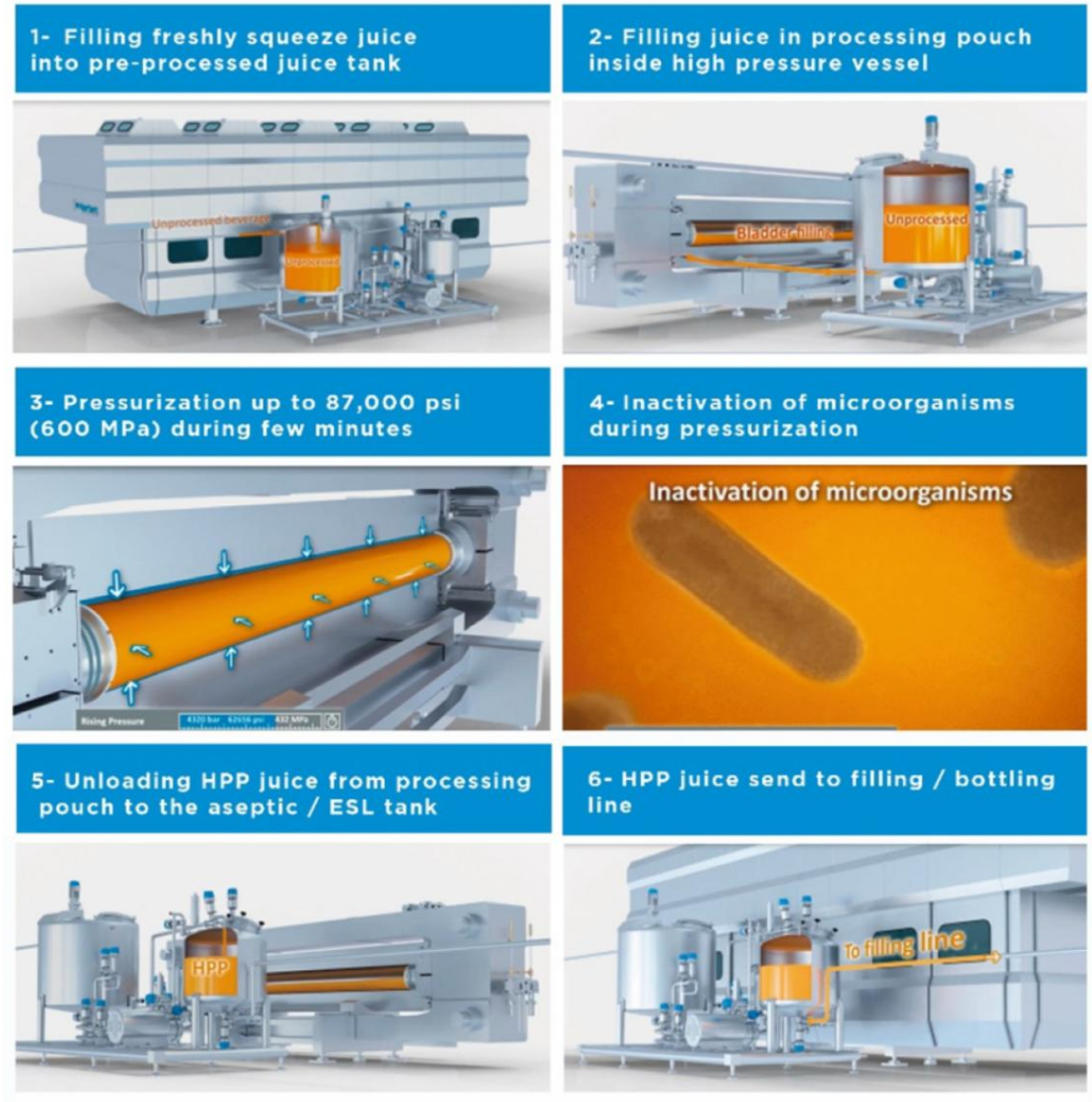
Gonza´lez-Angulo et al (2021)

http://functionalfoods.biz/wp-content/uploads/2014/09/High-Pressure-Processing-Market-Trends-2011-Dr-Ranjan-Sharma.pdf

HPP in-bulk processing



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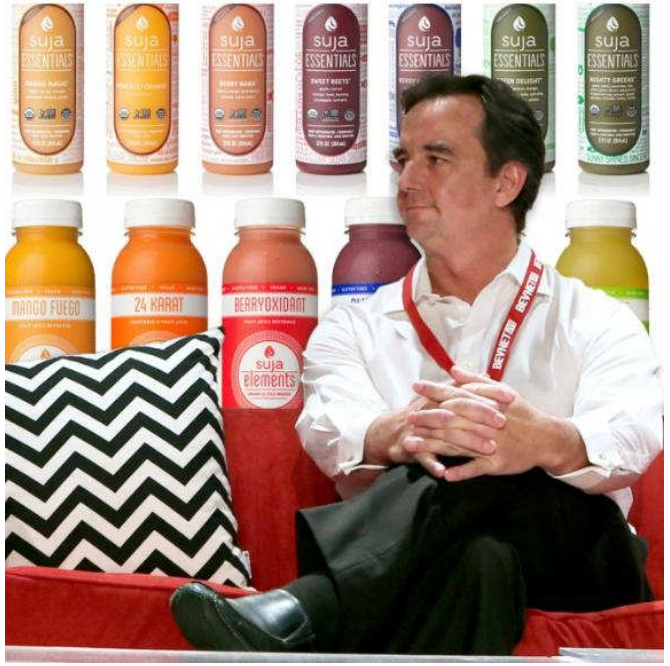
Houska et al. (2022)

Cold Pressure Council

a “Cold Pressure Council” was established in the United States with the mission statement “to lead, facilitate, and promote industry standardization, user education, and consumer awareness of high pressure processing.” https://www.coldpressurecouncil.org/

Barbosa-Ca´novas et al. (2022)

HPP: Commercial application worldwide



Coca-Cola and Suja announce an agreement to expand Organic Cold-Pressed HPP Juices market - Hiperbaric

France chooses HPP technology to serve refrigerated and sustainable juices on its high-speed trains (TGV) - Hiperbaric

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HPP: Commercial application in Thailand

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Legislative consideration-Thailand-HPP

กลุ่มผลิตภัณฑ์: ผลิตภัณฑ์พร้อมบริโภคชนิดเหลว รวมถึงชนิดเข้มข้นซึ่งต้องเจือจางก่อนการบริโภค ซึ่งไม่อัดก๊าซ 4 ประเภท ได้แก่

1) เครื่องดื่มในภาชนะบรรจุที่ปิดสนิท ตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง เครื่องดื่มในภาชนะบรรจุที่ปิดสนิท

2) ชา ตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง ชา

3) กาแฟ ตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง กาแฟ

4) น้ำนมถั่วเหลือง ตามประกาศกระทรวงสาธารณสุขว่าด้วยเรื่อง น้ำนมถั่วเหลือง

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เอกสารหมายเลข 3.1-1

เกณฑ์ทั่วไปและขอบเขตผลิตภัณฑ์ที่ให้ใช้กระบวนการพาสเจอไรส์ ด้วยการใช้ความดันสูง (High-Pressure Processing (HPP))

1. เกณฑ์ทั่วไปสำหรับการผลิตสำหรับการพาสเจอไรส์ ด้วย HPP

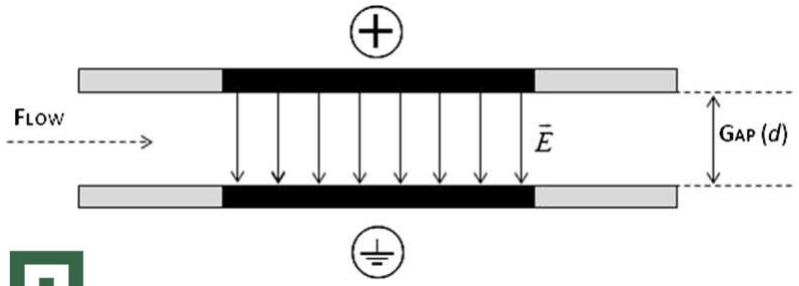
ที่ใช้เทคโนโลยี HPP สำหรับกระบวนการพาสเจอไรส์ แทนการใช้ความร้อน หรือใช้ร่วมกับความร้อน แบ่งเป็น 2 กลุ่มย่อย ตามเกณฑ์ค่า pH คือกลุ่มที่เป็นกรด (pH ≤ 4.6) และกลุ่มที่เป็นกรดต่ำ (pH >4.6)

