Tecnologie intelligenti per la sostenibilità delle produzioni alimentari

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
CAMPUS DI CESENA

22 '23 OPEN DISTAL

Marco Dalla Rosa

ALMA MATER STUDIORUM UNIVERSITA' DI BOLOGNA
DISTAL / CIRI AGROALIMENTARE
CAMPUS DI SCIENZE DEGLI ALIMENTI - CESENA

Tecnologie intelligenti per la sostenibilità delle produzioni alimentari

- Uso efficiente di materie prime come acqua ed energia,
- prevenzione degli sprechi alimentari
- gestione delle eccedenze alimentari,
- progettazione del packaging,
- riciclo e valorizzazione dei sottoprodotti

- innovazioni di prodotto e di processo attuate anche con approcci biotecnologici,
- tecnologie termiche a prestazioni migliorate
- tecnologie non termiche (pressioni di omogeneizzazione, HPP, campi elettrici pulsati, plasma freddo atmosferico, impregnazione sottovuoto, ultrasuoni;
- sistemi per aumento della efficienza dei flussi nei processi,
- analisi LCA

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AZIONI NECESSARIE

- Studio delle interazioni e degli effetti del processo e della materia prima sulla struttura degli alimenti —> **Texture & Rheology**
- Sviluppo di processi di trasformazione innovativi & non-termici
- Studio di packaging innovativi ed estensione della shelf life.
- Produzione di alimenti innovativi e salutistici (**Texture - rheology -function interaction**).
- Nanotecnologie per la realizzazione di rivestimenti innovativi (**edible coatings**)
- Riduzione e valorizzazione dei sottoprodotti (**circular bioeconomy**)

Smart Technologies to reduce energy demand/ environmental impacts

Emerging technologies

Classification on non-thermal technologies based on engineering aspects

Electrotechnologies and electromagnetic technologies

pulsed electric fields (PEF)
cold plasma technologies (CPT: e.g. atmospheric cold plasma, CAP; PAW)
magnetic fields (MF)
electrohydrodinamic processing (EHD)
ionizing radiation (IOR; e.g. electron bean (EB) processing

Pressure-based technologies

vacuum impregnation (VI)
high hydrostatic pressure (HHP/HPP)
hydrodinamic pressure processing (high pressure homogenization, HPH)
supercritical fluid processing

Mechanical technologies

ultrasonication (US)
hydrodinamic cavitation
shock waves

(Jambrak A.R. Ed., 2022)

Others

UV light
pulsed light
membrane technologies (microfiltration, membrane separation etc.)
modified atmosphere

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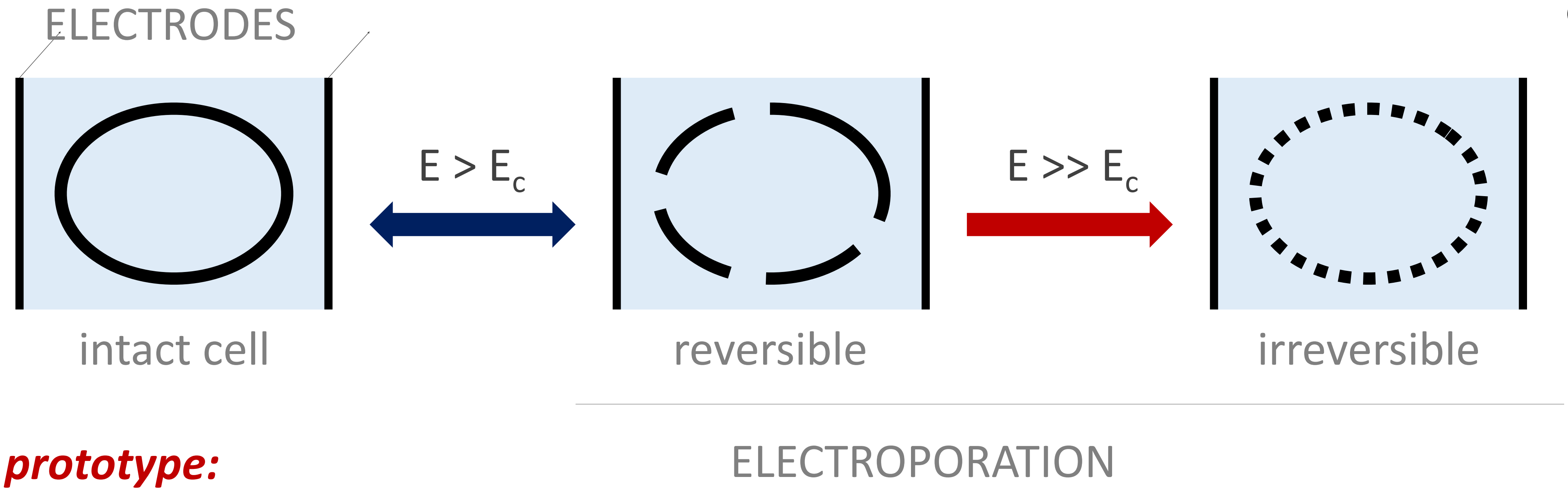
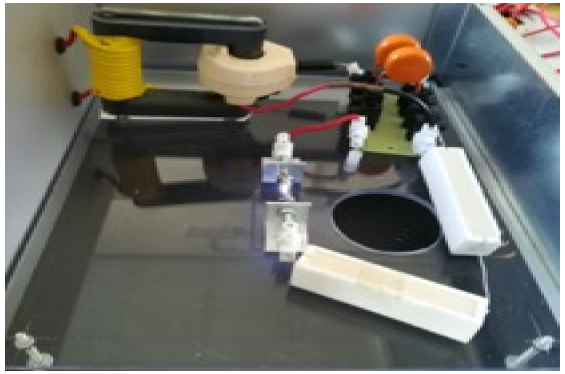
PULSED ELECTRIC FIELDS (PEF)
Increased efficiency of matter transfers

Coordinatore
Prof. P. Rocculi



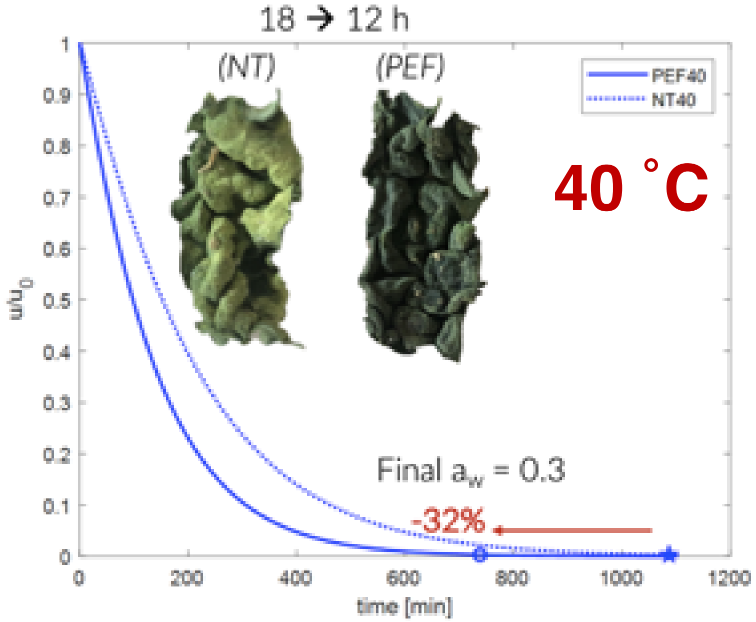
PEF prototype:
microbic inactivation/ electroporation

