



Non-Thermal physical technologies to preserve fresh and minimally processed fruit and vegetables

SHEALTHY AT A GLANCE

SMART AGRI FOOD INDUSTRIES EXPO

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Marco de la Feld

Elena Torrieri





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CONSUMERS DEMAND FOR HEALTHIER, FRESH, NATURAL AND LOCAL PRODUCED FOOD



Fruit and Vegetables (F&V) are key elements of a healthy and balanced diet providing humans with essential nutrients and bioactive compounds, including vitamins, organic acid, carotenoids, minerals, fibre, and polyphenols

2. What is SHEALTHY?



MISSION:

SHEALTHY is a 48-month Research & Innovation Action which develops an optimal combination of **non-thermal sanitization, preservation and stabilization methods** to improve the safety of fresh and minimally processed **Fruits & Vegetables products**

The combined and optimised mild technologies will be demonstrated and validated in the following specific applications:

Business case 1: Minimally processed fruit and vegetables



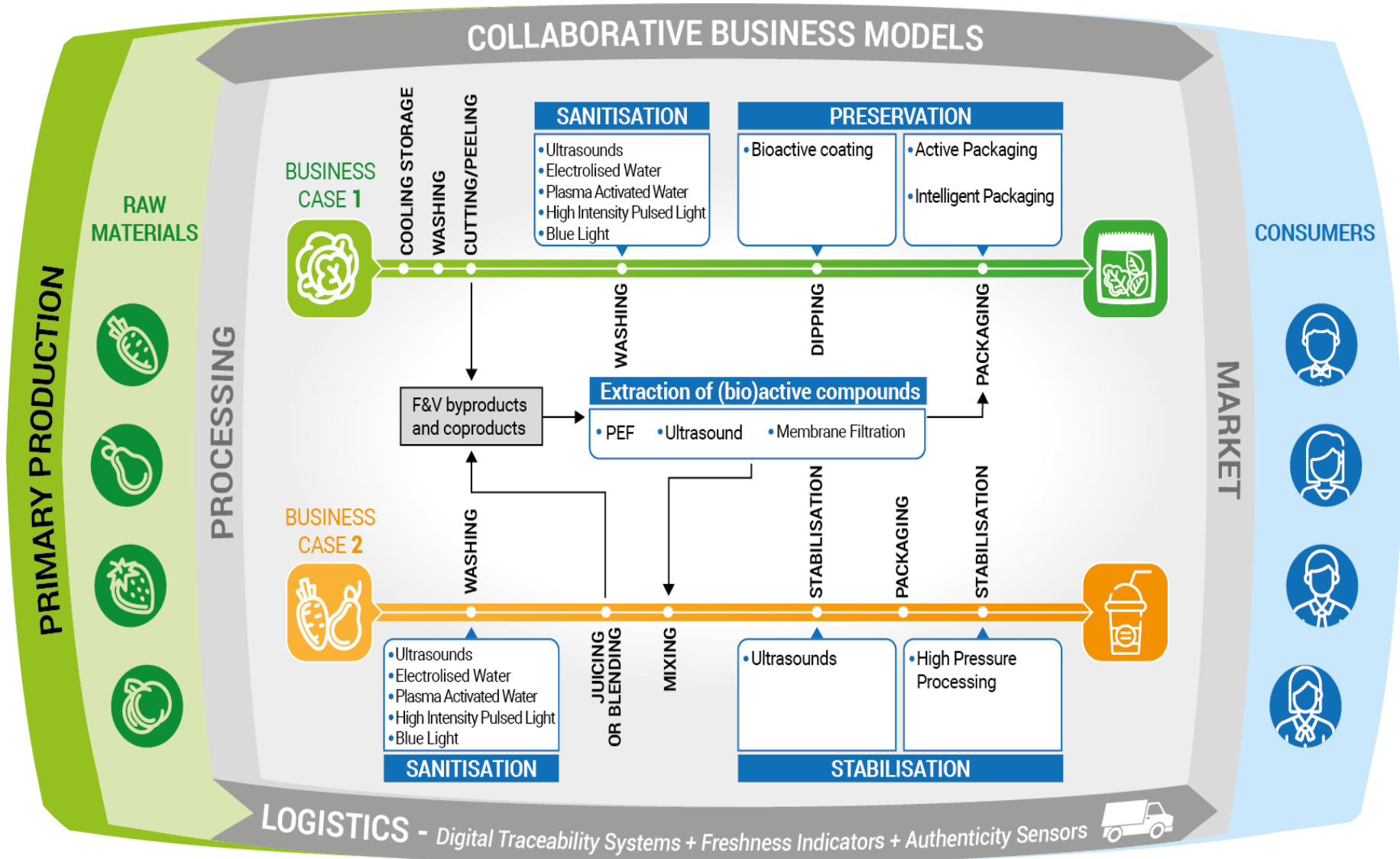
Business case 2: Fruit and vegetable-based juices & smoothies





1. To optimise the **combination of non-thermal technologies** of minimally processed **F&V**, improving their sustainably and F&V based juices and smoothies
2. Define new sustainable holistic and collaborative **Business Models** to increase the competitiveness of regional food producing & processing **SMEs**
3. To develop new **digitalised logistic systems** for the traceability of the food chain
4. Down-scaled processing technologies tailored to the **needs of SMEs**, the specificities of products and markets and supply chains
5. To maximise the **innovation impacts of the project** for contributing to the uptake of the project results