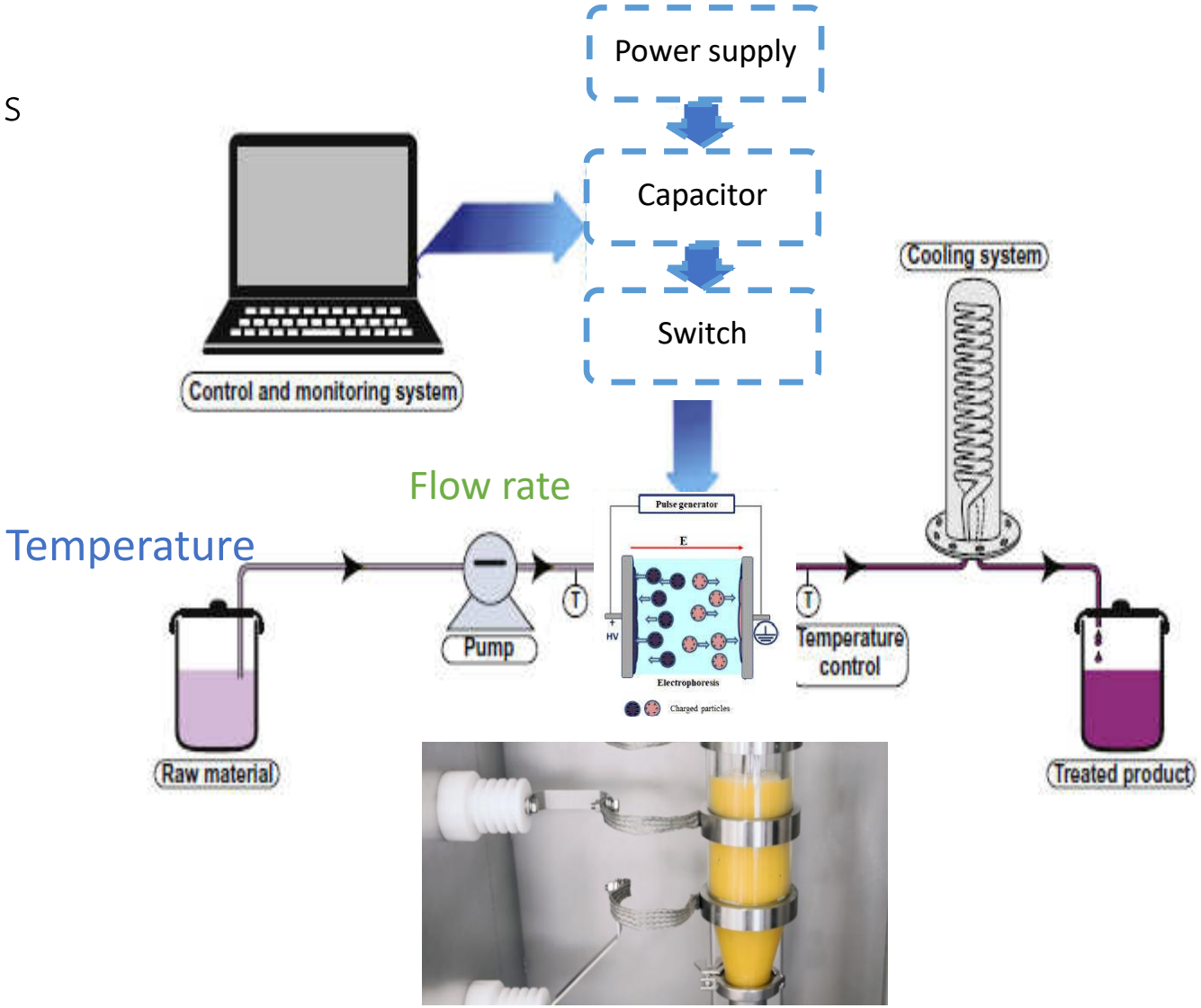
กลุ่มผลิตภัณฑ์	พารามิเตอร์	สภาวะ
ผลิตภัณฑ์พร้อมบริโภคชนิดเหลว ที่มี pH ≤ 4.6	สภาวะการเก็บรักษาก่อนการพาสเจอไรส์	Initial load ไม่เกิน 10^6 cfu/g และเก็บที่อุณหภูมิไม่เกิน 10°C
	สภาวะในการพาสเจอไรส์* - ความดันสำหรับการพาสเจอไรส์ - ระยะเวลาที่ใช้ระหว่างพาสเจอไรส์ (Holding time)	400 MPa ขึ้นไป 1-20 นาที และ ต้องมีผลการศึกษาแสดงว่าสามารถลดจุลินทรีย์ก่อโรคอ้างอิง** ได้ไม่น้อยกว่า 5 log reduction)
	สภาวะการเก็บรักษาหลังพาสเจอไรส์	ไม่เกิน 5°C
	อายุการเก็บรักษา	ตามผลการศึกษาอายุการเก็บรักษาของผลิตภัณฑ์
ผลิตภัณฑ์พร้อมบริโภคชนิดเหลว ที่มี pH > 4.6	สภาวะการเก็บรักษาก่อนการพาสเจอไรส์	Initial load ไม่เกิน 10^6 cfu/g โดยเก็บที่อุณหภูมิไม่เกิน 10°C
	สภาวะในการพาสเจอไรส์* - ความดันสำหรับการพาสเจอไรส์	600 MPa ขึ้นไป
	- ระยะเวลาที่ใช้ระหว่างพาสเจอไรส์ (Holding time)	3-20 นาที และต้องมีผลการศึกษาที่แสดงว่าสามารถลดจุลินทรีย์ก่อโรคอ้างอิง** ได้ไม่น้อยกว่า 5 log reduction)
	สภาวะการเก็บรักษาหลังพาสเจอไรส์	ไม่เกิน 5°C
	อายุการเก็บรักษา	ตามผลการศึกษาอายุการเก็บรักษาของผลิตภัณฑ์ (ต้องมีผลการตรวจวิเคราะห์เชื้อจุลินทรีย์ *Clostridium botulinum ที่แสดงอายุการเก็บรักษาตามที่แจ้งด้วย)*

Pulsed Electric Field (PEF)

Pulsed Electric Field (PEF)

- High electric field strength (10-80 kV/cm)
- Short electric pulses (a range of microseconds to milliseconds)
- Moderate temperature (<50°C)
- Batch or continuous treatment chamber
- Microbial inactivation
- Minimal or no detrimental effect on food quality attributes





Raso and A´ Ivarez (2016)

PEF: Application

- Preservation of foods
  - Beverages
  - Dairy and egg products
  - Beer
  - Vegetable oils
  - Soups
  - Sauces
  - Dressings
  - Yogurt
  - Pudding
  - Marinades
  - Baby foods
- PEF-assisted cell expression and extraction

http://www.divtecs.com/data/File/papers/PDF/pef_processing_ift0106.pdf

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http://www.pulsemaster.us/pef-products

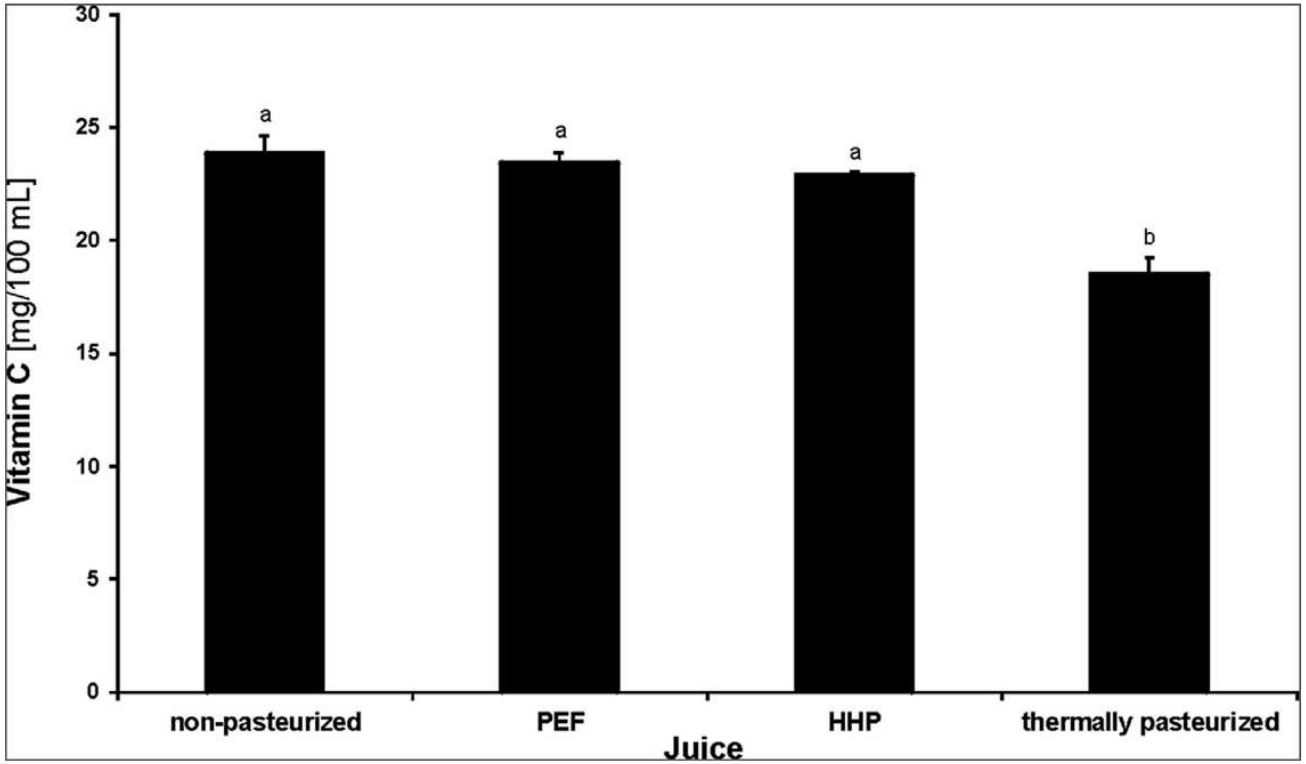
http://www.foodengineeringmag.com/articles/89902-fresh-juice-processor-automates-pasteurization-with-continuous-process

PEF: Products

Fresh green juice

PEF treated juice

Thermal treated juice



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https://www.dlg.org/en/food/topics/dlg-expert-reports/food-technology/dlg-expert-report-5-2018

Moussa-Ayoub et al. (2017)

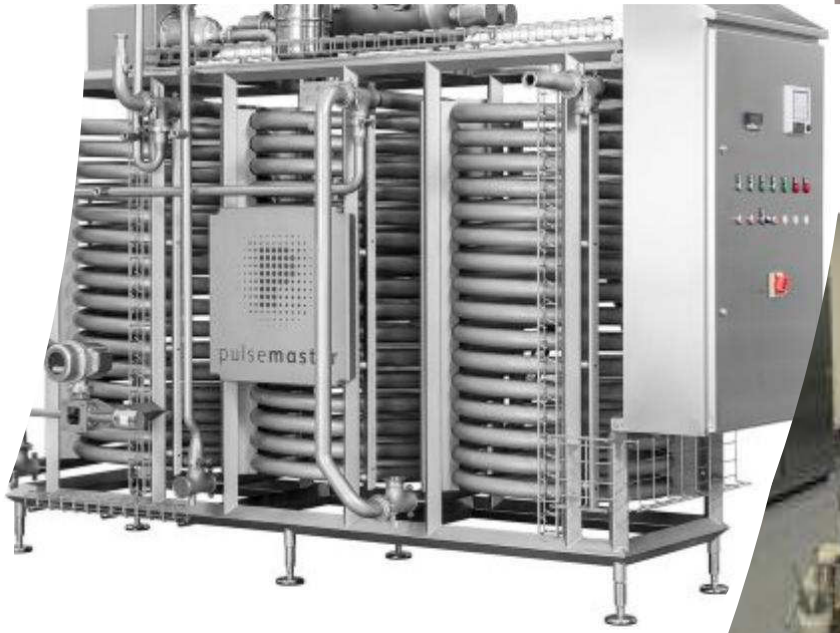
PEF unit

Diversified Technologies, Inc.
(DTI): 1,000–5,000 liters/hour

Pulsemaster
300–5,000 liters/hour

PurePulse
600–1,800 liters/hour

Elea
Up to 5,000 liters/hour



Juices & Smoothies | Boost Your Beverages — Elea PEF electroporation

- http://www.thedairysite.com/articles/3710/pulsed-electric-fields-in-food-production/

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PEF food products

Juices pasteurized by PEF are being marketed by Genesis Juice Cooperative in the Portland, Ore., area. Labels state that the product is "Processed by Pulsed Electric Field."