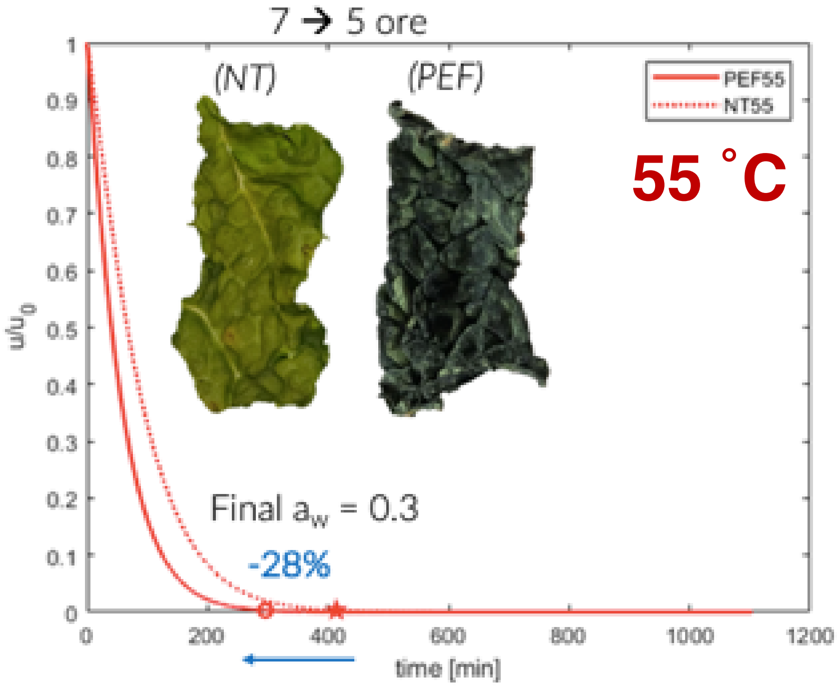


UP-SCALING

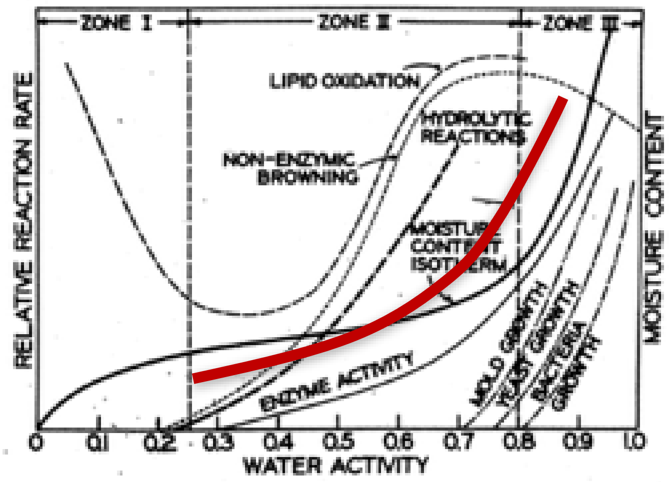
Industrial scale

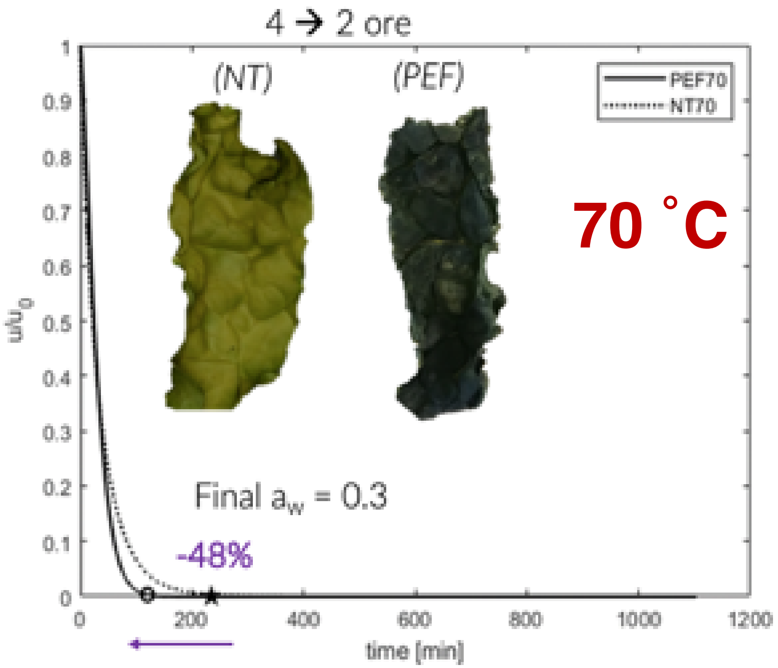
IGBT - based





Hot Air Drying





Miglioramento caratteristiche qualitative e cromatiche

Tempi e costi di esercizio ridotti

Maggiore produttività

Advanced Image Processing

Source:
F. D'Elia (Master thesis). **Effetto dei campi elettrici pulsati sull'essiccazione di prodotti vegetali,** 2019.

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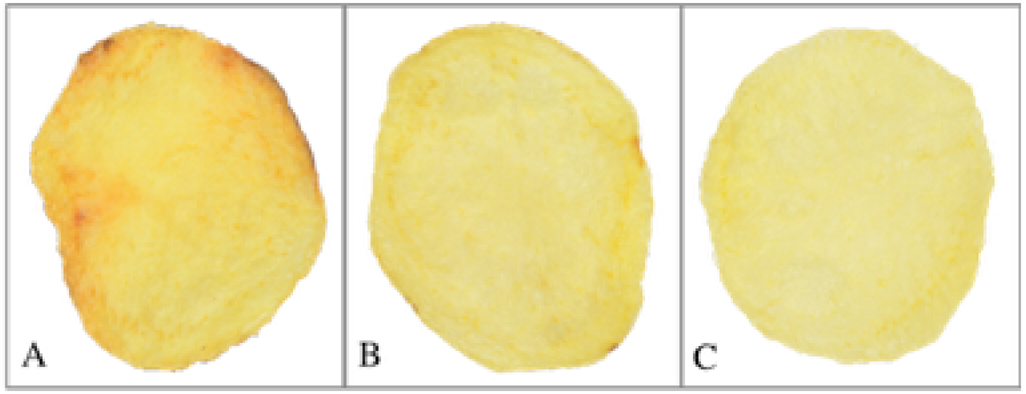
PEF in Potato Chips Processing

	Acrylamide (ppb) Means ± standard deviations
UNTREATED	1958 ± 64
BLANCHING	1617 ± 147
PEF	1355 ± 101

- ✓ **~30%** Reduction of acrylamide in samples pretreated with **PEF**
- ✓ **~17%** Reduction of acrylamide in samples pretreated with **Blanching**



A – Control

B – Blanching

C - PEF

Advanced Image Processing

Genovese J, Tappi S, Luo W, Tylewicz U, Marzocchi S, Marziali S, Romani S, Ragni L, Rocculi P.
Important factors to consider for acrylamide mitigation in potato crisps using pulsed electric fields. *Innovative Food Science & Emerging Technologies*. 55:18-26, 2019.

