PASTEURIZATION SOLUTION SPRINT

PROJECT REPORT

September 2022

Project *Briefing*

THE CONTEXT

As part of its ambitious environmental commitments, Dole is working towards the elimination of fossil-fuel-based packaging. One of the initiatives is the development of a bio-based packaging solution for its fruit bowls. In order to enable the transition to a compostable packaging solution, Dole is revisiting its current process for production of the packaged products and seeking alternative technologies.

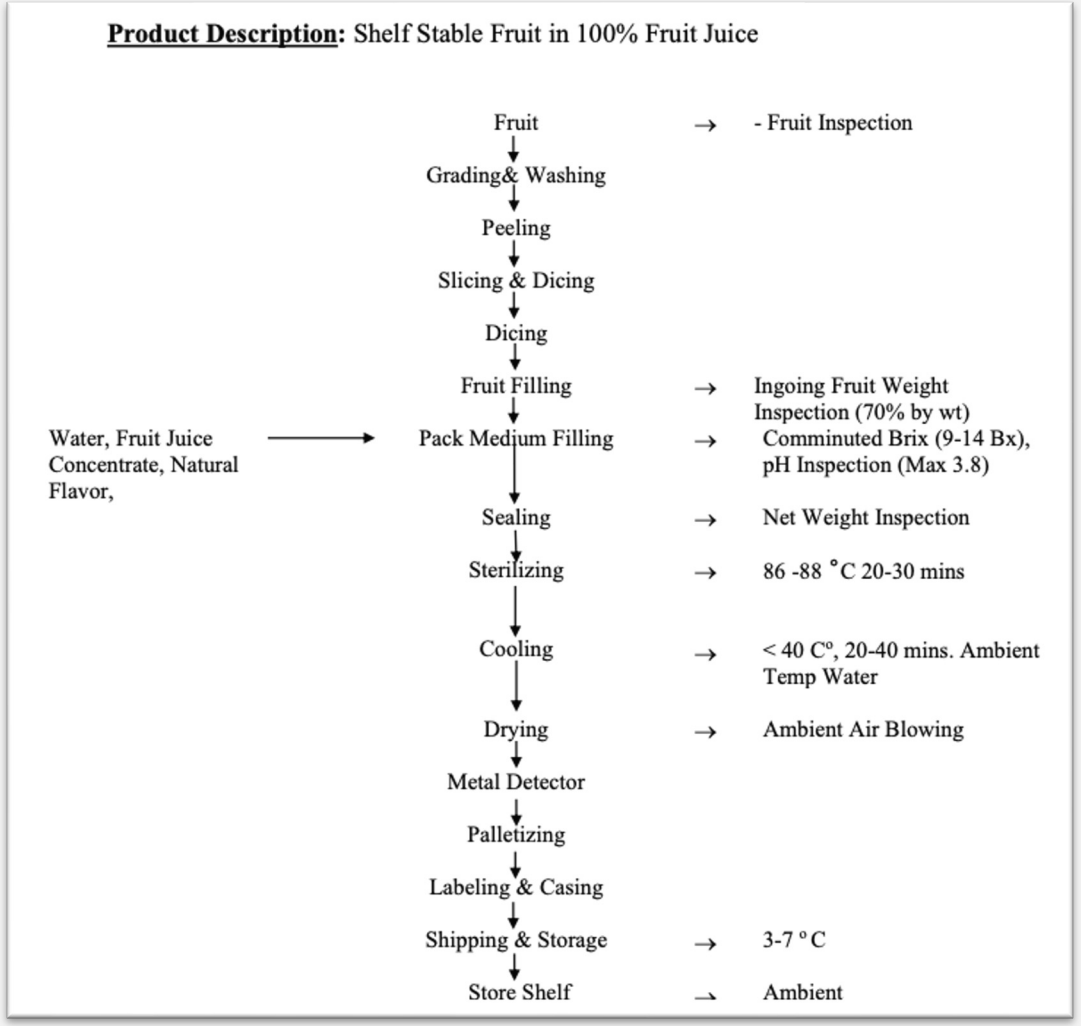
THE OBJECTIVE:

Screen and assess pasteurization processes alternatives (moving away from traditional pasteurization processes) that can be applied to bio-based packaging. The current process involves a heating step and a cooling step, both steps using water-baths. Ideally, the new solutions should not involve heat nor water and ensure achievement of the following parameters:

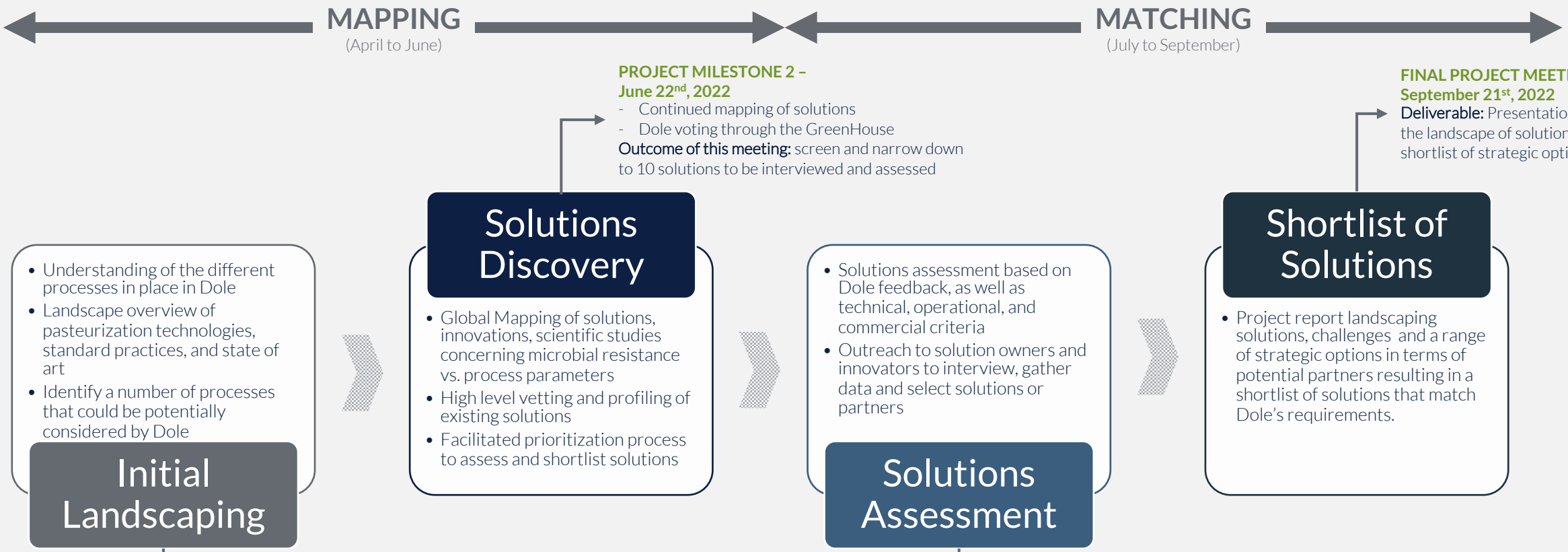
- A pasteurization technology that enables a shelf-life between 15 to 18 months for a non-chilled supply chain,
- Ensure an easy opening of the product packaging (no pressure build-up within the packaging), and
- Ensure there will be no damage to the functional properties of the new compostable packaging (e.g., barrier properties).

PROJECT DELIVERABLE

Landscape of solutions, and opportunities available, and a range of strategic options in terms of potential partners (technology, implementation, industry), resulting in a shortlist of solution.