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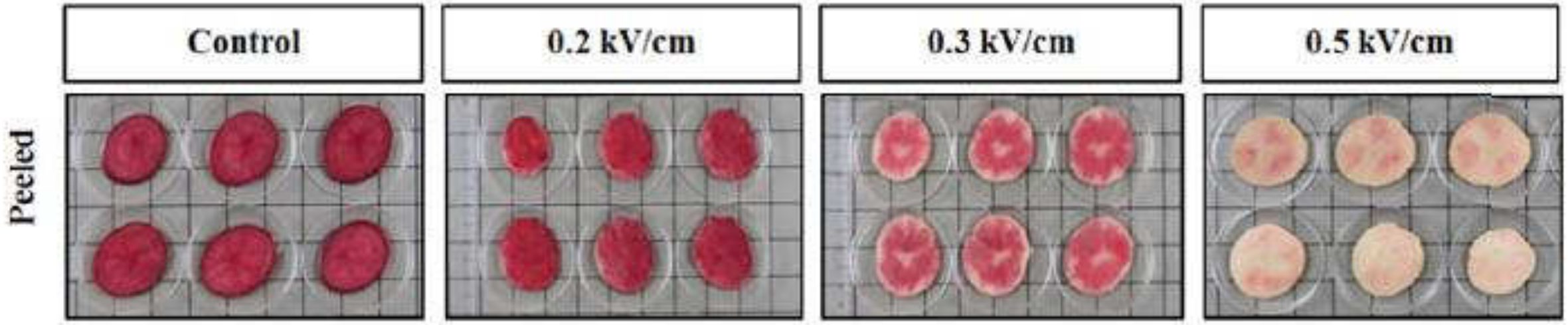
PurePulse makes it possible to give fresh fruit juices a 21-day long shelf life while preserving their natural vitamins, aromas, colours and flavours.

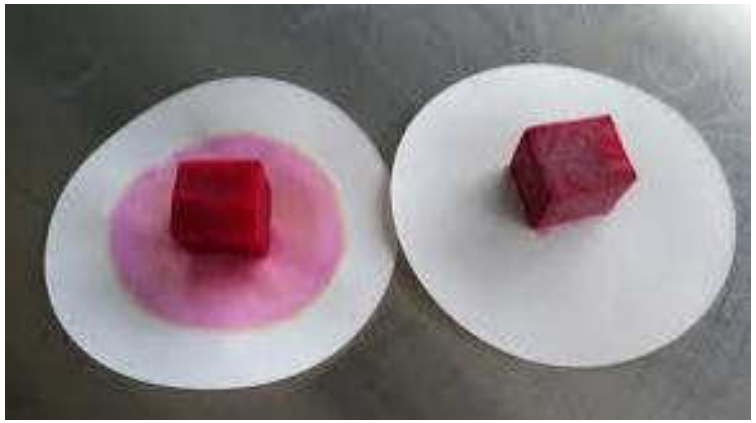
[See Elea's award-winning Smoothcut One PEF-system at Anuga FoodTec | PotatoPro]

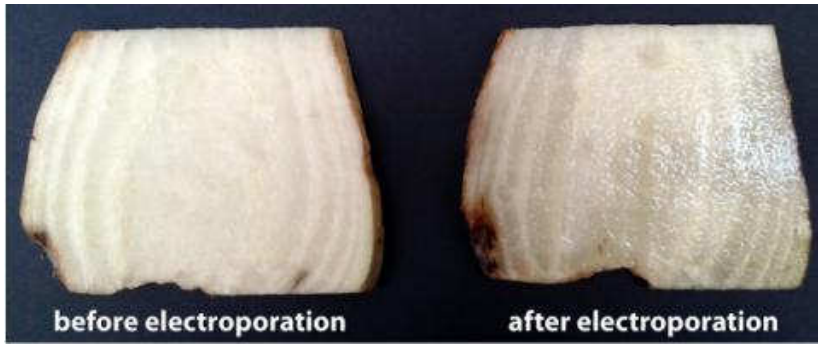
[UGA FoodPIC partners with industry to make the perfect orange juice | CAES Newswire]

[Pulsed Electric Field Processing Applications in the Food Industry | Ohioline]

Membrane permeabilization

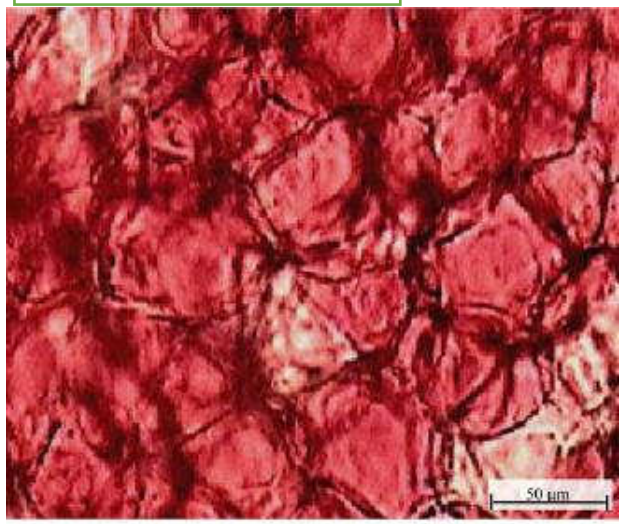


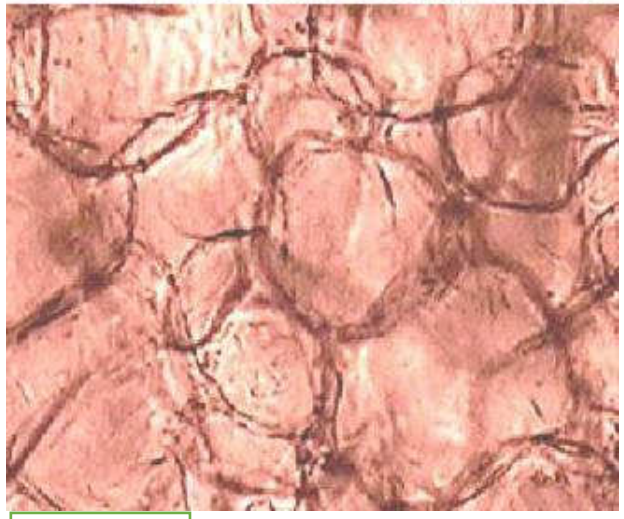




PEF-assisted cell expression and extraction

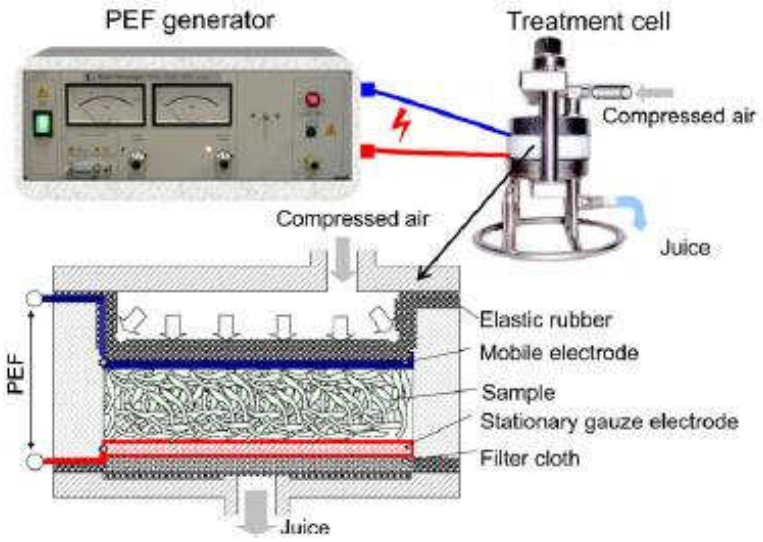
Untreated



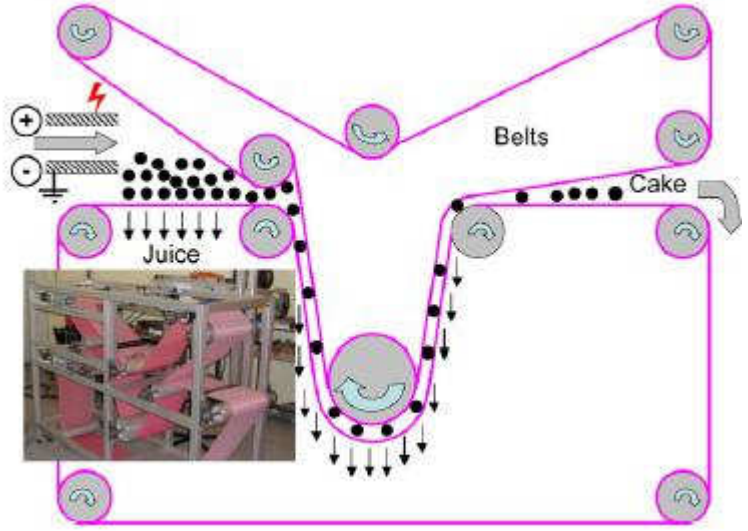


PEF

Microscopic images of the red beet tissue after aqueous extraction



Simple laboratory device for PEF-assisted pressing.



A pilot belt press used for PEF-assisted expression from the sugar beets.

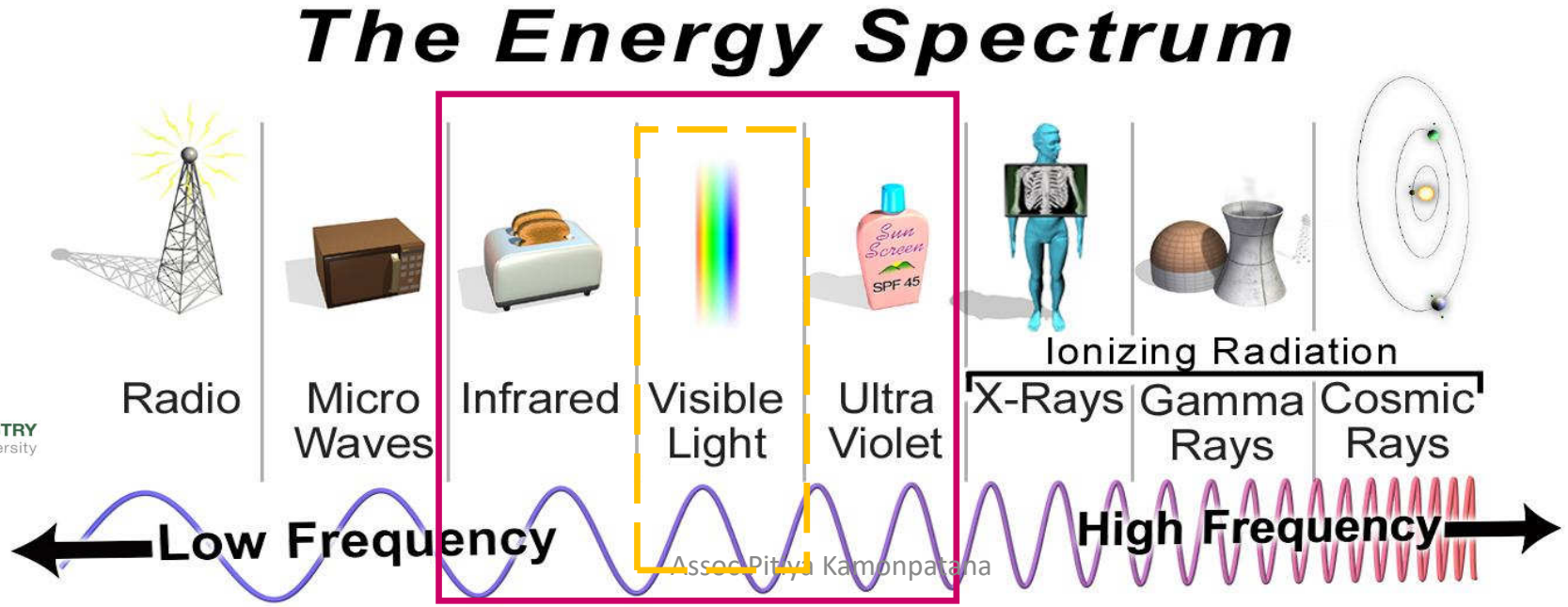
Ultraviolet Light (UV)