4. SHEALTHY Concept



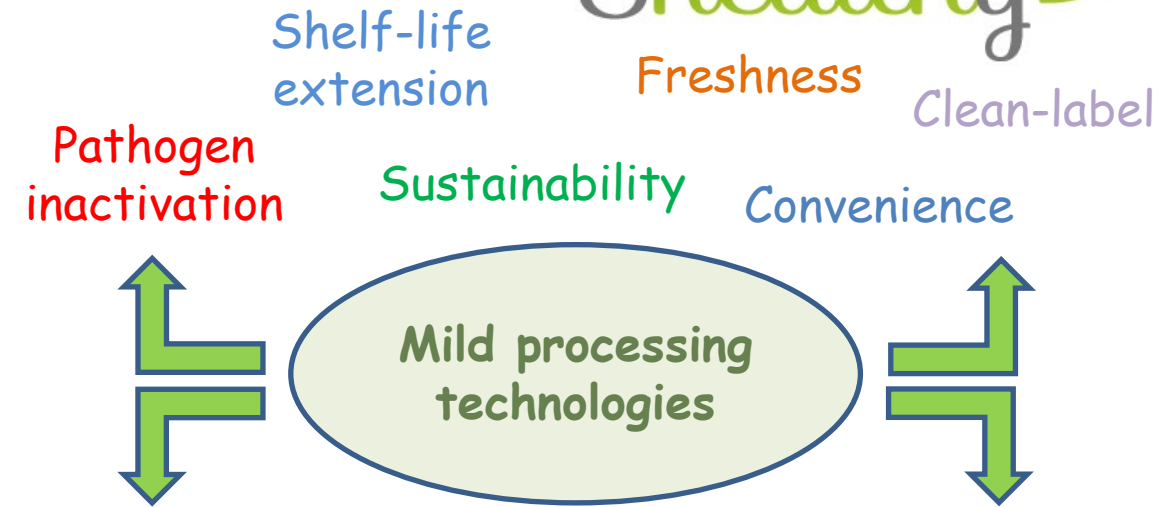
5. SHEALTHY target: Agrofood SMEs

- SHEALTHY wants to provide sustainable and flexible processing methods adapted to **the need of local F&V micro and SMEs.**
- Solutions will be developed with a specific **focus on regional and local food companies** looking for affordable, small scale and flexible solutions consistent with their products and facing limitations in terms of volumes of food treated.
- SHEALTHY develops **innovative BMs and novel logistics systems** (including technologies, advancing the knowledge of factors/drivers/authenticity and traceability system) that **will support traditional micro & SMEs** to adopt novel obstacles that intervene in innovation processes and creating new BMs to be applied at pilot trials.



6. SHEALTHY mild technologies: optimization and combination

- Mild technologies: non-thermal processing technologies aiming to destroy foodborne pathogens while preserving freshness, nutritional and sensorial aspects of food product