OPEN DISTAL 2023

PLASMA FOOD PRIN 2017

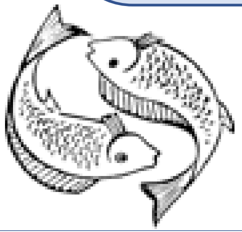
Coordinatore
Prof.M. Dalla Rosa

Gas plasma treatment (UNIBO)

Gas mixture
Temperature
Relative humidity

→ Characterization of plasma emission (UNIBO)

Title:
Optimization of cold plasma treatment for the stabilization of food products


Treatment of:
Seafood (mollusks and fish), fresh, MP and dehydrated fruit and vegetables, dried products (UNIBO)

Safety
Microbial inactivation (UNIBO)
Virus inactivation (ISS)
Mycotoxin inactivation (UNITE)
Biogenic amines (UNICAM)

Quality
Rheology (UNIPR)
Colour (UNIPR)
Texture (UNIPR)
Enzymes activity (UNITE)

Nutritional profile
Bioactive compounds content (UNICAM)
Lipid oxidation (UNIVPM)
Antioxidant properties in vitro/ex vivo (UNIPR)

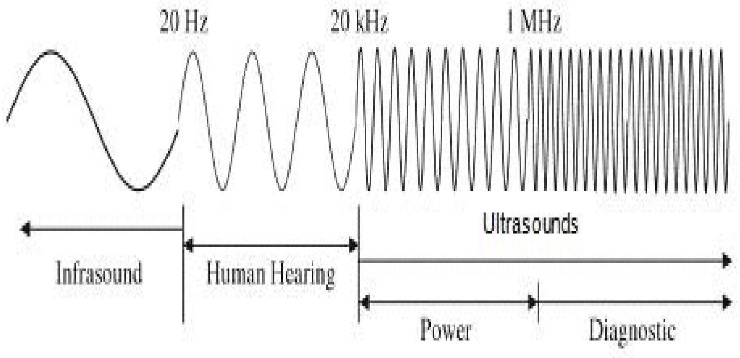
Metabolism of tissues
Heat production (UNIBO)
Respiration rate (UNIBO)
Cell viability (UNIBO)

Use of Ultrasounds (US)

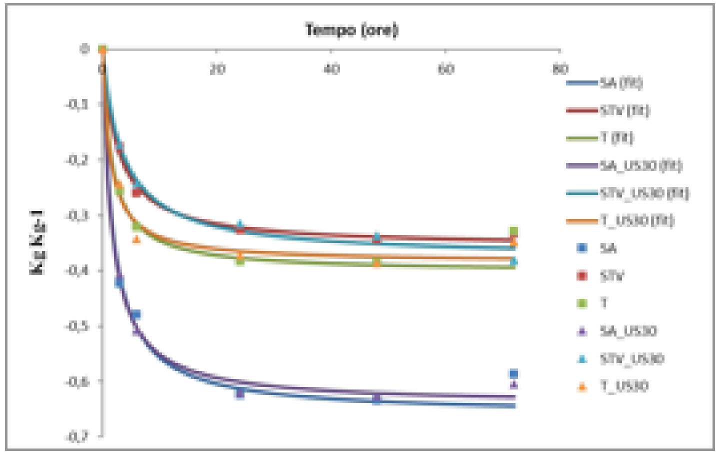
Coordinatore
Prof. P. Rocculi

US at high intensity (power >1 W cm^{-2} and low frequency <0,1 MHz

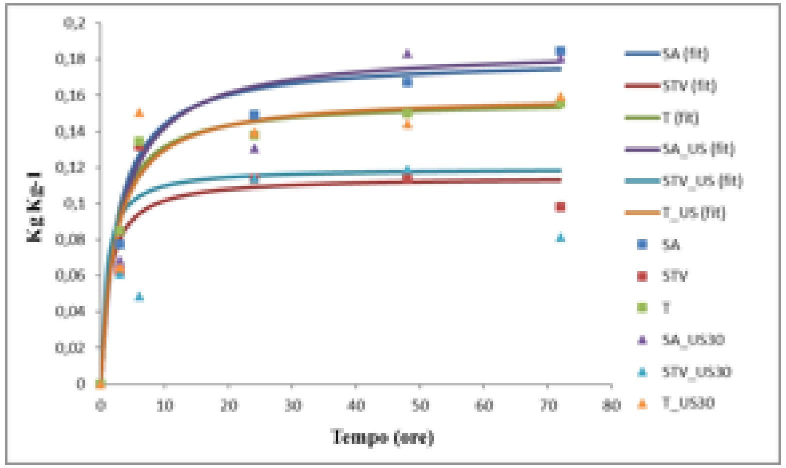
- ✓ Inactivate microorganisms and enzymes
- ✓ Improve mass transfer
- ✓ Improve heat transfer



Water loss



Solid gain



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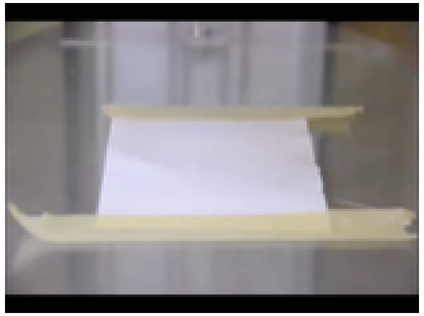
Digital innovation in in food processing

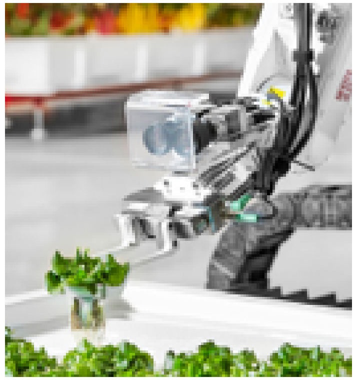
Non destructive analysis during processing