Pulse UV Light (PUL)

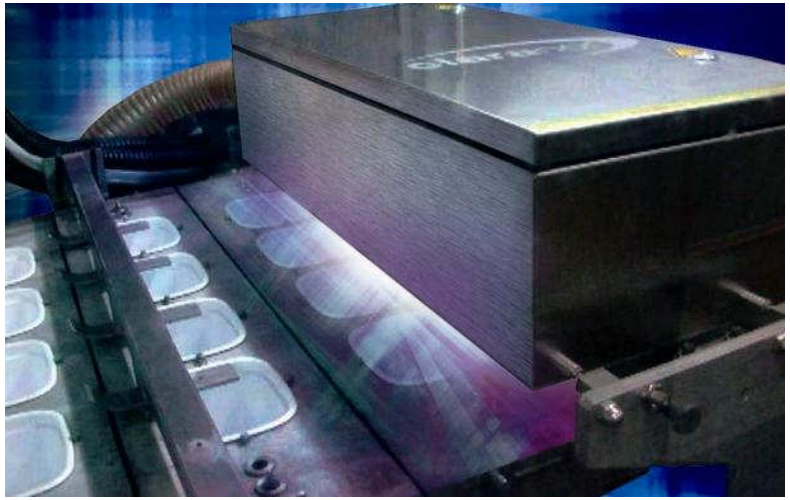
Pulsed Light(PL)

UV/Pulse UV light/Pulsed-light system

- The light produced by the lamp includes broad spectrum wavelengths from UV to near-infrared (100 to 1,100 nm): UV (100–400 nm), visible light (400–700 nm), and infrared (700–1,100 nm).
- The wavelength:100 and 400 nm belongs to UV irradiation→ UV A (315–400 nm) UV B (280–315 nm) UV C (200–280 nm)
- In 2000, the US FDA amended the food additive regulations to provide for the safe use of UV radiation at a wavelength of 253.7 nm (Koutchma, 2021)



PL vs Continuous UV light

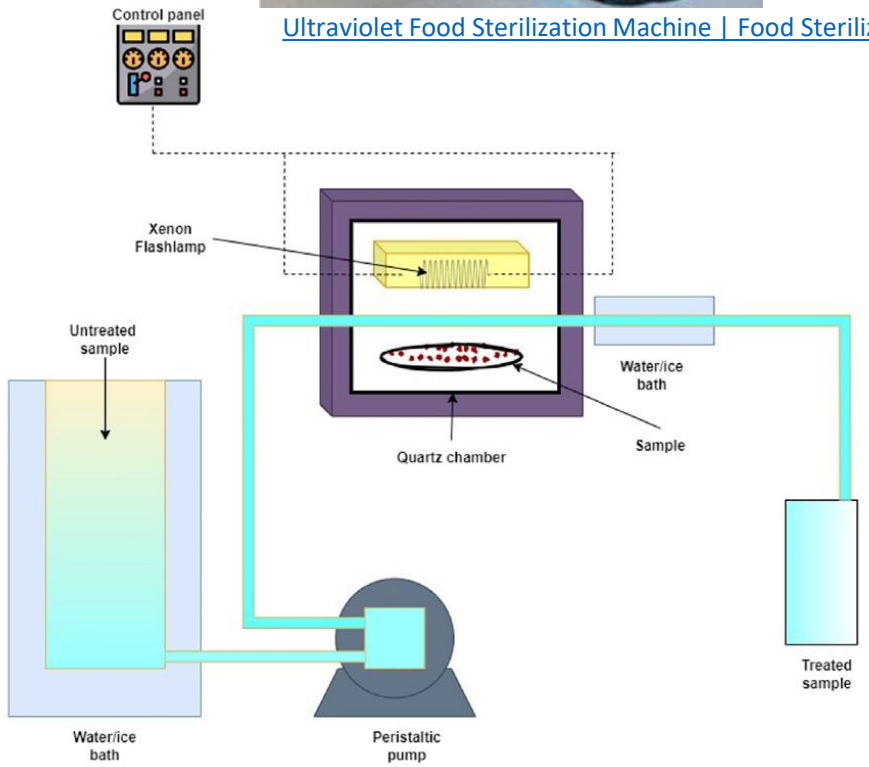


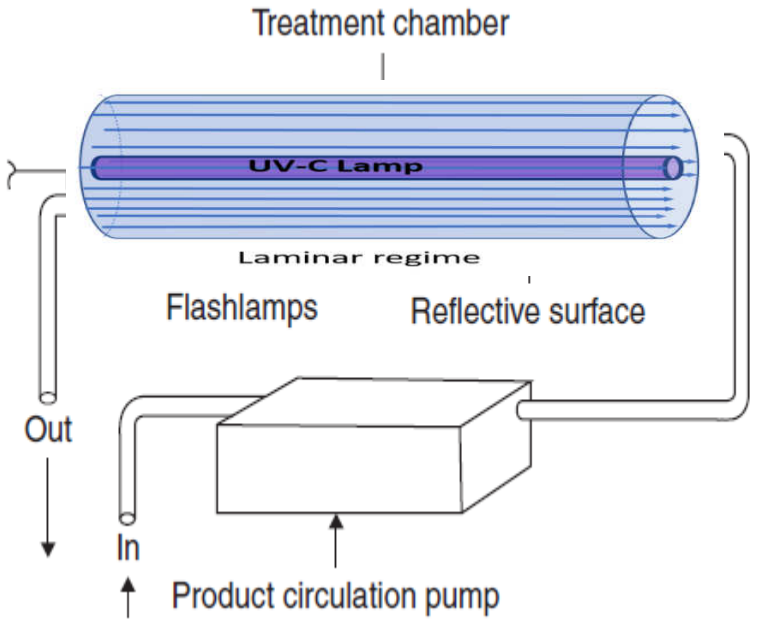
- Continuous UV light has several disadvantages, such as poor penetration depth and low emission power, whereas PL sterilization has comparatively higher penetration depth and emission power.
- Xenon lamps are commercial sources of PL that are more environmentally friendly than UV lamps because they do not use mercury (Koutchma, 2017).

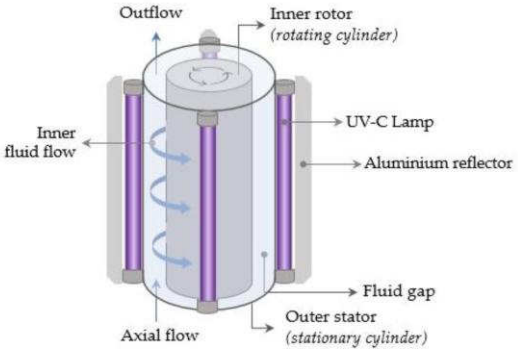
- PL treatment is more effective and rapid for microorganism inactivation than continuous UV light, because the energy is multiplied manifold (Food and Drug Administration 2000; Dunn et al. 1995)
- In general, temperature increase of products exposed to PL is much lower and localized in a thinner surface layer than that of an equivalent continuous UV light treatment, due to the short duration of pulses.

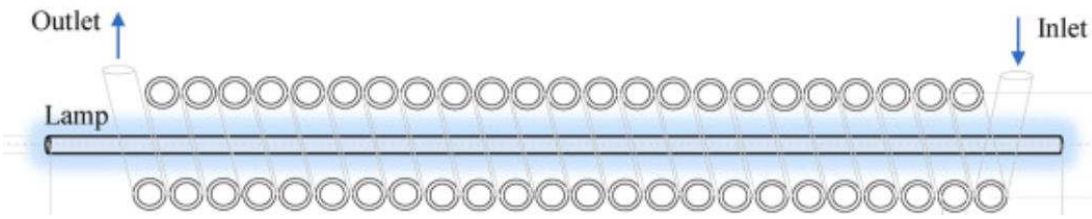
UV/Pulse UV light/Pulsed-light system

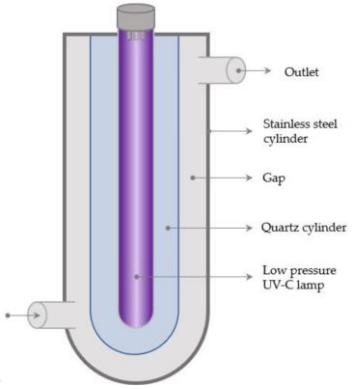
Ultraviolet Food Sterilization Machine | Food Sterilizer







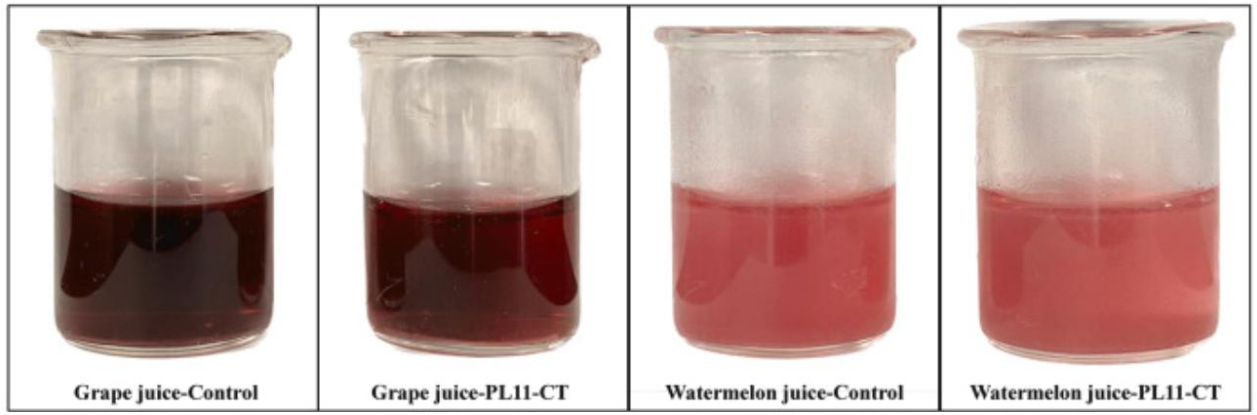




UV food products

Grape juice

Watermelon juice



Maximum ΔE = 4

Maximum ΔE = 2

Total anthocyanins
Total phenolics
Antioxidant capacity
Vitamin C
Trans-resveratrol
Tycopene content