Project *Structure & Timelines*



Current *Process*

Enzymatic deactivation for all fruits
(72°C for 2 min)

FRUIT PIECES

- The fruit pieces should be processed within 2 hours to avoid enzymatic activation triggering fermentation process.
- Pineapple: cleaned after harvesting, peeled, and sliced. Transferred in metal reusable trays (previously washed with chlorinated water).
- Mandarin – canned and already pasteurized
- Other fruits: Orange, and cherries

ROTARY FILLING MACHINE

- Molanar is the equipment supplier, and they currently don't have an aseptic filling machine for fruits.
- The rotary table fills it up pre-dosing cups with the fruits. From there, the fruit pieces drop into the final cups.

Pre-filled cup

FRUIT FILLING

- Manual completion of the fruit filling to the plastic bowls

FILLING COMPLETION

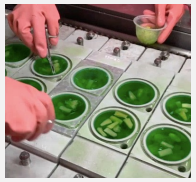
- This is the final stage of the filling process and comprises of filling the cups with the maximum amount of pineapple pieces to make sure it looks full to consumers
- This stage also ensure fruit pieces are pushed down to avoid problems during the sealing stage

QUALITY CONTROL

- Removal of small fruit pieces with tweezers
- Quality control

JUICE FILLING

QUALITY CONTROL



- Checking the rim (whether there are fibers or fruit pieces that might affect the sealing) and touching with chlorinated water.
- Possible improvement is to use UV to avoid manual intervention in the product

HEAT SEALING

QUALITY CONTROL

- Quality check after sealing

PASTEURIZA-TION

1. Load the cups to the hot water bath and let it be for 20 min at 95°C
2. Cold water for cooling down for 20 min
3. Cups off-loading
4. Product is held for 7 days before is released

Pasteurization *Alternatives*

	FILLING TECHNOLOGY	Process Pasteurization + Cold Fill juice Aseptic*	In-pack Pasteurization + Hot Fill juice Hygienic*	Post-fill Pasteurization Conventional	Feasibility packaging & product
PASTEURIZATION ALTERNATIVES	Heat – Heath Exchangers	Juice only, not fruit	Juice only	N.A.	Not suited for fruit pieces
	Heat – Hot Water Bath	N.A.	N.A.	Post pack, current process	Not suited for sustainable packaging
	Heat – Batch Cooking	Fruit and chunks	N.A.	N.A.	Suited for sustainable packaging
	Electromagnetic Heat – Microwave	N.A.	Chunks MW Heated + Hot Juice* (TBD)	Possible, low efficiency	Suited for sustainable packaging
	Electromagnetic Heat – UV	Juice only	Juice only	N.A.	Suited for sustainable packaging and juice, yet to be tested
	Electromagnetic Heat – Radio Frequency	N.A.	Juice only, potentially fruit chunks	N.A.	Suited for sustainable packaging and juice, yet to be tested
	Electromagnetic Heat – E-beam	N.A.	Fruit and chunks	N.A.	Suited for sustainable pack., yet to be tested, requires regulatory assessment
	High Pressure Pasteurization	Juice, chunk in development	N.A.	Post pack, chilled SC	Suited for sustainable pack., high quality improvement required, chilled SC required
	Ohmic	Juice and chunks	N.A.	N.A.	Suited for sustainable pack., high quality improvement, unknown technology
	Dry Steam / Air Retort	N.A.	N.A.	Post pack, to be tested	Could be suited, to be tested
		Expensive filler and expensive upstream modifications	Limited upstream modifications and hygienic filler required	Most affordable considering investment required	

ubuntoo * Technological alternatives yet to be developed (TBD)