Visual assessment

3D Printing

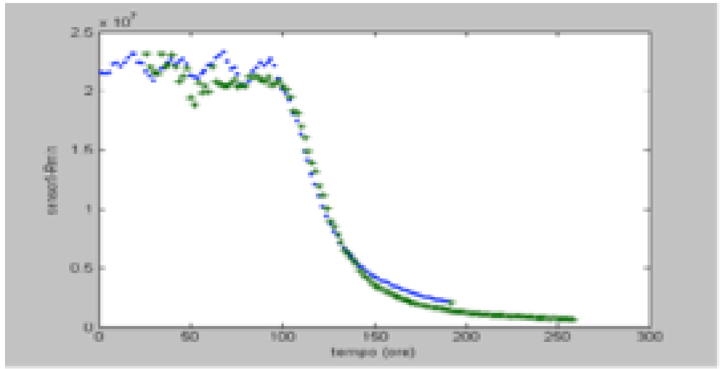


By courtesy of Severini, 2018

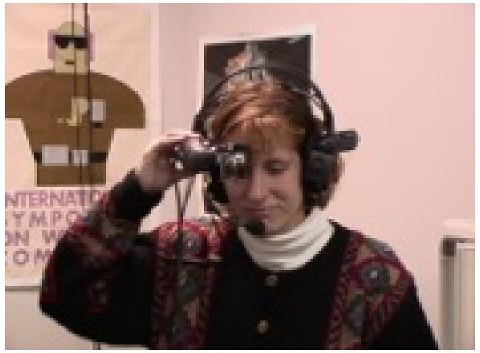


Robotics

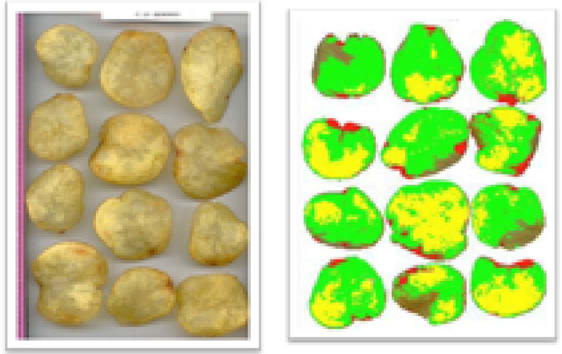
Rheological properties driven



e-nose response



wearable data acquisition system



advanced image analysis

Modeling frozen vegetables shelf-life by thermophysical properties

DISTAL

Journal of Agricultural Engineering 2021; volume LII:1199

pagepress

Simple and efficient approach for shelf-life test on frozen spinach and parsley

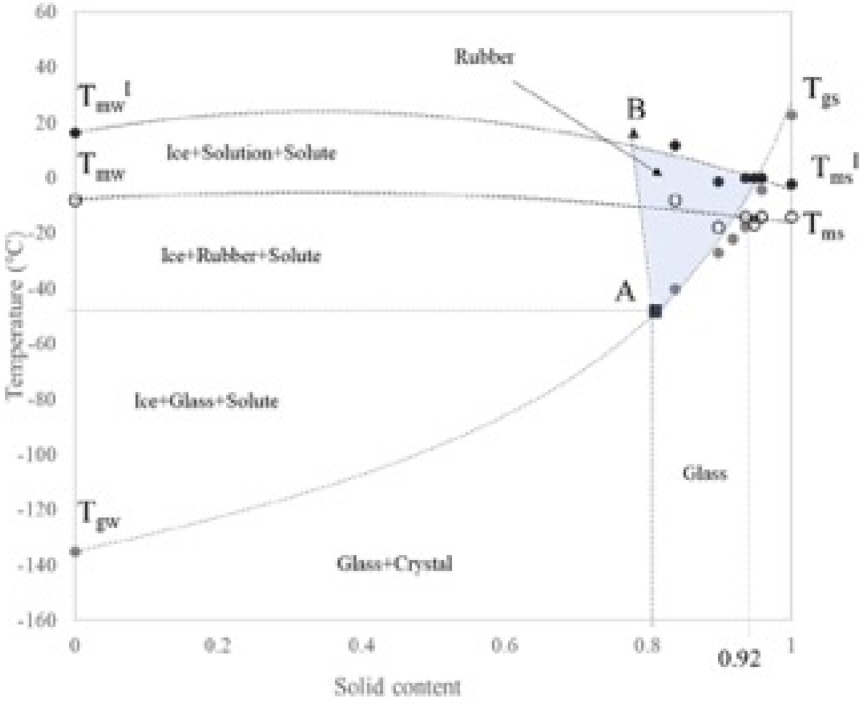
Eleonora Iaccheri,[1] Chiara Cevoli,[1,2] Santina Romani,[1,2] Marco Dalla Rosa,[1,2] Giovanni Molari,[2] Angelo Fabbri[1,2]

ORIGINAL ARTICLE

Journal of Food Process Engineering WILEY

Thermophysical properties of frozen parsley: A state diagram representation

Eleonora Iaccheri[1] |



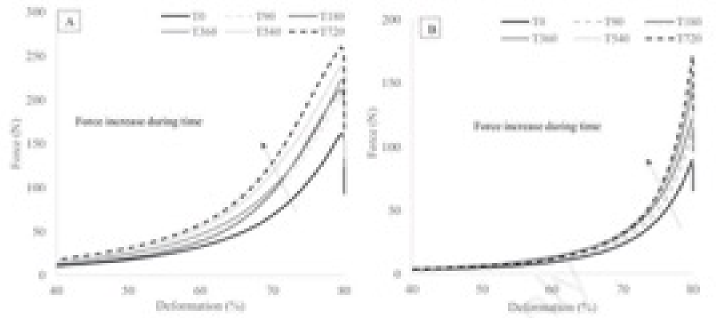


Figure 2. Mean force-distance curves of spinach (A) and parsley (B) samples stored at -26°C as a function of time (0-720 days).

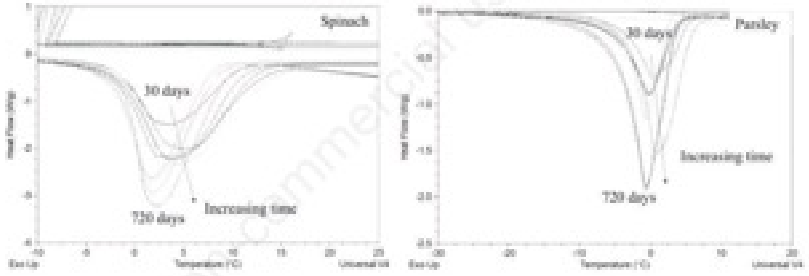
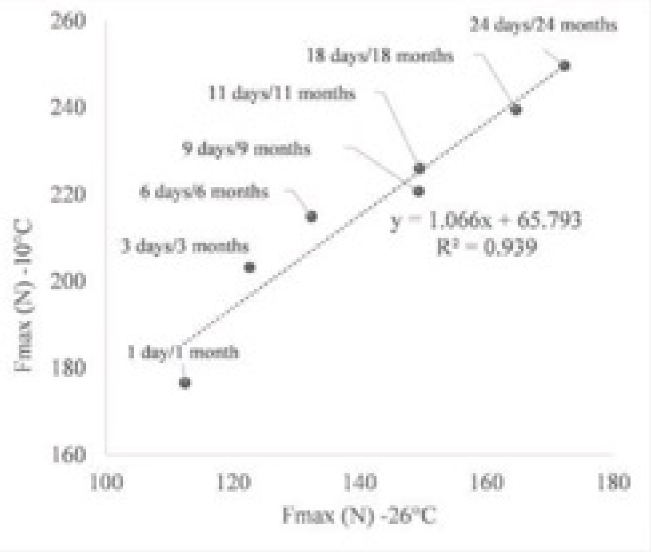


Figure 3. Endothermic peak of ice melting of spinach and parsley samples during storage time, referred to spinach and parsley samples stored at -26°C.