PL > Conventional heating

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Pratap-Singh and Mandal (2024)

Coconut water

Donsingha and Assatarakul (2018)

Conventional pasteurization
Color→ Day 6
Microbial count → Day 5
UV 3.2 J/mL
Color → Day 10
Microbial count → Day 11

UV food products

Starbucks Picks Up Sol-ti Wellness Shots

June 06, 2025

Natural Products News Briefs: Sol-ti Expands Product Availability

Starbucks and Sol-ti Partnered for Two New Wellness Refreshments

Sol-ti Press

Ex-Pressed Juicery Chief Kalra Joins Sol-ti as President and CEO - BevNET.com

Organic Living Beverages® from Sol-ti® | San Diego, CA, USA

WARNING LETTER

March 16, 2023

WL 653764

Dear Mr. O'Donnell:

The United States Food and Drug Administration (FDA) inspected your facility, located at 8380 Miralani Dr, Ste A, San Diego, CA 92126 from December 19, 2022, through February 8, 2023. We found that you have serious violations of the juice Hazard Analysis and Critical Control Point (HACCP) regulation, Title 21, Code of Federal Regulations, Part 120 (21 CFR Part 120). In accordance with 21 CFR 120.9, failure of a processor to have and implement a HACCP plan that complies with the requirements of 21 CFR Part 120 renders the juice products adulterated within the meaning of Section 402(a)(4) of the Federal Food, Drug and Cosmetic Act (the Act) [21 U.S.C. § 342(a)(4)]. Accordingly, your ready-to-drink (RTD) juice products and juice ingredients are adulterated in that they have been prepared, packed, or held under insanitary conditions whereby they may have been rendered injurious to health. You may find the Act, the juice HACCP regulation, and the Juice HACCP Hazards and Controls Guidance through links in FDA's home page at www.fda.gov.

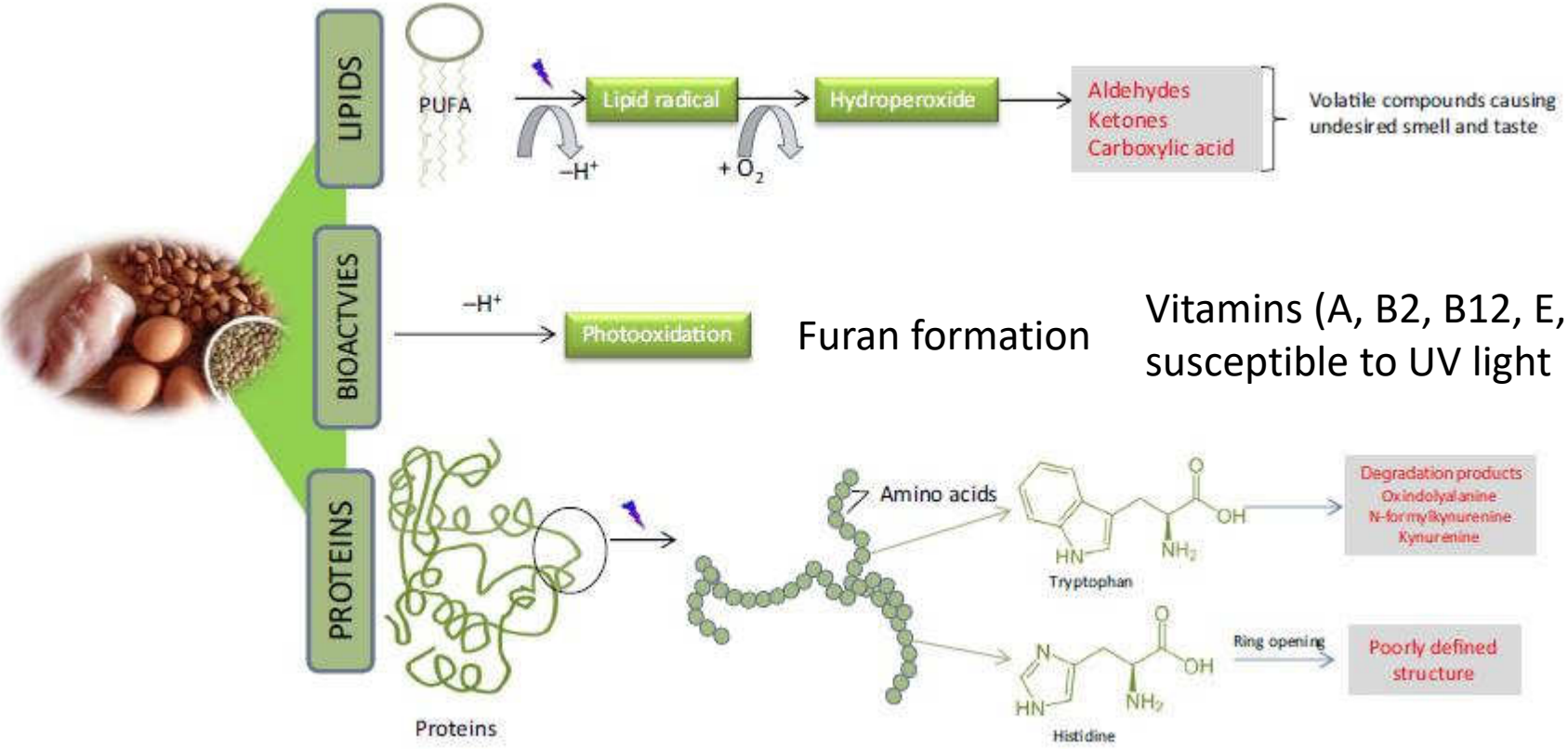
We received your response, dated February 28, 2023, concerning the FDA 483. After reviewing the inspectional findings and your response, we are issuing this letter to advise you of FDA's remaining concerns.

Sol-ti Inc. - 653764 - 03/16/2023 | FDA

Safe use of UV/ Pulsed UV light/Pulsed-light system

- Radiation sources consist of xenon flash lamps consisting of wavelengths covering the range of 200 to 1000 nm.
- Pulse duration is no longer than 2 ms.
- PL is used for surface microorganism control
- Foods treated with pulsed light shall receive the minimum treatment reasonably required to accomplish the intended technical effect
- Total cumulative treatment shall not exceed 12.0 J/cm^2 for PL-food treatment as FDA recommended . Koutchma (2017)

Limitations of UV/PUL/PL

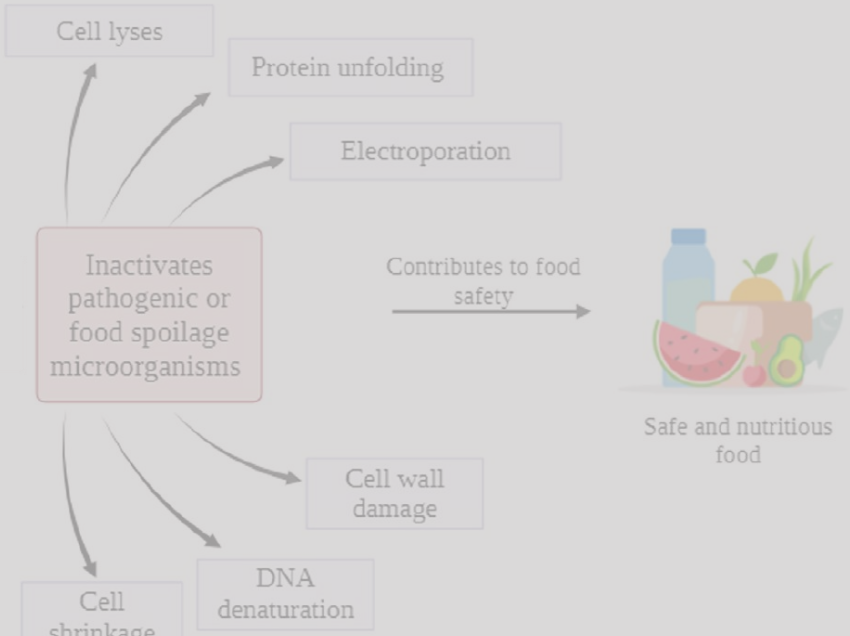


Furan formation

Vitamins (A, B2, B12, E, D, K), carotenes and colorants are also susceptible to UV light

Novel Non-thermal Processing

- High pressure processing (HPP)
- Pulsed electric field (PEF)
- Ultrasound (US)
- Ultraviolet light
- Cold or non-thermal plasma (NTP)
- High pressure homogenization (HPH)
- Membrane filtration

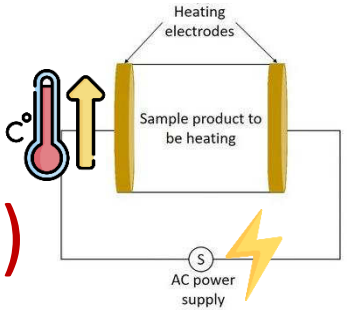


Source: modified from Khan et al. (2017)

- Mild temperature short time (MTST)
- Mild temperature long time (MTLT)
- High temperature short time (HTST)
- High temperature long time (HTLT)