Solutions *Discovery Pipeline*

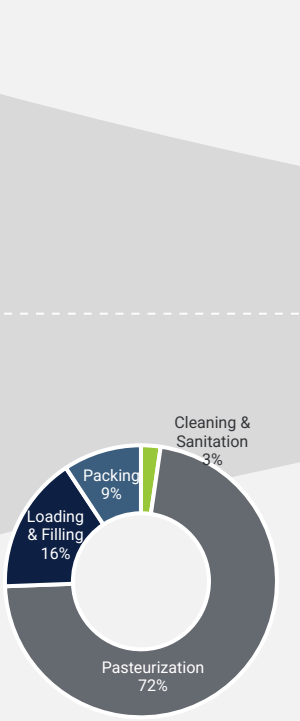
Landscape of Food Processing Solutions

Pasteurization Alternatives

200+ solutions

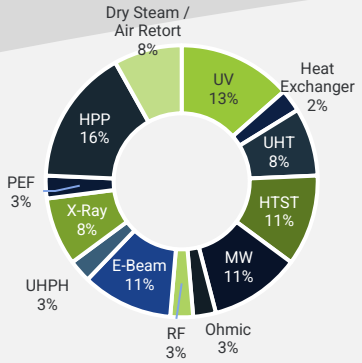
Mapped solutions

38 solutions



Suggested solutions

31 solutions



Ready For Review

12 solutions

Shortlist of solutions

Shortlist of promising potential partners

7 solutions

FACILITATED PRIORITIZATION PROCESS

Solutions Landscaping
Landscape overview of food processing & pasteurization solutions

→ **Suggested Solution**
Screening & Solution profiling

→ **Ready for Review**
Interview & gather detailed technical information

→ **Endorsed**
Endorsed for prototyping, partnership or investment

Discarded
Determined unfit but available to revisit in the GreenHouse.

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PEF – Pulsed Electric Field, HPP – High-Pressure Processing, UV – Ultraviolet , UHT – Ultra-High Temperature , HTST – Hight-Termperature Short-Time, MW – Microwave, RF – Radio Frequency, UHPH – Ultra-High Pressure

Endorsed **Solutions**

SOLUTION NAME	COMPANY NAME	SHORT DESCRIPTION	TECHNOLOGY	APPLICATION	NDA	STATUS	ADVANTAGES	CHALLENGES
Gentle Processing	Quantun Mechanical Technology	Technically proven and commercially viable green food processing technology	X-Ray Electron Beam	Fruit Pieces & Juice	✓	Gentle Processing will run a test with Dole pineapple fruit dole to investigate the Temperature Profile and understands whether the packaging and the product will heat differently.	• The technology might potentially enable to reduce the processing temperature that's current 90C.	• A second round of testing will be required using Gentle Processing pilot equipment to Dole's facility. • Ensure the core of the fruit chunks will experience the same temperature increase as the juice and packaging
Raslysation	Lyras	Energy efficient, and sustainable UV light pasteurization process	UV Decontamination	Fruit Juice	✓	Lyras has shared the budget to ship a test kit and a engineer to perform the tests at Dole's facility.	• Lyras' technology could be considered for the juice pasteurization at the final point of filling.	• Lyras technology wouldn't be applicable to the fruit pieces. • Particulates at the centimeter size would create shadow areas and wouldn't provide na uniform pasteurization. • Needs to confirm efficacy on killing spores.
Industrial Microwave Pasteurization Techniques	Microwave Techniques	Producing electromagnetic energy to improve product quality	Microwave	Fruit Pieces	✓	Shared product samples and MT are currently runnig test to determine the temperature profile.	• Preliminary test performed by Dole has demonstrated Microwave technologies to be effective for fruit chunks. • Microwave processing could be applied for for after the filling stage, and before the sealing.	• Not suitable for the after-sealing stage
Pasteurization and Sterilization equipment	STALAM	Pasteurization technologies to extend the shelf life of foods and prevent spoilage	Radio Frequency	Fruit Pieces & Juice	✓	Dole will visit STALAM facility late September. STALAM to suggest a detailed testing plan.	• Radio Frequency has a good potential for fruit chunks and might be an alternative to Microwave technologies.	• Preliminary test with packaged product using the coveryorized RF equipment was not successful. • High water-content products might be a challenge for RF processing • The in-process alternative would imply in a higher CAPEX project for Dole
Ypsicon	Ypsicon	Offering patented food processing technologies	UV Decontamination & UHPH	Fruit Juice	✓	Dole & Ypsicon has signed a NDA to share information and run preliminary tests	• The combination of UV and thermal pasteurization might enable the reduction on the pasteurization temperature	• Ypsicon set-up would allow the application in the fruit juice only • Prticulates might create shadow areas
Lagarde Autoclaves	Lagarde	Using steam and air to sterilize and pasteurize food and beverage packaging	Dry Steam	Fruit Pieces & Juice post-pack	✓	Dole & Lagarde has signed a NDA to share information and run preliminary tests	• Reliability of the thermal treatment & potential preservation of the packaging and their contents, • Energy saving • Reduced maintenance costs.	• Assessment on post-pack products yet to be carried out
E-Beam Technology	Texas A&M AgriLife Research	Reducing microbial pathogen in foods using Electro Beam and X-Ray	Electron Beam	Fruit Pieces & Juice		Signing NDA and starting discussions on regulatory status for food processing	• Gamma is no longer a feasible technology • Wide range of applications in the Food Industry, including packaged items, and food and vegetables	• It requires torough understanding on regulations and testing