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Sustainable Packaging

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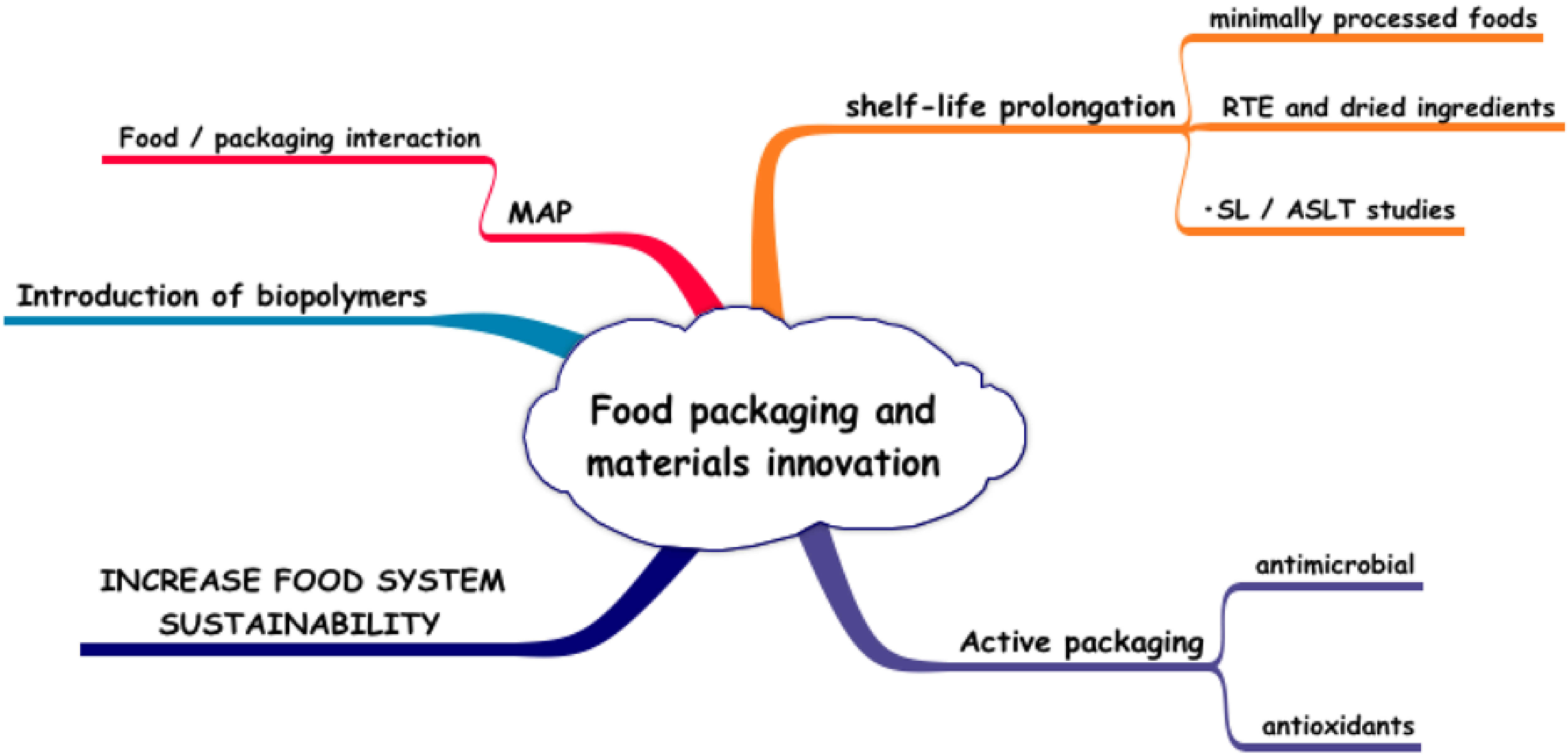

Food packaging and materials innovation
shelf-life prolongation
minimally processed foods
RTE and dried ingredients
•SL / ASLT studies
Food / packaging interaction
MAP
Introduction of biopolymers
INCREASE FOOD SYSTEM SUSTAINABILITY
Active packaging
antimicrobial
antioxidants

MAP - Minimally processed fruit

ELSEVIER

Available online at www.sciencedirect.com

SCIENCE DIRECT

Postharvest Biology and Technology 35 (2005) 319–328

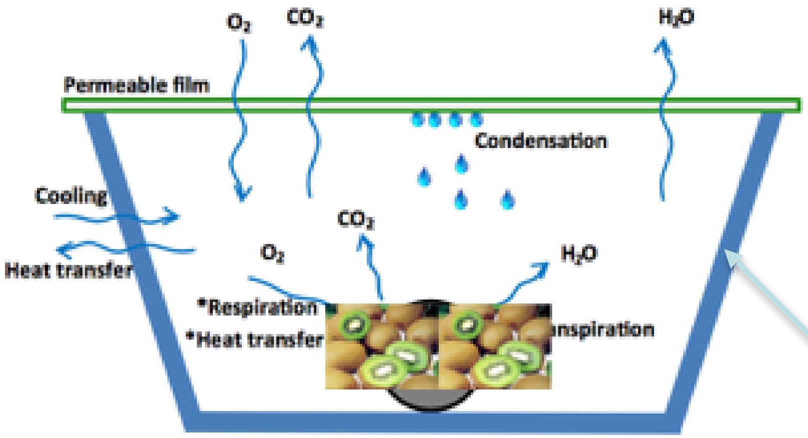
Postharvest Biology and Technology

www.elsevier.com/locate/postharvbio

Effect of MAP with argon and nitrous oxide on quality maintenance of minimally processed kiwifruit

Pietro Rocculi*, Santina Romani, Marco Dalla Rosa

SELECTED PERMEABILITY NEEDED



Low heat transfer

Medium - high mechanical resistance

<u>Respiring foods</u>

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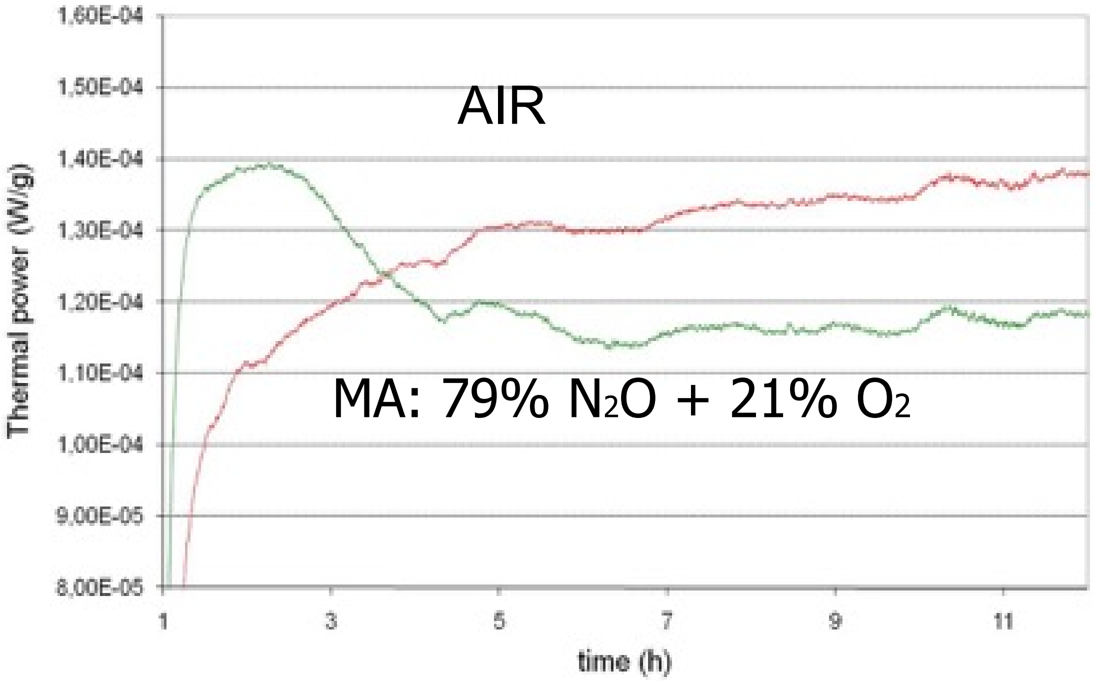
Metabolic heat production & N_2O inhibitory effect by Isothermal Calorimetry