Conventional Thermal Processing

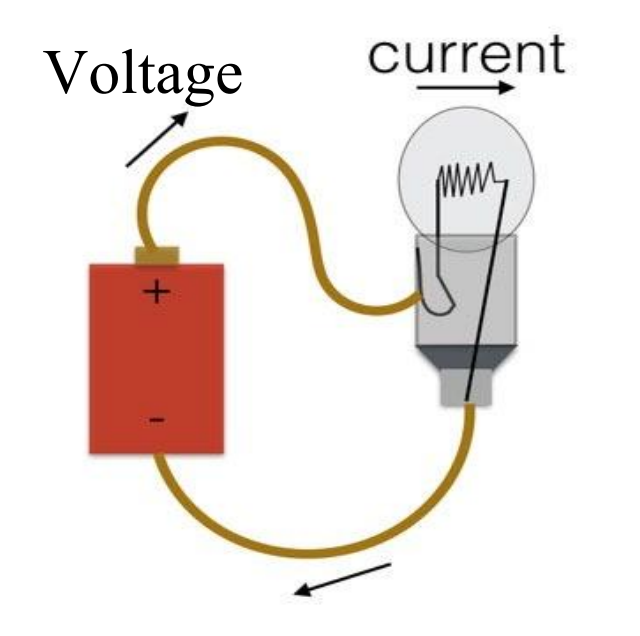
Novel Thermal Processing



- Ohmic heating (OH)
- Microwave heating

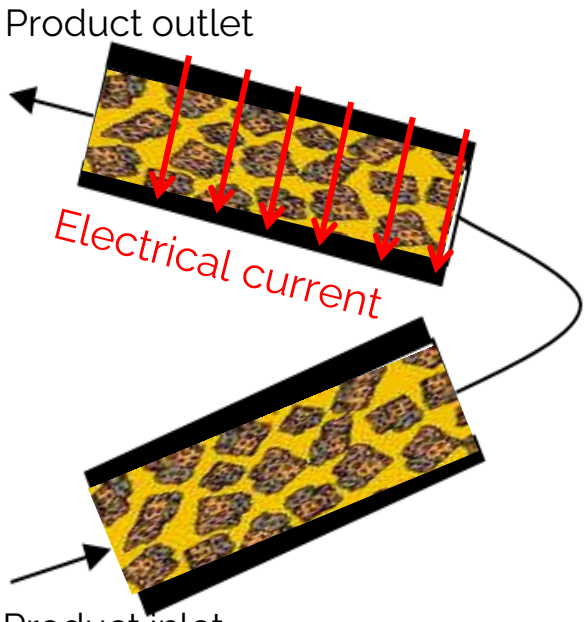
Ohmic Heating

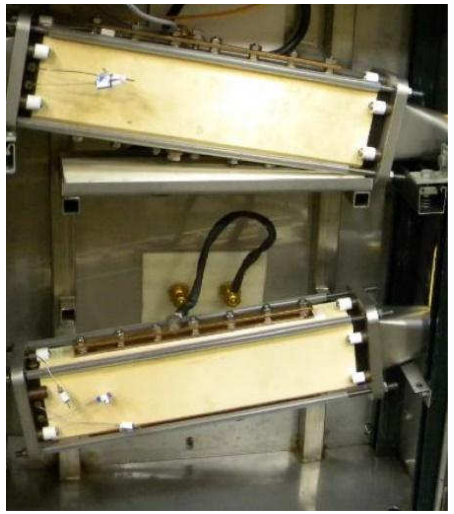
Ohmic Heating (OH)

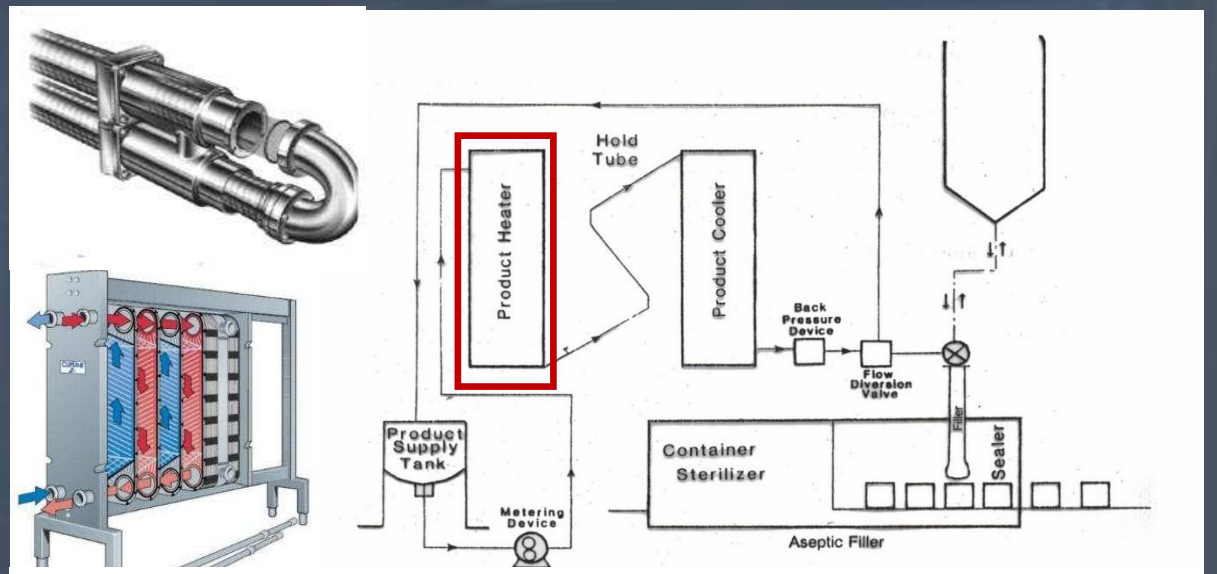


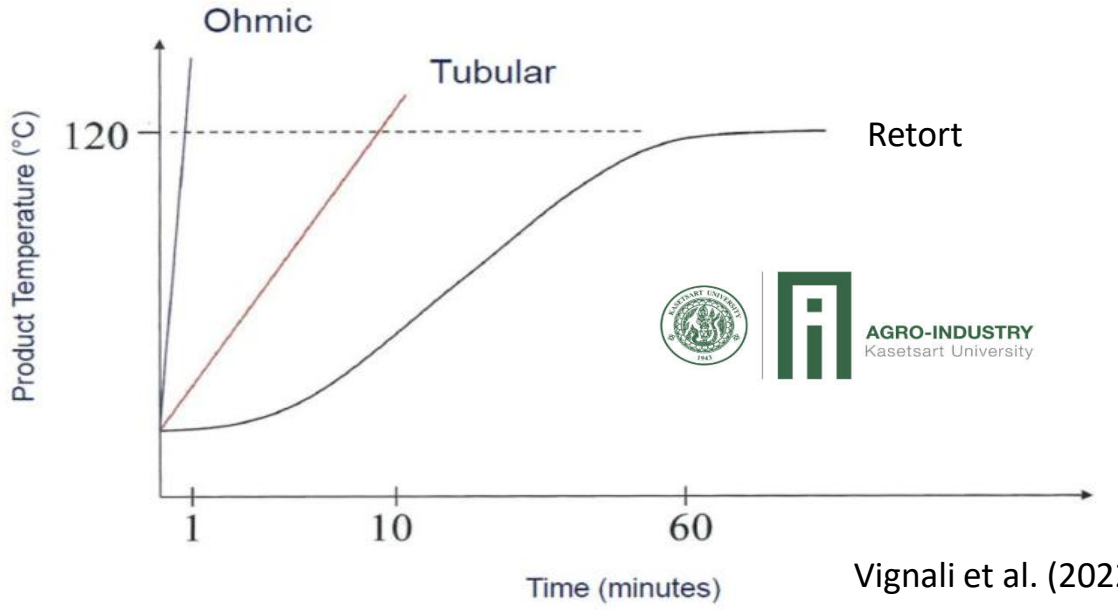
- ✓ Electrical energy is dissipated into heat.
- ✓ It is also possible to heat materials at extremely rapid rates.
- ✓ OH produces an inside-out heating pattern.

Continuous-flow Ohmic Heating system-Ohmic UHT









Vignali et al. (2022)

- High Product Quality: ↑ Vitamin C > 5 times
- High Process Efficiency: ↓ Fouling 90%
- High Energy Efficiency: 92-95%
- Clean Energy

Commercial continuous-flow ohmic heating system

1991

Approval of APV Ohmic heating technology for the production of ambient stable low acid ready meals in the UK

1993

FDA in the United States approved the Ohmic heating technology for low acid fluids containing particulates

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Kasetsart University

The full commercialization of **Ohmic heating technology depends in part on the development of adequate safety and quality-assurance protocols** in order to obtain an approved filing of the process with the FDA for all possible food materials (Ye et al., 2003).

OH food products

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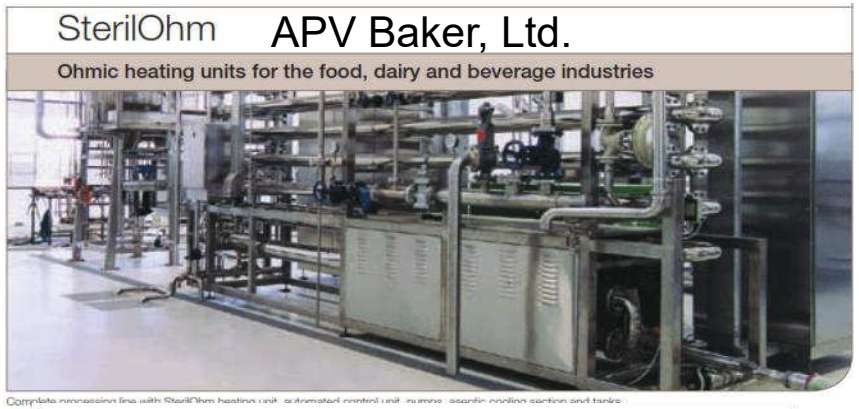
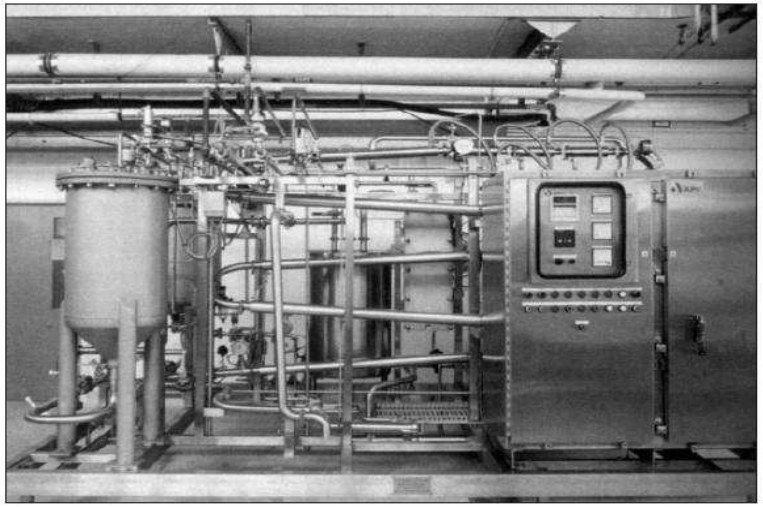
FOOD SCIENCE &TECHNOLOGY
KASETSART UNIVERSITY

Product	Bioactive compounds	Ohmic heating	Conventional heating	Sources
	Vitamin C (mg/100ml)	F_0 = 6 min 63% (25.98[a])	10% (4.04[b])	KU Ohmic Lab
Ohmic heating  Fresh sugar cane juice	Phenolic content	F_0 = 6 min 63%	44%	KU Ohmic Lab
Aroma cocont water 45 Day  Ohmic heating	Tyrosol Phenolic content	74°C for 15 s 97% 97%	90% 93%	KU Ohmic Lab Zulekha et al. (2018)

Examples of commercial ohmic heating systems





The 5 kW pilot scale ohmic heating system by APV Baker, Ltd. (Courtesy of APV Baker, Ltd.)