ENDORSED
SOLUTIONS

Gentle Processing

Headquarters
Prince Albert, SK, Canada

Organization Type
Established Company

Year Founded
2011

Technology
Ionising Radiation (X-Ray / E-Beam)

Visit Website

NON-IONIZING FOOD PROCESSING TECHNOLOGY

Gentle Processing is a **non-ionizing food processing technology** that processes food and food ingredients while keeping its natural nutrients intact.

The equipment is **safe and certified to CSA safety specifications**. It has been designed to control the energy in a way that any potentially dangerous exposure is eliminated. The technology produces a precise quantum energy field that is distributed evenly across the application. This efficiency **enables efficient, high-volume processing without affecting the nutritional structure of the treated product**.

The treatment of Gentle Processing reduces processing times and boosts throughput. It also improves flavour profiles, extends shelf life, and reduce microbial load.

How the process works:

- *Gentle Processing* ***uses a unique technology that interacts with the water molecules inside the food product to expose it to energy****. The water molecules align themselves with the optimum quantum energy as a result of this process, causing the polarity of the molecules to fluctuate between positive and negative millions of times every second.*
- ***Internal friction and heat are generated*** *because of the quick shift in orientation, leading in an increase in temperature and the evaporation of certain water molecules. This procedure uses a powerful CPU and patented software, as well as specialized electrodes that have been tailored to emit the appropriate amount of energy to treat the product.*
- *It* ***uses energy to treat food items*** *with a process that is* ***non-ionizing and non-chemical in nature****.*
- *It* ***alters the interior environment of the treated product*** *to make it* ***less conducive to microbial growth****. This consistent approach reduces processing time and improves efficiency.*

The technology can be used for **pulse crops, oil seeds, cereals, infant and baby food, liquids, nuts, pet foods, spices, cannabis processing, and non-food/gentle drying.**

Lyras

Headquarters
Aalborg, Denmark

Organization Type
Start-up

Year Founded
2017

Technology
UV Decontamination

Visit Website

ENERGY EFFICIENT, AND SUSTAINABLE UV LIGHT PASTEURIZATION PROCESS

Lyras is a startup that has developed Raslysation for preserving various food and non-food liquids.

The solution is a pasteurization process that relies on using ultraviolet (UV) light to inhibit the growth of bacteria and other microbes in liquid products as a way to preserve them.

The solution's benefits include:

- ***Reduced energy consumption:*** *the solution uses up to 90% less energy compared to traditional pasteurization methods, mainly it does not heat and cool the products to inhibit bacterial growth, which require large amounts of energy.*
- ***Extended shelf life:*** *it treats spores effectively and is effective in killing bacteria.*
- ***Higher quality:*** *the solution does not affect the taste, quality, or even nutritional content of the products when they are subjected to the process, ensuring that these portions of the products are retained.*

The company produces two types of Raslysation machines: the CPS system that uses the full Raslysation process and requires its patented light filter technology, and the LTUV machine that does not use the light filter.