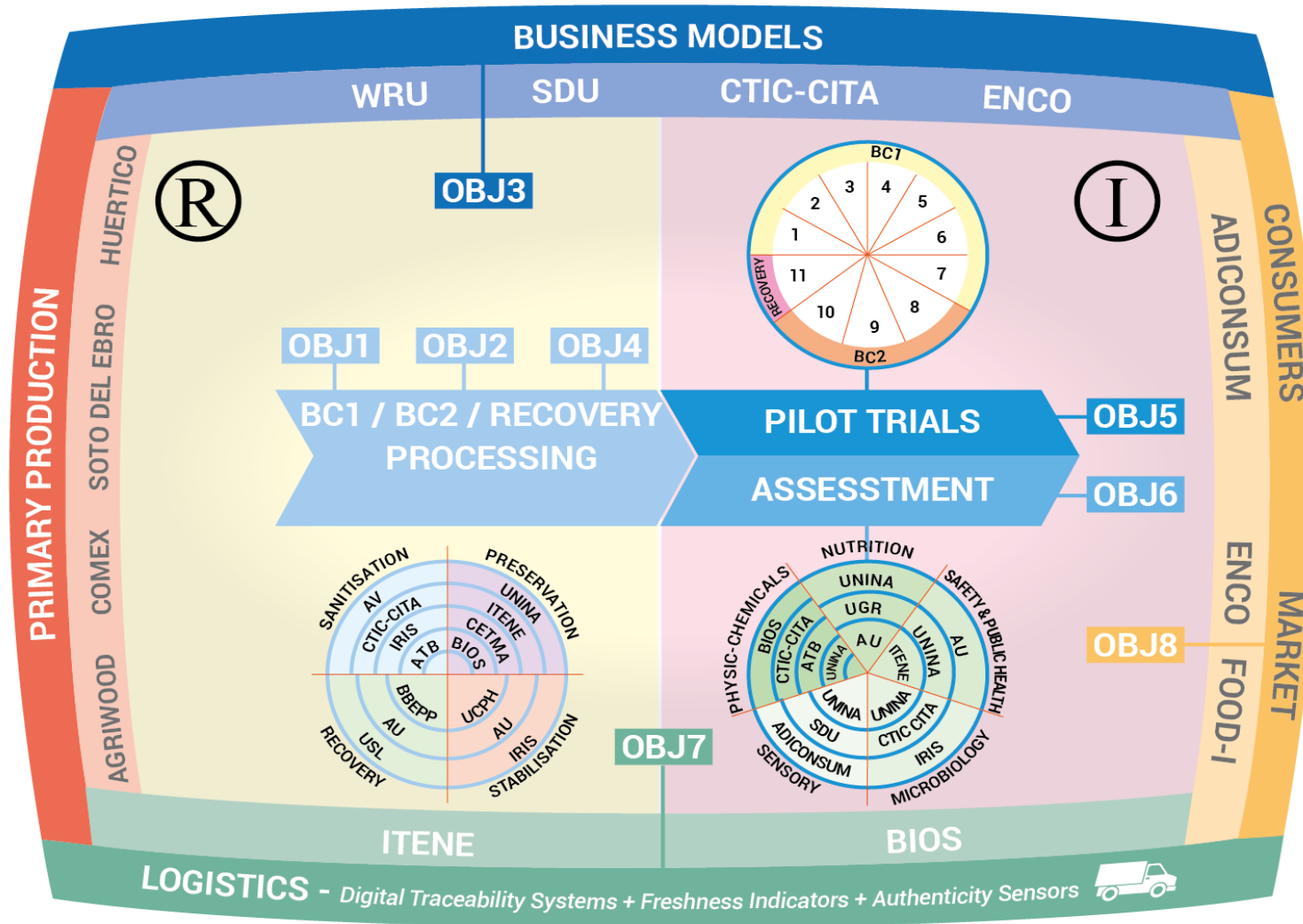


What we still need for successfully application?

- Optimization for each specific commodity
- Clear knowledge of the benefits and restrictions
- Combination of technologies
- SME-oriented application
- Assessment of impacts on product characteristics, traceability and authenticity, sustainability and public health



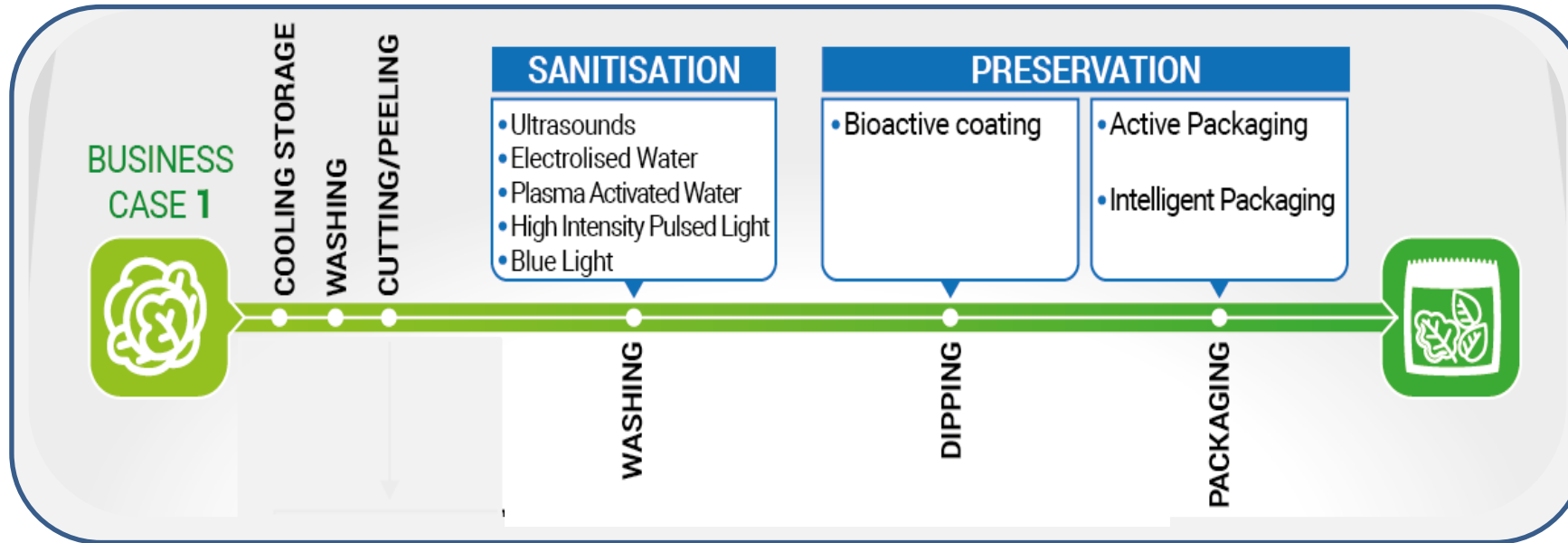
6. SHEALTHY mild technologies: optimization and combination



- 10 mild technologies and theirs combinations
- 7 pilot trials for minimally processed F&V
- 3 trials for juices and smoothies
- 1 pilot plan for recovery
- 1 Decision support system for each Business case