This was confirmed by the O2 and CO2 levels detected on the sample-ampoule head space at the end of the experiment:

- Air: 19.1% O2, 1.2% CO2;
- MA: 20.2% O2, 0.5% CO2

Argon and Nitrous oxide (N_2O) MAP


Contents lists available at ScienceDirect
Food Research International
journal homepage: www.elsevier.com/locate/foodres

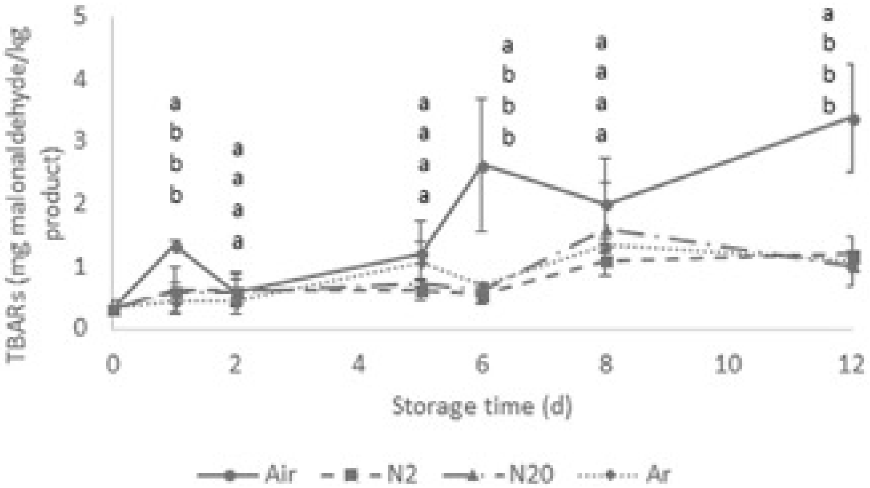
The impact of gas mixtures of Argon and Nitrous oxide (N_2O) on quality parameters of sardine (*Sardina pilchardus*) fillets during refrigerated storage

Ana Cristina De Aguiar Saldanha Pinheiro[a], Eleonora Urbinati[a], Silvia Tappi[b,*], Gianfranco Picone[a], Francesca Patrignani[a,b], Rosalba Lanciotti[a,b], Santina Romani[a,b], Pietro Rocculi[a,b]

Ar and N_2O lowest level of
Total mesophilic bacteria
Total psychrotrophic bacteria

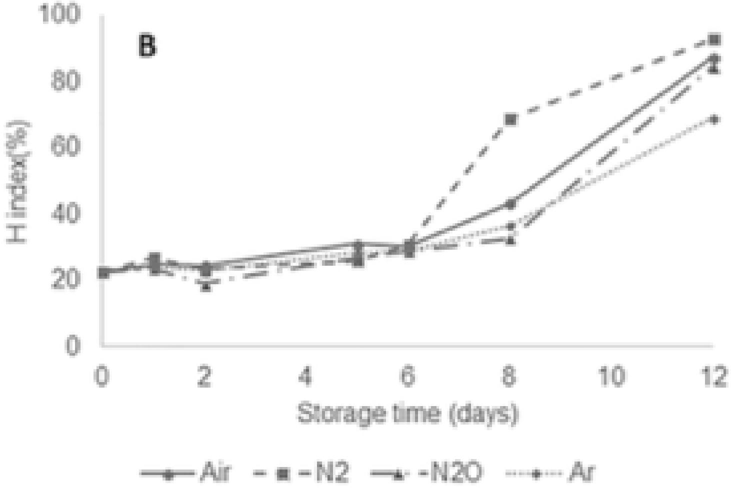
Product stored in argon was also characterized by the lowest level of total coliforms

TBARs



- GOOD QUALITY:5 mg malonaldehyde/kg,
- The fish may be consumed up to a level of 8 mg MA/kg in TBARS value

H Index

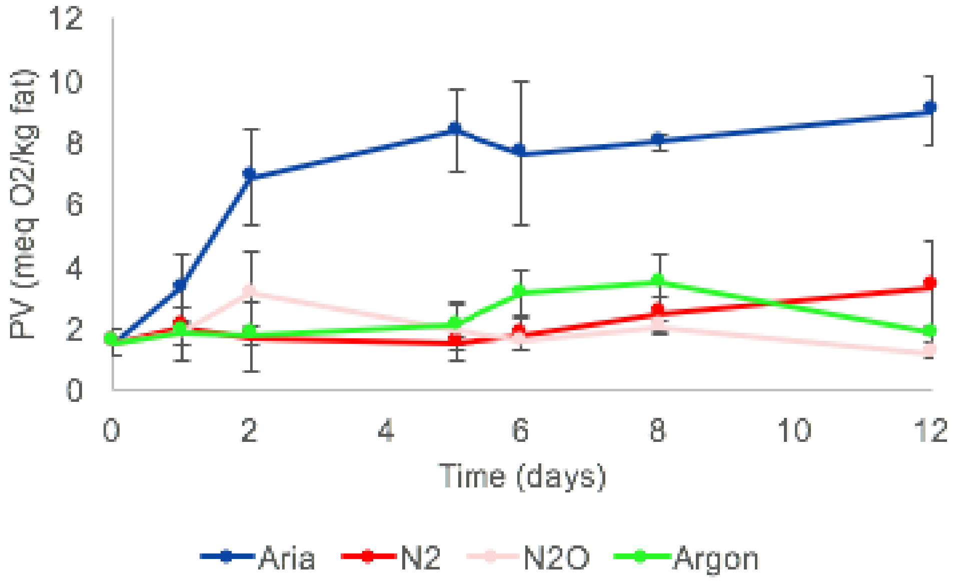


$H\ index\ (\%) = (Hx)/(IMP + Ino + Hx) * 100$

TMAO, TMA, Inosine, AMP, Hypoxanthine, ATP, ADP, IMP by HR-NMR

Colour was affected by MAP and resulted in higher L* and lower a* values in Air sample

Fat oxidation was inhibited by MAP as shown by PV values.



Tappi et al., 2018, FoodOmics Conference, Cesena (ITA)

Research Article SCI
Received: 5 March 2014 Revised: 12 June 2014 Accepted article published: 21 August 2014 Published online in Wiley Online Library:
(wileyonlinelibrary.com) DOI 10.1002/jsfa.6888