Constructor	Applications (Specified by the Constructor)
Alfa Laval	Fruits and derivatives, vegetables, prepared foods, cheese, liquid eggs, ready-to-eat dishes, sauces, and juices
Raztek	Liquid egg and egg white
Emmepiemme	Fruits and derivatives, vegetables, dairy product, egg products, algae, syrups, sauces, and ready-to-eat foods
INDAG High Power Heating System (IPS)	Liquid products including chunks and highly viscous foodstuffs
SPX (APV Baker)	Fruit preparations and dressings with high fruit content (also sterile, for pH-neutral products)
Yanagiya	Tofu production
JBT Corporate	Liquid, semi liquid, concentrated, and highly viscosity products containing fibers, small cells and featuring high viscosity such as puree and soups Fruit preparations and fruit jam with dices Soup and sauces including products containing large size particles, 50-70 mm
CFT group	Fruit and vegetables (whole, diced & purees, juices) fruits, pulps, juices, smoothies soups, ready meals, sauces like cheese-based sauces and white sauces jams with particles

Commercial Ohmic Heating: Products

Low acid soups with particulates, commercialized by Unilever since 2011 -Poland

New Heating Technologies Open Up Opportunities For Campbell And The Soup Industry

By Isaac Fletcher, contributing writer, Food Online

Innovations currently in development could allow soup manufacturers' final product to better retain color and nutrients

In order to eliminate pathogens during canned soup production, soup is held at a high temperature and then cooled. This process, though a necessary one, ends up depleting the final product of nutrients and altering the soup's color. However, the development of new technologies could provide a solution that still meets sanitary standards and leaves the final product with more nutrients, flavor, and appetizing color.

One of these technologies, Ohmic heating, has been used in the dairy industry for sterilization, but Campbell Soup is experimenting with applying the process to aseptic soups and juices. In an Ohmic heating process, electricity is run through the food in order to heat it up. Dave Watson, vice-president of engineering for Campbell Soup/Pepperidge Farm says that Ohmic heating applied to aseptic products would result in a faster, more efficient sterilization process — when compared to conventional retort heating — and leave soup with a firm, al dente bite.

https://www.foodonline.com/doc/new-heating-technologies-open-up-opportunities-for-campbell-0001

http://www.freshplaza.com/article/113389/France-Campbells-launches-vegetables-in-CombiblocMidi

http://www.canadianpackaging.com/packpress/campbell-uses-carton-pack-for-soups-in-france/

http://ohioline.osu.edu/fse-fact/0004.html

https://www.academia.edu/41158031/OHMIC_HEATING_RECENT_TECHNOLOGY_IMPROVEMENT_AND_OVERVIEW_OF_LATEST_APPLICATIONS_WITH_ASEPTIC_PACKAGING_MASSIMO_ZONCA_INDEPENDENT_EXPERT_ON_FOOD_PROCESS_and_PACKAGING

Commercial ohmic heating units for laboratory, pilot scale or industrial application

Who	Year	Where	Power	Product
Sous Chef Ltd (H.J. Heinz division)	1989	UK	75 kW	Prepared meals of meat and vegetable (5, 10, 25 L bulk packaging)
Confidential	NA	Europe	75 kW	High acid products such as fruit in syrup and vegetables and meats
Confidential	NA	Europe	300 kW	Low acid particulate foods
Advances Food science (AFS) Land O'Lakes	1992	US, IL	50 kW	R&D assistance for product development, a continuous system
Ohio State Un.	1993	US, OH	60 V, 60 Hz	Liquid, solid, and mixture
NCFST/FDA/APV Bedford Park	1994	US, IL	5 kW	Dynamic batch Ohmic heating unit for research tests
Nissei Co0 Wildfruit division (1 of 6 Ohmic heaters)	NA	Japan	75 kW	High acid particulate foods such whole strawberries in syrup (10 L units or 10 kg bags in box)
Confidential	NA	Japan	75 kW	Prepared meal
Confidential	NA	Japan	300 kW	High acid particulate foods

Who	Year	Where	Power	Product
Nestlé Food Service Division "Chef Mate brand"	NA	US, MO	300 kW	Shelf stable low acid beef stew and ravioli in #10 can packaging
CTCPA Dury-lès-Amiens	1995	France	10 kW	Pilot scale installation. Aseptic tank of 150 and 20 L bags in box
UTC Compiègne	1990	France	5 kW	Capacity of 1 kg per batch at a laboratory scale Testing facilities for a full range of products
Odin Packaging System, Parma	NA	Italy	NA	NA
EPRI, Palo Alto	1996	US, CA	NA	Liquid, batch, and continuous system
Agriculture Canada Food NRes. Center	1999	Canada	5 kW 0-30 kH	Continuous liquid and solid food
Centro di Tramariglio	2001	Italy	50 kW	Continuous aseptic Ohmic heating system
Sala Baganza, Parme	2002	Mexico	250 kW	NA
Société cofidentielle	2003	France	20 kW	Product containing meat

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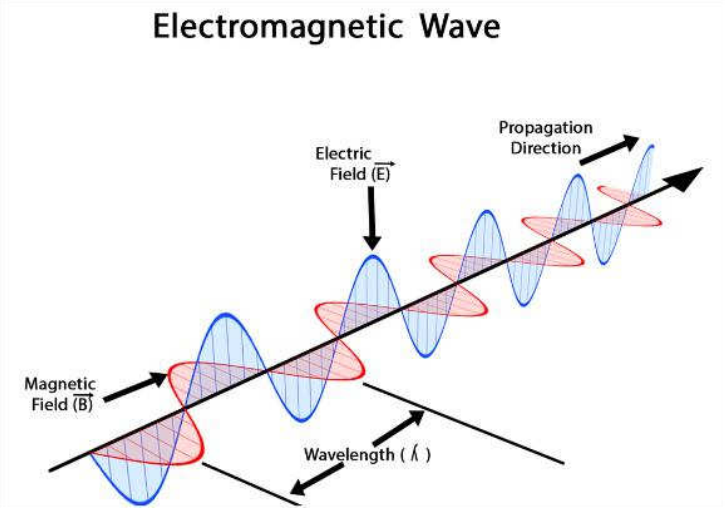
Kasetsart University

Rodrigues *et al*. (2021)

Commercial continuous-flow ohmic heating system

Systems - Sterideal® Ohmic Heat Exchanger [A355]

Microwave heating



Pressure-Assisted Thermal Sterilization Validation | SpringerLink

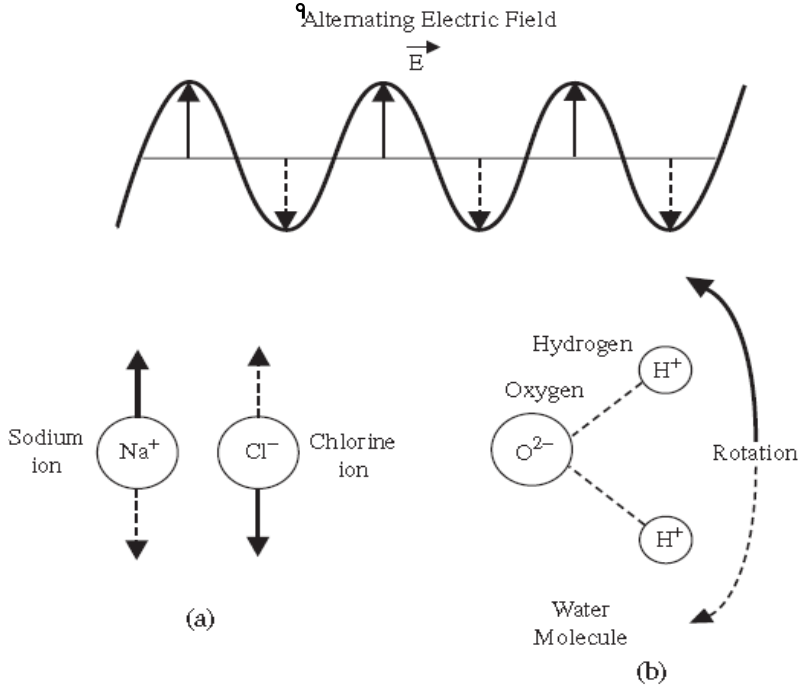
Pressure-assisted thermal sterilization of avocado puree in high barrier polymeric packaging - ScienceDirect

Microwave heating

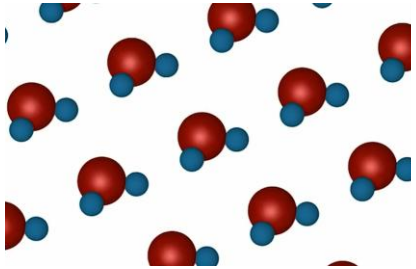
- Absorption of microwave energy in the food :
  - Ionic polarization

    การโพลาไรเซชันของอิออน
  - Dipolar rotation

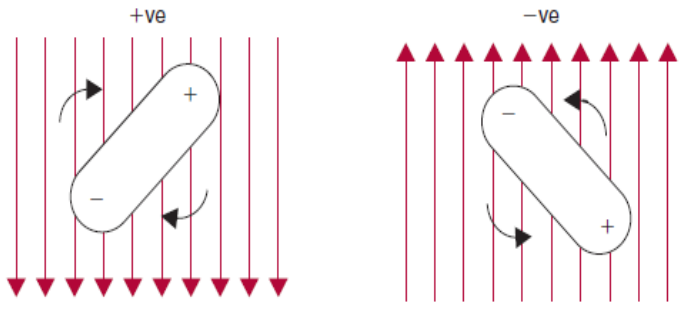
    การหมุนของสารประกอบที่มีขั้ว



Mechanisms of microwave interaction with food. (a) Ionic; (b) dipolar.