7. SHEALTHY mild technologies for BC1: sanitization and preservation

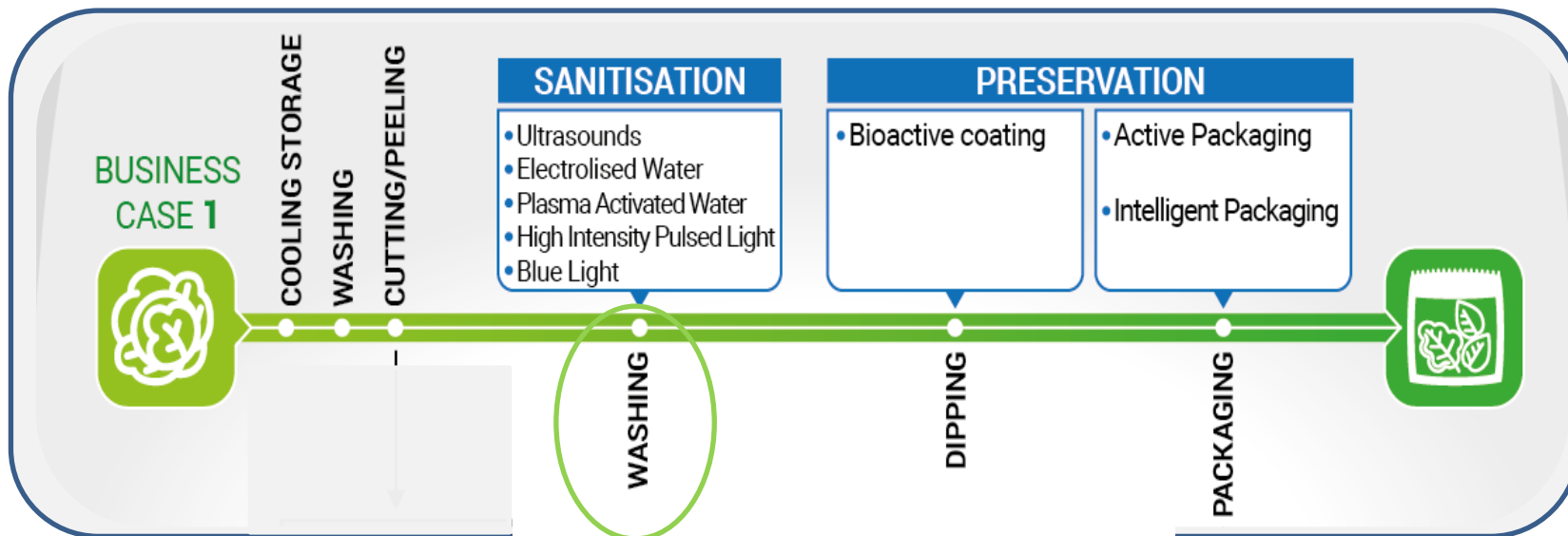


1. Spinach
2. Lettuce
3. Fennel
4. Cherry tomatoes
5. Pear
6. Strawberry
7. Nectarine
8. Roseberry



- **The impact of novel technologies** on food safety and quality as a basis for process and product development is determined.
- **Optimization of process parameters** is defined

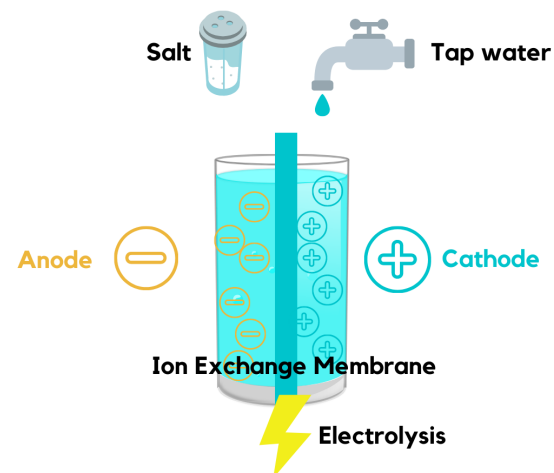
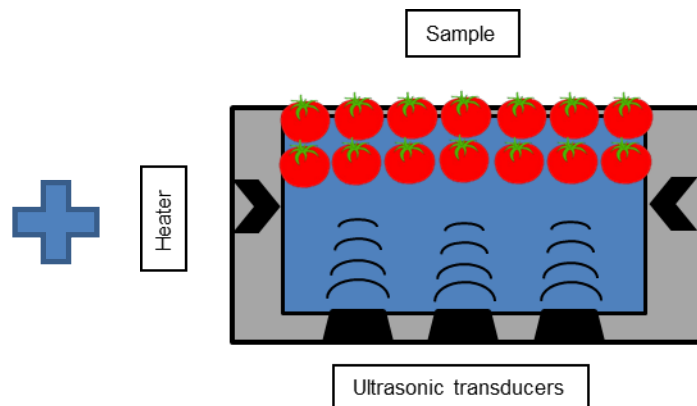
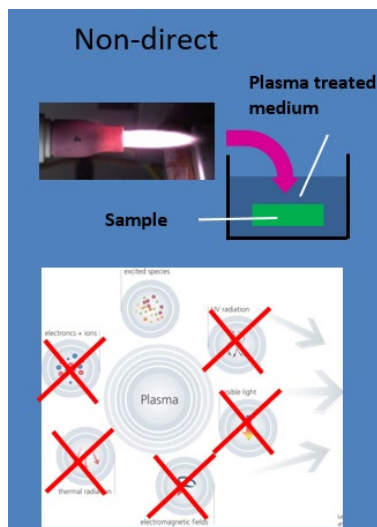
7. SHEALTHY mild technologies for BC1: sanitization and preservation