STALAM

Headquarters
Veneto, Italy

Organization Type
Established Company

Year Founded
1978

Technology
Radio Frequency

Visit Website

PASTEURIZATION TECHNOLOGIES TO EXTEND THE SHELF LIFE OF FOODS AND PREVENT SPOILAGE

STALAM S.p.A. offers **radio frequency pasteurization and sterilization equipment** which can **extend the shelf life of foods** in order to **prevent food spoilage**.

The company's technology has a **low thermal impact** by utilizing radio frequency, which is a **thermal processing** and **drying technology** that is based on the **dissipation of electromagnetic energy** within the product. In addition, this technology was developed to **assist food manufacturers** with pasteurizing their products and **reduce carbon gas emissions**.

How does the equipment work?

- *Unlike traditional technologies, it uses a radio frequency heating process to produce heat directly inside the product mass.*
- *Finally, it doesn't use chemicals in the process as a means to **retain** the **taste** of the food.*

STALAM S.p.A. offers a wide range of pasteurization equipment, such as **SANIPACK+**, which can be used to **pasteurize packaged products** like **fresh pasta**, **bread loaves**, and **gnocchi**; **SANIFLUID+**, which was developed to sterilize and pasteurize **liquid products in the tube**; and **EGGPURE+**, which was created in **collaboration with Innovo Solutions** to pasteurize **liquid eggs** at low temperatures.

All of its technologies and services are available throughout Italy.

Several partnerships have been made by the company, including **Herux Technologies**, **JBT FOOD-TECH S.p.A.**, and **STC S.r.l.**, among others.

In 2015, STALAM S.p.A.'s technology for **pasteurizing almonds** was **TERP-approved** by the **United States Department of Agriculture (USDA)** or **Almonds Board of California protocols**.

Industrial Microwave Pasteurization (IMS)

Headquarters
North Carolina, USA

Organization Type
Established Company

Year Founded
1997

Technology
Microwave

Visit Website

PRODUCING ELECTROMAGNETIC ENERGY TO IMPROVE PRODUCT QUALITY

Industrial Microwave Systems (IMS) has developed an Industrial Microwave Pasteurization technology in order to enhance product quality.

The company's technology produces electromagnetic energy to heat products, making it suitable for pasteurization and sterilization processes. In addition, its technology can reduce the discoloration of products and better retain their nutrients.

How does it work?

- *Each system is capable of heating a multi-phase or single product by **pumping** it through a **microwave-transparent heating tube** in the center of the **cylindrical heating chamber**or applicator.*
- *Finally, there is **no need for hot tube sidewalls for heat transfer** due to the **volumetric heating** caused by the agitation of the polar molecules in the product.*

A wide range of technologies are being offered, such as the 100kW Liquid Heating Microwave System, which can be utilized for heating meat slurries and dairy-based foods; the Industrial Microwave Purée Heating, which employs a microwave system technology to sterilize vegetables and fruits; and the Industrial Microwave Beverage Processing, a technology that can improve the product quality of beverages via a thermal processing method.

Several partnerships have also been formed, including with the US Department of Agriculture (USDA) and North Carolina State University's Department of Food Science researchers, among others. IMS received multiple recognitions: it won the "Food Technology Industrial Achievement Award" in 2009, given by the Institute of Food Technologists (IFT), and it obtained the United States Department of Agriculture's "2009 Agricultural Research Services Technology Transfer Award". In July 2021, IMS was acquired by Microwave Techniques, LLC., enabling them to support clients from various industries by integrating their product portfolio with the latter.