Application of PLA in food storage

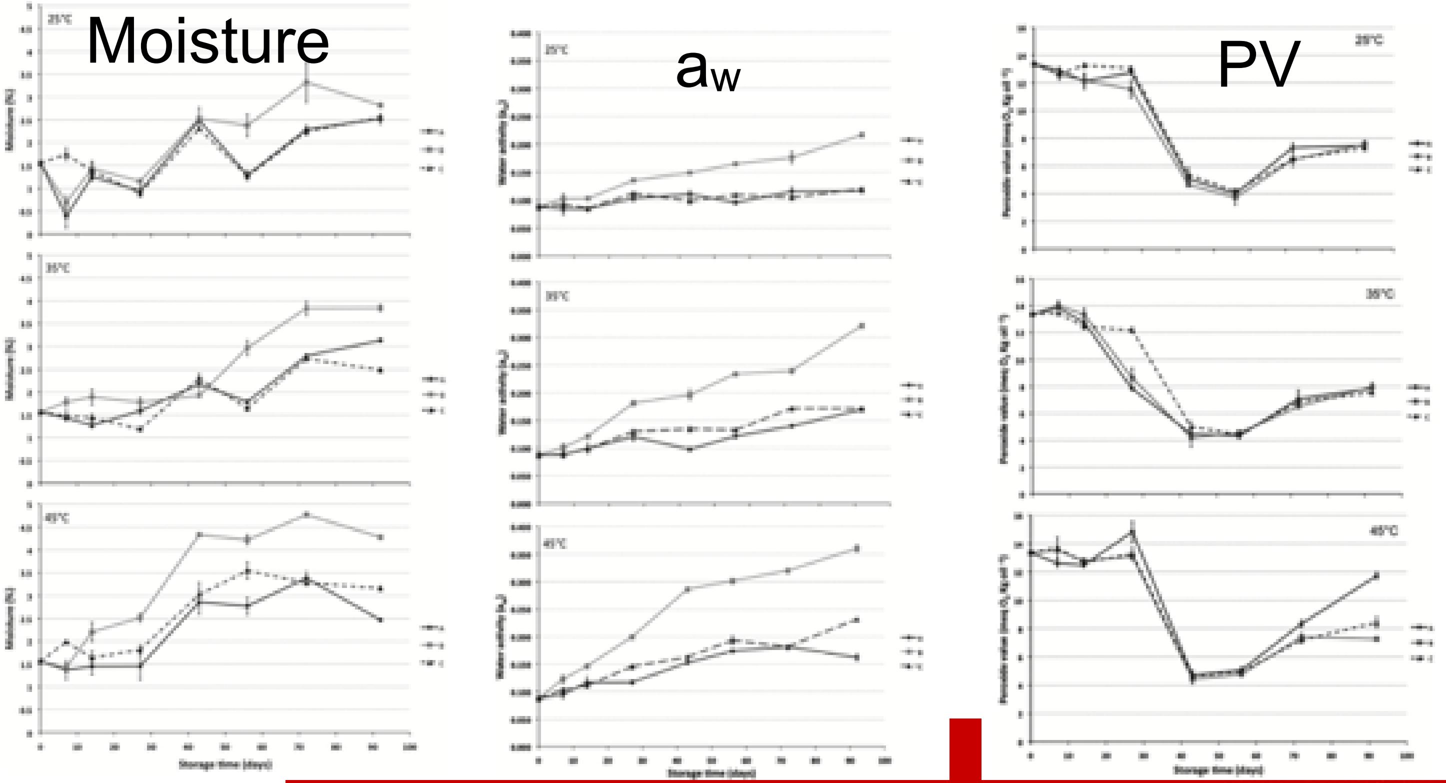
Effect of different new packaging materials on biscuit quality during accelerated storage

Santina Romani,[a,b*] Silvia Tappi,[b] Federica Balestra,[a] Maria Teresa Rodriguez Estrada,[a,b] Valentina Siracusa,[c] Pietro Rocculi[a,b] and Marco Dalla Rosa[a,b]

Table 1. Thickness and transmission rate characteristics of the packaging multilayer films

Packaging materials	Thickness (μm)	WVTR (g m^{-2} d^{-1})	O_2TR (cm^3 m^{-2} d^{-1})	CO_2TR (cm^3 m^{-2} d^{-1})
Met OPP/paper	63.14 ± 2.70b	0.50 ± 0.04a	9.94 ± 0.61b	58.17 ± 0.86b
Met PLA/paper *	57.16 ± 2.05a	2.24 ± 1.03b	1.61 ± 0.09a	4.01 ± 0.09a
Met OPP-EVA-POA/paper **	59.02 ± 2.09ab	1.95 ± 0.08b	14.97 ± 0.87c	81.30 ± 2.84c

* biobased & compostable   ** partially biodegradable not compostable



samples in flexible packaging with EVA-POA and mainly PLA underwent the more hydration

No dramatic effects on biscuit quality and safety since the low aw values

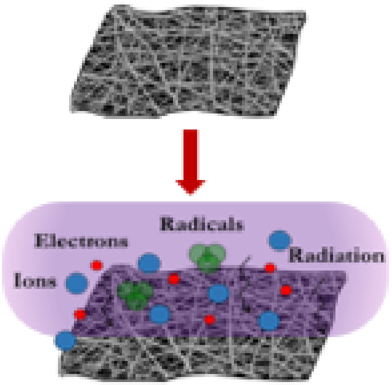
No remarkable differences in the evolution of primary and secondary lipid oxidation were observed among differently packed biscuits during storage

Multilayer production and characterization

Multi-layer assembly step

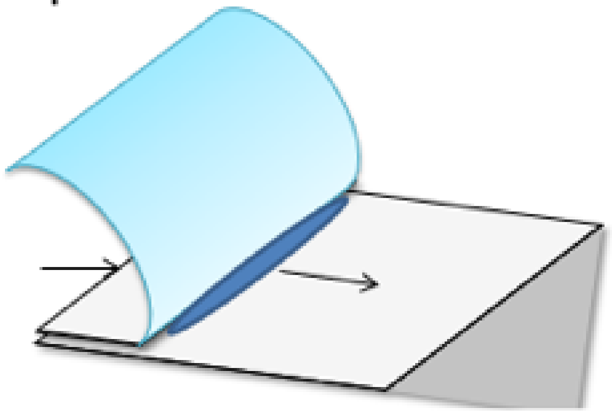
Coordinatore Prof. S. Romani

1. Trattamento plasma



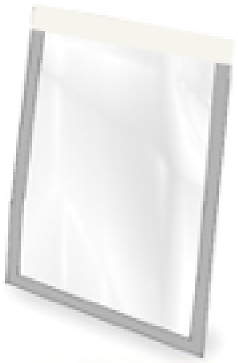
Funzionalizzazione plasma a freddo del PLA

2. Deposizione dello strato attivo

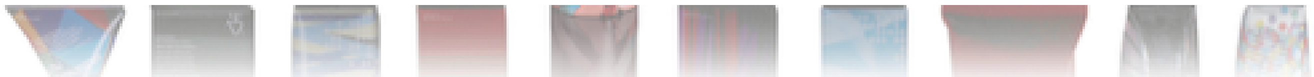


Deposizione manuale a lama del gel attivo

3. Accoppiamento e saldatura del multistrato



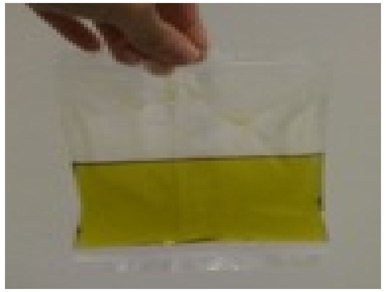
Termosaldatura laterale del multistrato



Stability analysis on model and food systems

Multilayer shelf-life studies / Oxygen Scavenger

Sample model systems (sunflower oil)



Control

Multilayer active film (Oxygen scavenger)

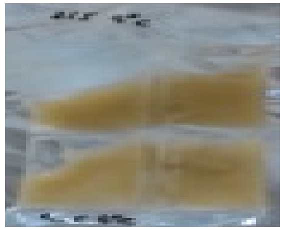
Real systems samples (Condiments / ready sauces)

Control

Multilayer active film (Oxygen scavenger)

strong antioxidative and antimicrobial effects

Shelf-life studies Monolayer / Antimicrobial



Model / real model samples (Smoothies based fruit and vegetables)