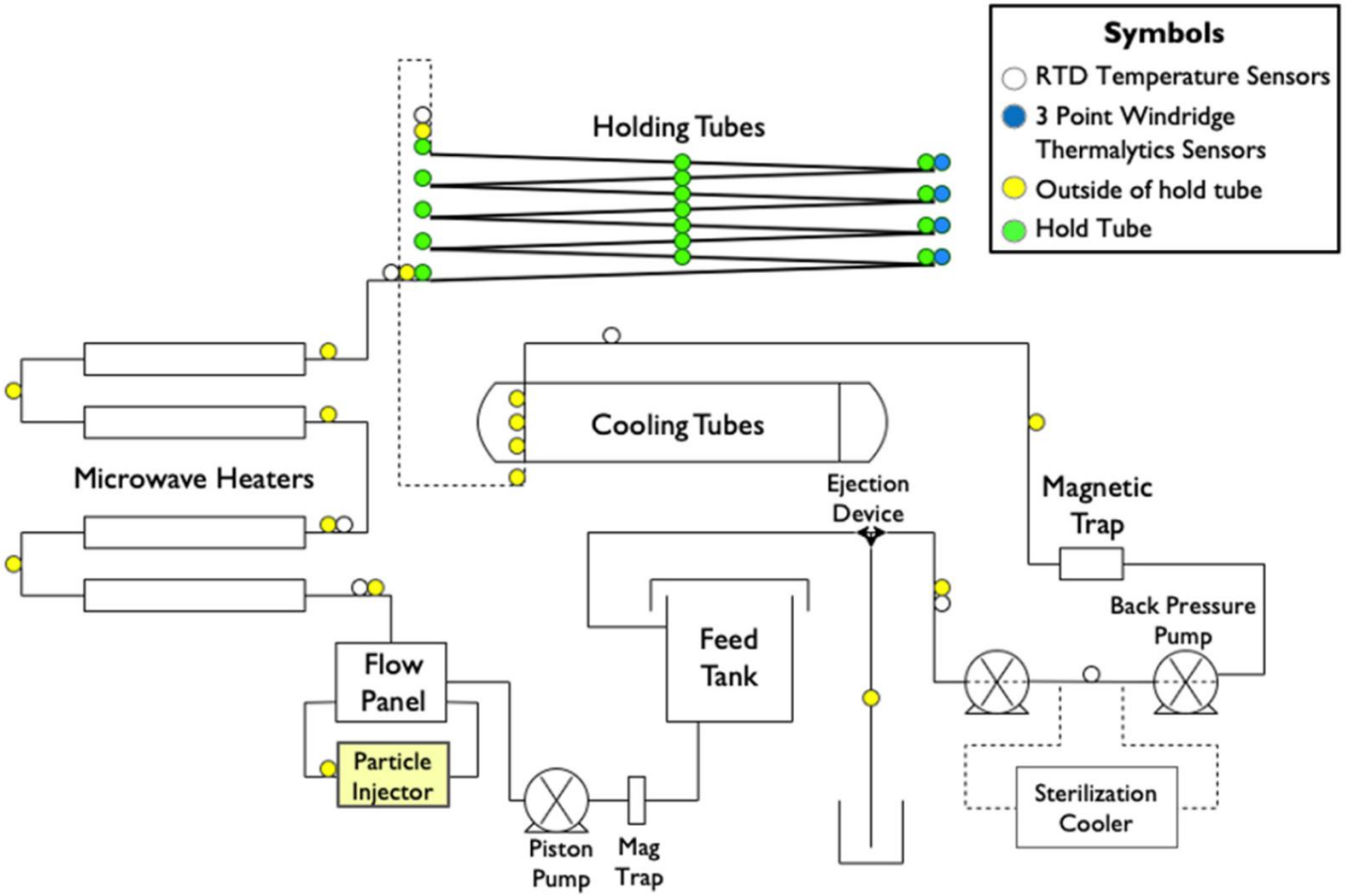
- US Federal Communication Commission (FCC) allocates
- Microwave
  - 2450 MHz for home type ovens
  - 915 MHz for industrial use



https://www.youtube.com/watch?v=6-J4NRl7t1o

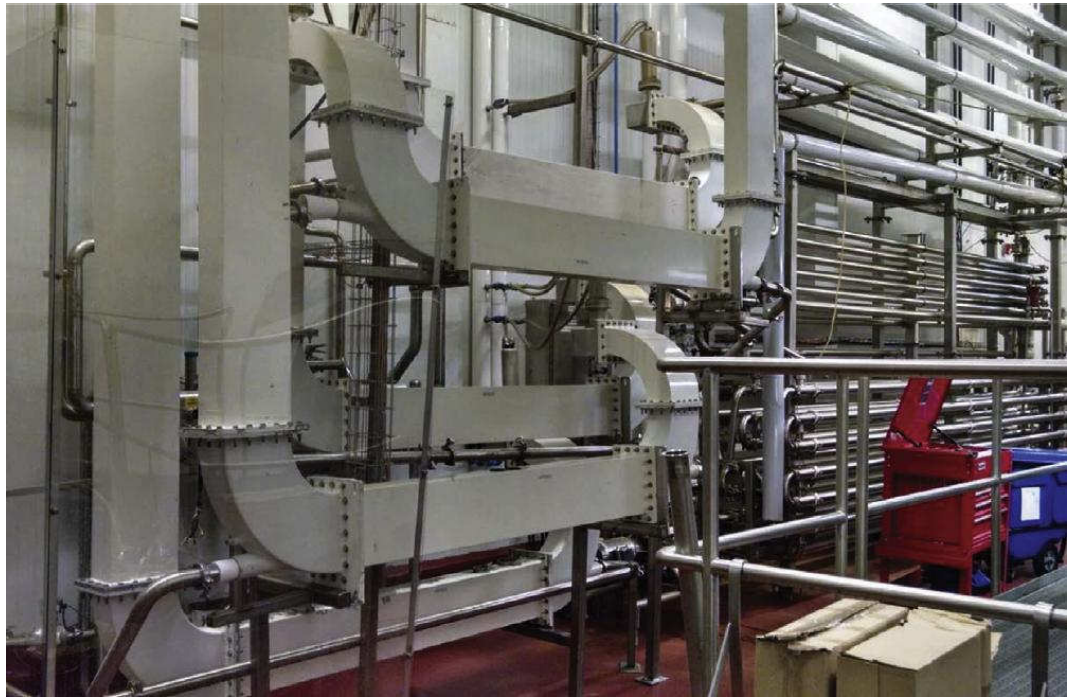
Continuous flow microwave processing

Tomato vegetable soup with a total amount of 15% discrete food particles



Sawale et al. (2024)

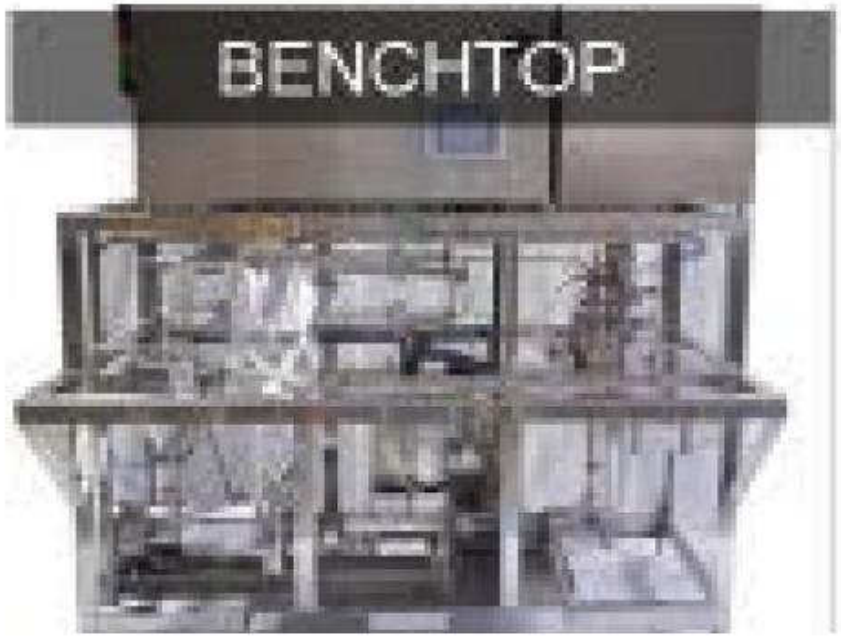
300 kW, 915 MHz installation AseptiWave (second-generation continuous flow microwave technology) at Wright Foods (Troy, NC).



Simunovic and Sandeep (2022)

Continuous flow microwave processing

Current range of commercial offerings of continuous flow microwave processing (heating, pasteurization, sterilization) at different scales produced by SinnovaTek (Raleigh, NC).



2450 MHz ~1 ton per day

915 MHz ~1 ton per hour

915 MHz ~4 tons per hour

Simunovic and Sandeep (2022)

Continuous flow microwave processing

Variety of consumer and food service products commercialized using AseptiWave (second-generation) technology at Wright Foods (Troy, NC).

Simunovic and Sandeep (2022)

- A line of vegetable soups in aseptic cartons
- A line of 100% aseptic fruit purees in cartons

A #10 can replacement aseptic bag of banana puree

- A line of 100% aseptic fruit smoothies
- A line of vegetable purees/soup starter blends for food service in aseptic bags.

Challenges and Solutions

- Challenges:
  - High initial investment in technology.
  - Limited awareness among food producers.
- Solutions:
  - Government and industry incentives: Financial support (grants, subsidies and tax breaks)->reduce the financial burden for businesses investing in advanced technologies.
  - Training and capacity-building programs->build confidence and encourage widespread adoption.
  - Partnerships between government and industry stakeholders->foster innovation and create a favorable environment of adoption.

Novel food processing techniques

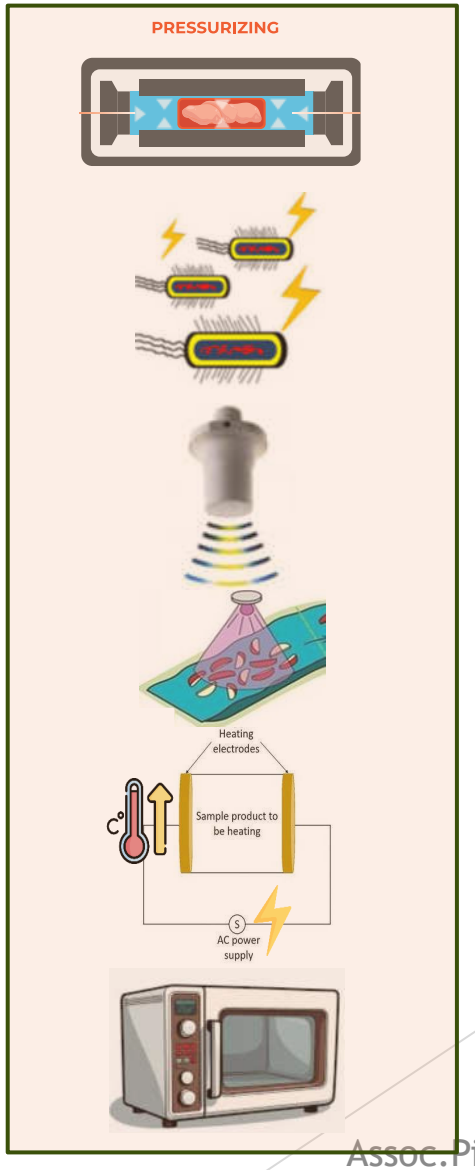
ผลิตภัณฑ์เครื่องดื่ม

ลักษณะทั่วไปของอาหาร เช่น ลักษณะปรากฏ เนื้อสัมผัส pH

อุณหภูมิ และระยะเวลาในการเก็บรักษา

บรรจุภัณฑ์

ระดับการฆ่าเชื้อ: Pasteurization หรือ Sterilization



Cost

Tightening of government regulation

Environment

AGRO-INDUSTRY
Kasetsart University

Thank you

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