Ypsicon

Headquarters
Barcelona, Spain

Organization Type
Established Company

Year Founded
2011

Technology
UV Decontamination

Visit Website

OFFERING PATENTED FOOD PROCESSING TECHNOLOGIES

Ypsicon is a company focused on **innovative technology development**, as well as the design and integration of components and equipment for the **cosmetics, pharmaceutical, and food industries. Its patented technologies include:**

- ***UHPH (Sterilization and homogenization by means of continuous ultra-high pressure):*** *In place of employing heat, UHPH uses continuous ultra-high pressure and a combination of physical forces at a valve to sterilize and homogenize beverages and other liquid commodities. UHPH produces commercially sterile products with a long shelf life at room temperature, while keeping their original organoleptic and nutritional features, thanks to the lack of thermal impact on products.*
- ***UV-Therm pasteurization****: It combines germicidal ultraviolet light with moderate thermal treatment that enables significant microbe count reductions at lower temperatures that are good for heat-sensitive products.*
- ***UV-C aseptic filling****: UV light is used to sterilize PP, PET, HDPE, and glass bottles to fill liquid items aseptically. It does not require current chemical products in the industry, which ensures a 100% clean label aseptic filling procedure.*

These technologies **produce 100% natural products without the use of additives or preservatives.** They can be used on an industrial scale to **develop high value-added products with long shelf-life, while retaining or boosting their original features.**

The technologies have **a wide range of applications in various sectors** including for pharmaceutical or cosmetic products, wine, dairy products, vegetable milks, fruit juices, egg products, and other liquid products such as soups and broths.

Among the company's partners are **Parc de Recerca UAB, AZTI Tecnalia, and Centro para el Desarrollo Tecnológico Industrial.**

Lagarde

Headquarters
Malataverne, France

Organization Type
Established Company

Year Founded
1972

Technology
Steam & Air

Visit Website

USING STEAM AND AIR TO STERILIZE AND PASTEURIZE FOOD AND BEVERAGE PACKAGING

Lagarde Autoclaves has developed the Steam & Air retort, which employs a thermal treatment process suitable for sterilizing and pasteurizing in food and beverage applications.

A direct steam injection process is used by the technology to reduce energy costs while also sterilizing and pasteurizing the packaging and packaged products inside the retort chamber. Unlike hot water spray and full water immersion technologies, this machine is capable of reducing operational costs as well as water consumption. In addition, this technology can be used by the food and beverage industry.

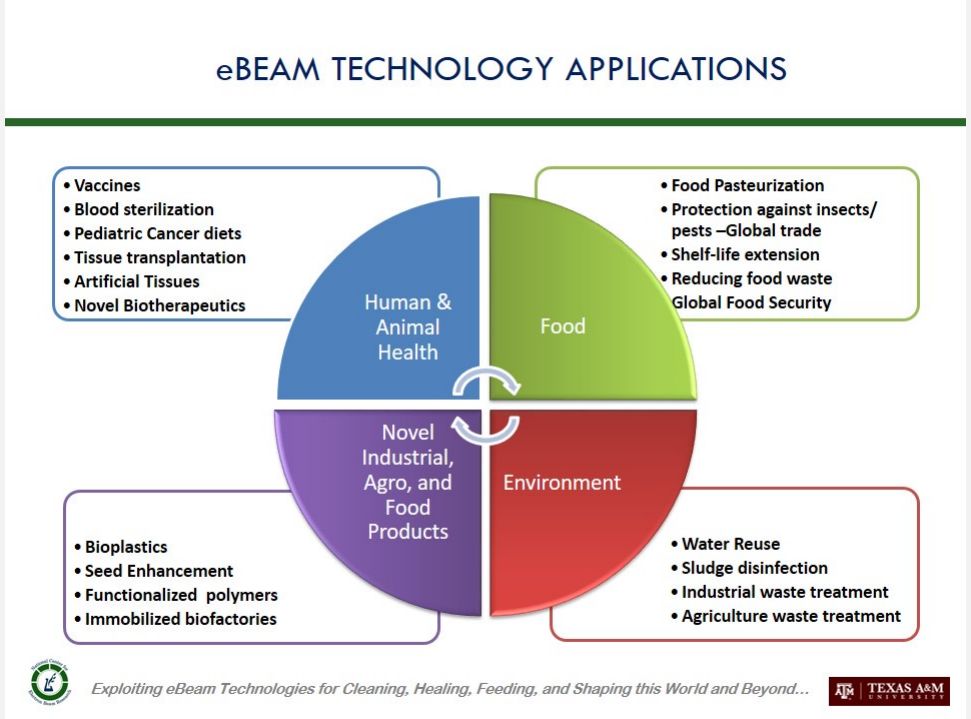
Other key features and benefits of the Steam & Air retort include:

- *It is equipped with a fan to distribute heat throughout the chamber.*
- *It can reduce production costs.*
- *It can reduce the users' environmental impact.*
- *A plate heat exchanger or fresh water is utilized for cooling.*

The company's technology is available across France. It is also CE, FDA, and ISO 9001-certified.

Lagarde Autoclaves also collaborated with R-Food Tech to distribute its machine in Latin America.

University of Texas



Headquarters
Texas, USA

Organization Type
University

Year Founded
2005

Technology
E-Beam

Visit Website

USING ELECTRONS TO IMPROVE QUALITY OF LIFE AND WORLD ECONOMIES

The National Center for Electron Beam Research (NCEBR) is an academic institution devoted to the research, development, and commercialization of Electron Beam (eBeam) technologies.

The use of electrons from commercial electricity for a variety of purposes known as Electron Beam (e-Beam) technology has paradigm-shifting applications in the fields of agriculture, public health, medicine, the environment, the automotive industry, the wire and cable industry, and the defense and aerospace industries.

It is possible to use electrons to raise the quality of life for people all around the world by accelerating them to 99.99999% the speed of light and energizing them to 10 million electron volts. Because eBeam technology is programmable, it may be applied in a variety of ways and supplied at incredibly exact doses.

The center has made significant investments in programs that aim to improve food safety, prevent the importation of invasive insects and pests, and provide innovative methods for sterilizing medical supplies and devices. The development of eBeam and X-ray technologies that can be adapted to various foods, medical devices, and agricultural items is ongoing. In the food industry, eBeam technology has a great potential for food pasteurization, protection against insects, and shelf-life extension.

It has recently started an ambitious project to create and test a line of eBeam pasteurized foods intended for hospital patients in collaboration with the International Atomic Energy Agency (IAEA), a pediatric oncologist, hospital food caterers, and about a dozen other international organizations. The first group of foods is intended for children with cancer.

The NCEBR has been accredited as the IAEA Collaborating Centre for Electron Beam Technology by the International Atomic Energy Agency (IAEA).

Other Solutions

SOLUTION NAME	COMPANY NAME	SHORT DESCRIPTION	TECHNOLOGY	APPLICATION	STATUS	SOLUTION PROFILE	WEBSITE
MATS	915Labs	Food and beverage processing systems	Microwave	Fruit Pieces	On hold, Yet to be interviewed	link	link
AseptoRay	AseptoRay	Cold pasteurization solution based on UV light technology	UV Decontamination	Fruit Pieces & Juice	On hold, Yet to be interviewed	link	link
Electronic Cold-Pasteurization	REVEAM	Extending the shelf life of perishable foods and reducing foodborne pathogens	Electron Beam	Fruit Pieces & Juice	On hold, Yet to be interviewed	link	link
Irradiation Solutions	A Brown Company	Irradiation solutions for sterilization	Electron Beam	Fruit Pieces & Juice	On hold, Yet to be interviewed	link	link
eXelis Food	IBA Industrial Solutions	X ray solution for sterilization centres to replace gamma sterilization facilities	X-Ray	Fruit Pieces & Juice	On hold, Yet to be interviewed	link	link

THANK YOU

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"In Africa we have a concept known as ubuntu based upon the recognition that we are only people because of other people"

NELSON MANDELA