Plasma activated water

Ultra Sound

Electrolyzed water



Plasma activated water

- Inactivation effect combination of low pH (<3,5) and reactivity of species.
- Loses activity if not used with 48 h (can be frozen for storage).
- Antimicrobial effects evenly distributed on the surface → 2 min of contact time can lead to 1.5-2.5 log₁₀ reduction
- Little effect on color, texture and ingredients of intact fruit & vegetables

Ultra Sound

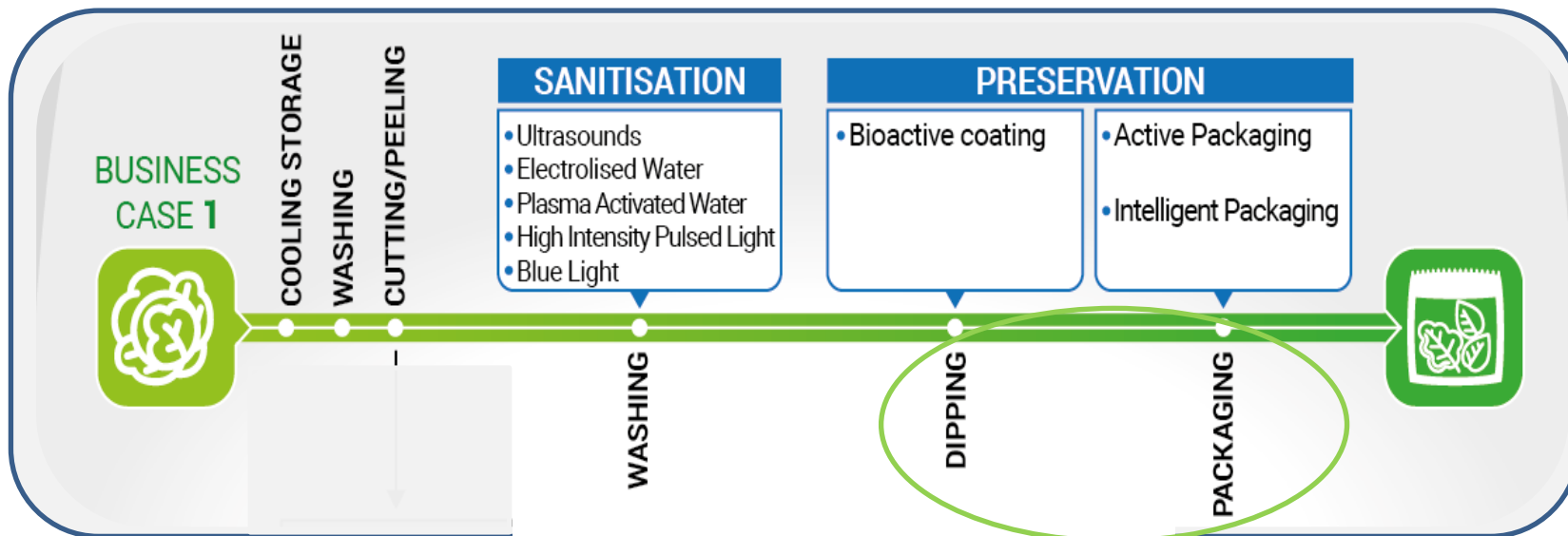
- Bouyant of the product must be minimized. Additional instruments should be included (net, holding platform) to ensure the total immersion of the samples in the treatment media.
- Spinach, lettuce and fennel can not be properly treated
- Cherry tomatoes and pear correctly processed with promising results
- No changes in colors or texture observed; s showed

Electrolyzed water

- No effective for the sanitization of spinach, fennel and nectarine;
- Good results for cherry tomatoes and pear
- The greatest reduction which has been obtained is 3,8 Log CFU/g for spoilage bacteria and 2,1 Log CFU/g for pathogens when 100% EW has been used;
- No changes in color, texture and nutritional quality



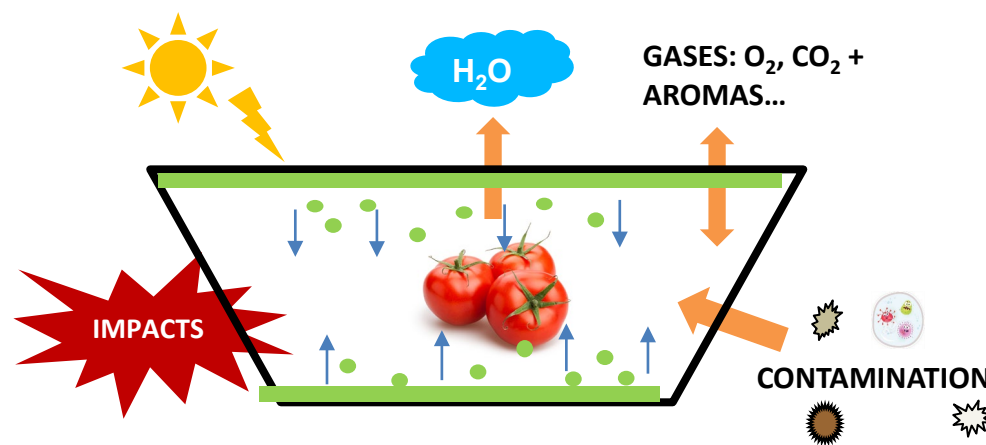
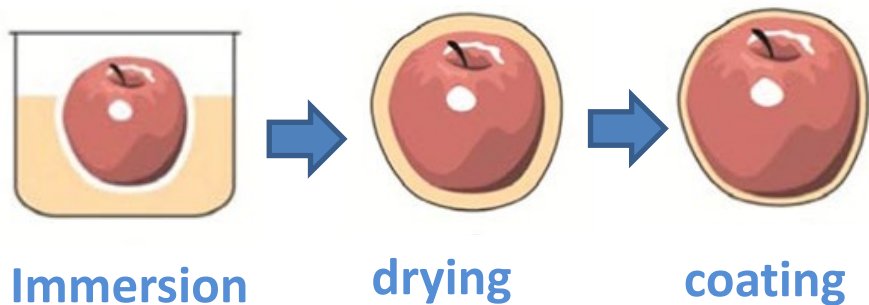
7. SHEALTHY mild technologies for BC1: sanitization and preservation



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Bio active coating:
antimicrobial or antioxidant

Active packaging:
antimicrobial or antioxidant



7. SHEALTHY mild technologies for BC1: sanitization and preservation

Bioactive coating



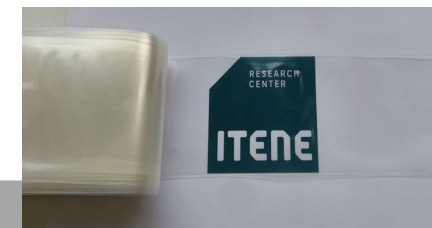
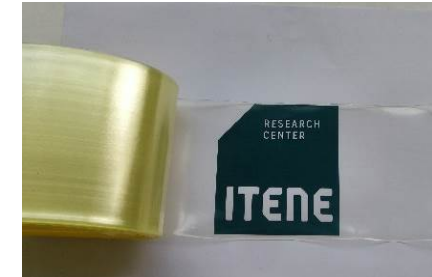
- Sodium caseinate and whey protein-based films can be used as effective delivery and carrier systems for lactic acid bacteria to develop bioactive edible film or coating with antimicrobial properties. The coating showed a good antimicrobial activity against *L. innocua* C6
- Antioxidant coating based on sodium caseinate and propyl gallate preserve fennel nutritional quality of almost 30% respect to control;
- Sodium caseinate based coating reduce the senescence of pear by extending the shelf life of 50%



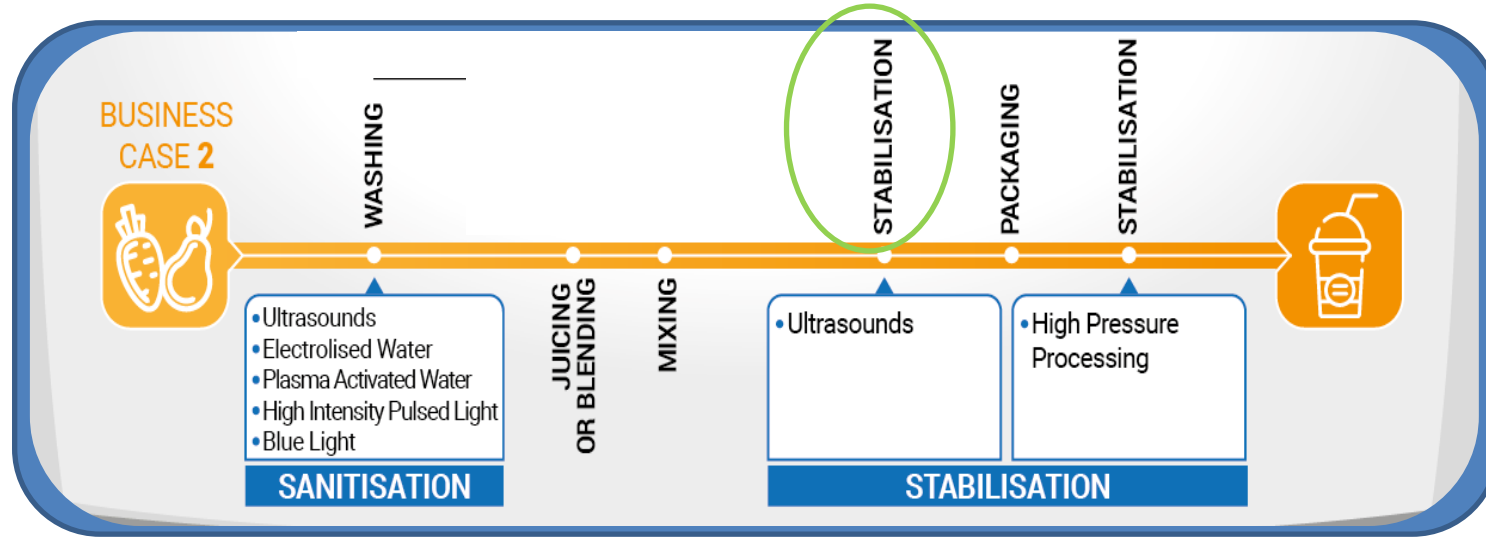
Active packaging



- The most powerful essential oils are thyme and oregano, which are effective against every microorganism.
- Cinnamon showed some effectivity against the target microorganisms, mainly against *A. niger*.
- Essential oils from citrus fruits (lemon, mandarin, orange and grapefruit) turned out to present just a slight effectiveness against yeasts, but not against bacteria and molds.
- PP and PLA film with selected EO has been realized. Film showed good antimicrobial and antioxidant properties.



8. SHEALTHY mild technologies for BC2: sanitization and stabilization

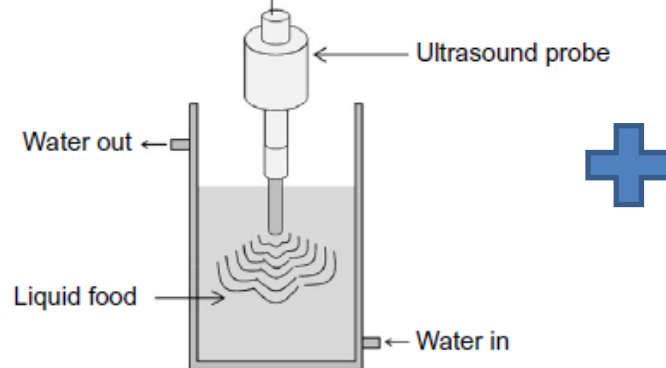


1. Orange juice
2. Apple juice
3. Carrot juice
4. Carrots juice
5. Smoothies (mix of F&V)

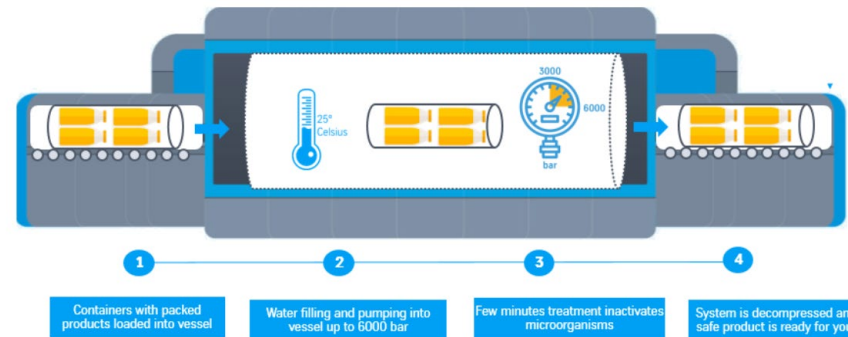
Ultrasound generator



Ultra Sound



High Pressure Processing



8. SHEALTHY mild technologies for BC2: sanitization and preservation



Power US

- For *E. coli* and *Salmonella*, the ultrasound application promoted up to 5-log reduction.
- PPO was inactivated in 80% in apple and carrot juice but in orange juice, the reduction was only 20% after 500 Ws/mL.
- Regarding the POD activity, in apple juice the reduction of this enzyme was lower than 20%, while in carrot juice the inactivation rounded 40% and in the orange juice a 60% inactivation was achieved after 500 Ws/mL.
- The ultrasound promoted an increment in the polyphenols, ascorbic acid, beta-carotene content
- Browning can be a critical aspect to control

HPP

- Apple juice: Shelf life 12 weeks, 4 °C and room temperature, TPC , Y%M < 10 cfu/mL.
- Orange juice: Shelf life 11 weeks, 4 °C and room temperature, TPC and Y&M < 10 cfu/mL;
- Optimal preservation of nutritional, physical and sensory properties
- Carrot juice: pH 6.2; spoilage after 5 days at 25°C.



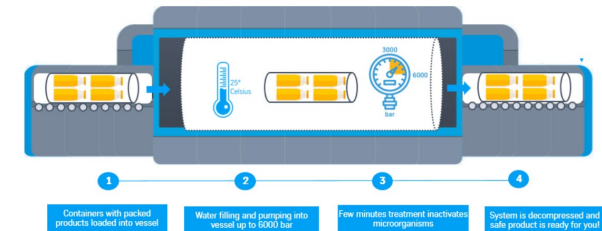
Fruits /
Vegetables

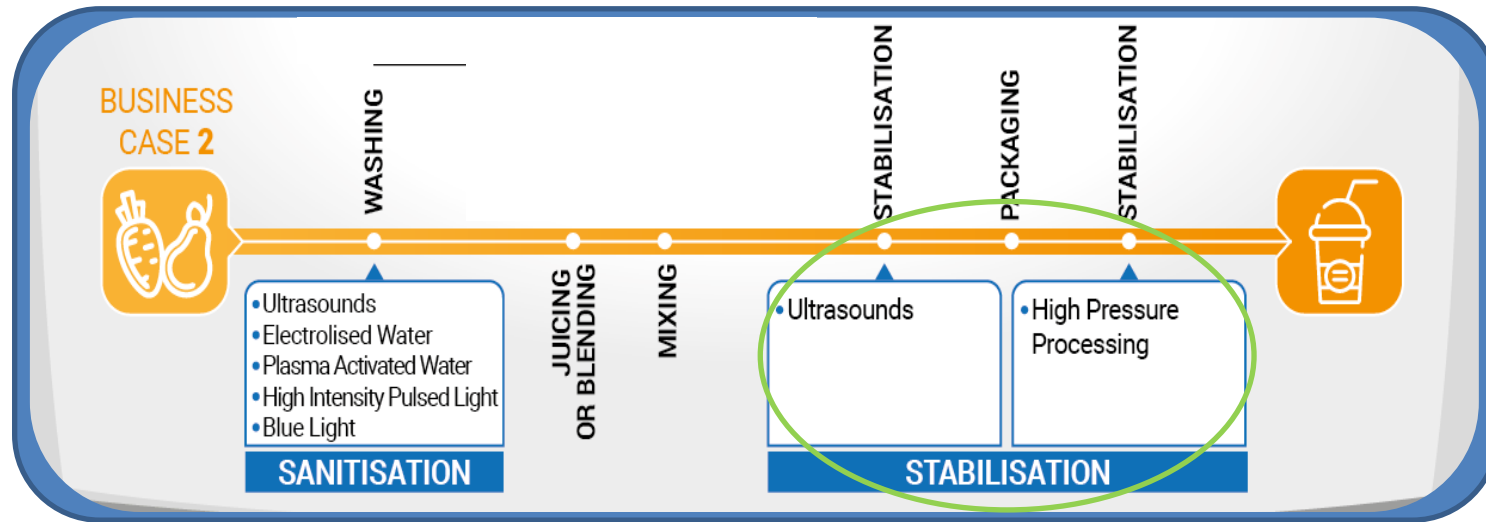


Juicing /
Juice



Ultrasound
Processing





Mathematical Model Development

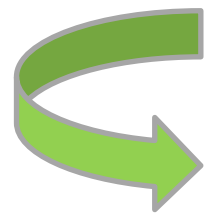
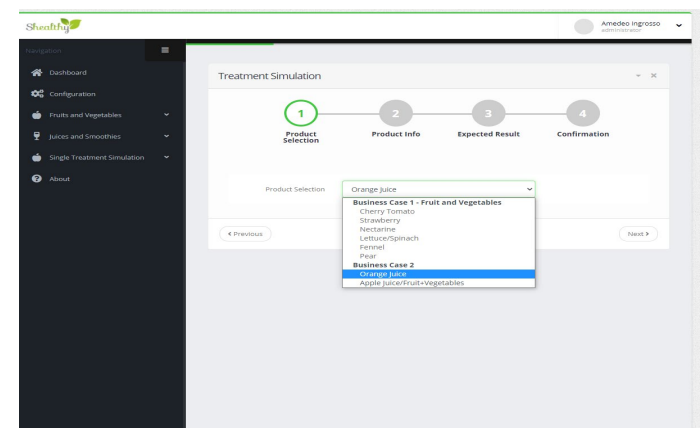
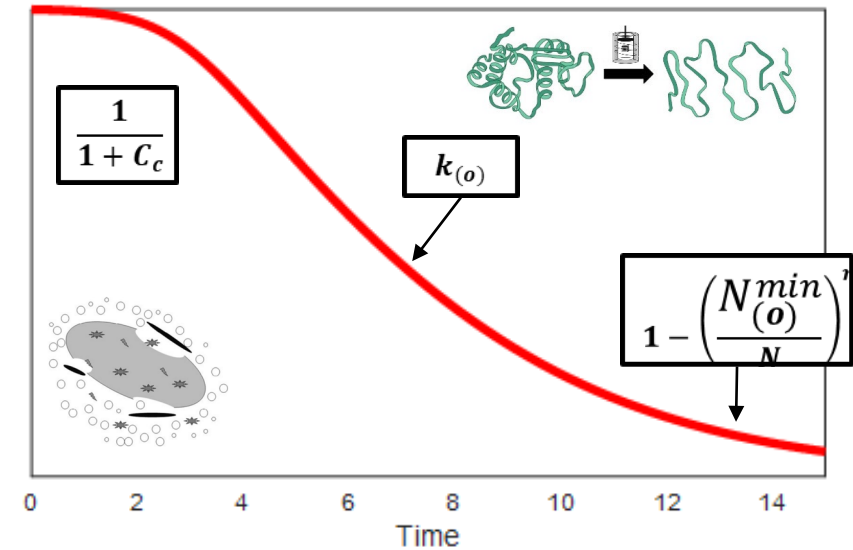
■ Stabilisation (US-HPP)

- ✓ Microorganisms
- ✓ Enzymes

■ Storage

- ✓ Safety index
- ✓ Decay of nutritional compounds

DSS system



The system is online and working on a CETMA temporary domain.

<http://www.cetma.it/SHEALTHY-DSS/high-pressure.aspx>





Marco de la Feld

m.delafeld@enco-consulting.it



Elena Torrieri

elena.torrieri@unina.it