Control

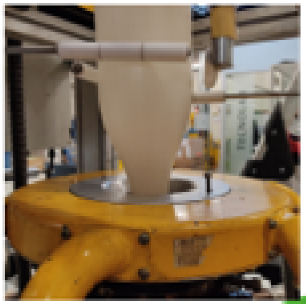
Active Film (Lisozima) Monolayer

Resp. Scientitico
Prof. R. Lanciotti

INGREEN

Coordinatore
INEUVO

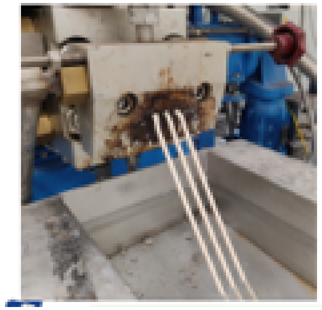
Film blowing:
- Compound transformation into film
- Processability compliance



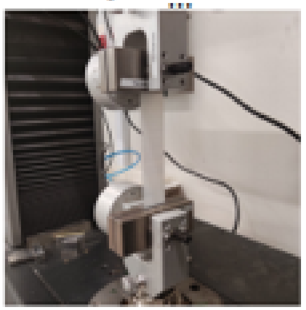

Purified PHA

Commercial bag-in-box

Extrusion compound:
- Melt & blend
- PHA+biobased matrix+additives




Characterization:
- Mechanical
- Thermal
- Barrier
- ...




INGREEN
Horizon 2020 European Union Funding for Research & Innovation
BBI JU
Bio-based Industries Consortium

ACTIVE PACKAGING for fresh produce: «*ATTIVO*»

bestack
L'EVOLUZIONE NELL'IMBALLAGGIO
CONSORZIO NON-PROFIT IMBALLAGGI IN CARTONE ONDULATO

Inventori: Lanciotti R., Patrignani F., Gardini F., Siroli L.

By-products /waste valorization & reduction /

Recovery of fuctional components

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Bio-based ingredients for sustainable industries through biotechnology

AIMS

Selection of the most appropriate strain(s)/ consortia in relation to the:

i) physico-chemical, composition and process features of each considered side stream/by-product;

ii) features of the end products to be obtained;

iii) constraints of scaling up at industrial level (yield, production rate);

iv) integration and acceptance of new biotechnologies in the existing industrial facilities;

v) competition with non bio-based compounds already available in the market.

Horizon 2020 European Union Funding for Research & Innovation

Bio based Industries Consortium

BBI JU

INGREEN in the Top 50 for bio-based innovations

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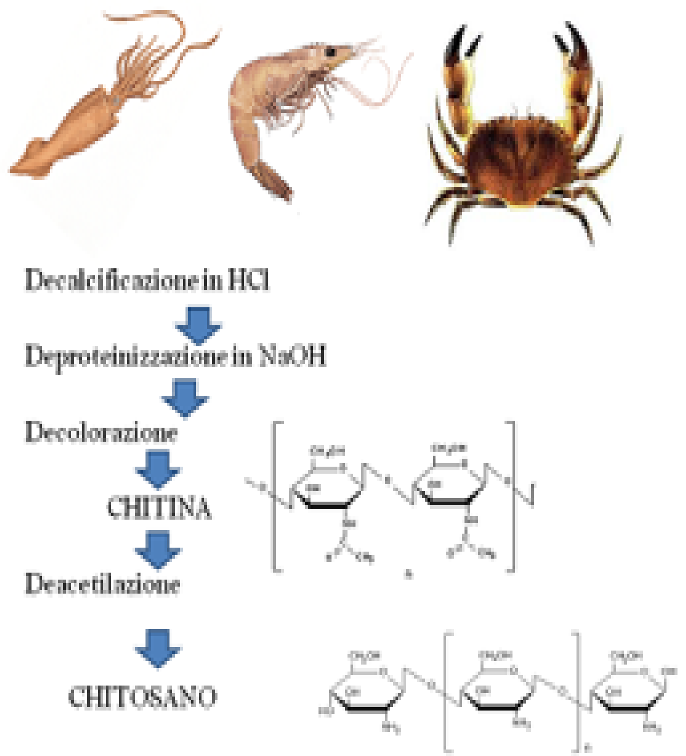
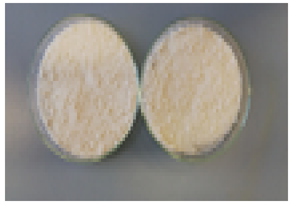
Chitin and Chitosan extraction from crustacean carapace

PhD Thesis Ana Cristina De Aguiar Saldanha Pinheiro



✓ Food industry applications of chitosan:

- ✓ **Antioxidant**
- ✓ **Emulsifying agent**
- ✓ **Edible film/coating**
- ✓ **Flocculating and clarifying agent**
- ✓ **Food Preservative:**
- ✓ **Antimicrobial and antifungal properties**
- ✓ **Food fiber**
- ✓ **Immobilization of enzymes**
- ✓ **Additive - stabilization of color, texture, odor**



Extraction from carapace of mantis shrimp:
Yield ≈ 10%

Evaluation of innovative non-thermal technologies (Ultrasound, Pulsed Electric Fields, Plasma) for modulating the molecular weight and thus the characteristics of extracted chitosan

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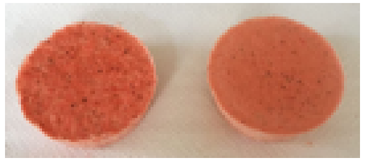
PRODUCTS OBTAINED ON A PILOT / SEMI-INDUSTRIAL SCALE

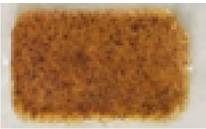
kiwifruit Puree di by-product kiwifruit stabilized with HPH

Slices of kiwifruit treated with OD and dried at low temperature

97°C, 25 min | HPH | 70°C + HPH

Dried snacks - Different formulations of kiwifruit with other ingredients





molecules

MDPI

Article

Design of Healthy Snack Based on Kiwifruit

Urszula Tylewicz [1,2], Malgorzata Nowacka [3,*], Katarzyna Rybak [3], Kinga Drozdzal [3], Marco Dalla Rosa [1,2] and Massimo Mozzon [4]

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CO-FRESH

Rsp. Sci. UNIBO
Prof. L. Vannini

«CO- creating sustainable and competitive FRuits and vEgetableS' value cHains in Europe»

Ridisegnare e co-creare approcci innovativi nella catena agro-alimentare attraverso 7 *pilot cases*

1. Sostenibilità
2. Equilibrio socio-economico
3. Competitività economica

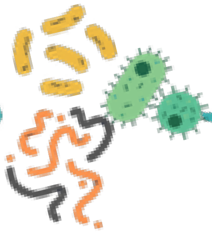
Pilot case n 1: frutta biologica fresca e trasformata

le Terre di Zoe

Valorizzazione per via biotecnologica degli scarti per la produzione di ingredienti funzionali

Tecnologie sostenibili
Condizioni di processo mild
Limitato utilizzo di sostanze chimiche

Campi elettrici pulsati (PEF)



Ingrediente Funzionale

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000852

Toward a More Sustainable Diet

alternative feed & food / alternative protein

plant-based products / reformulation

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Alternative protein sources

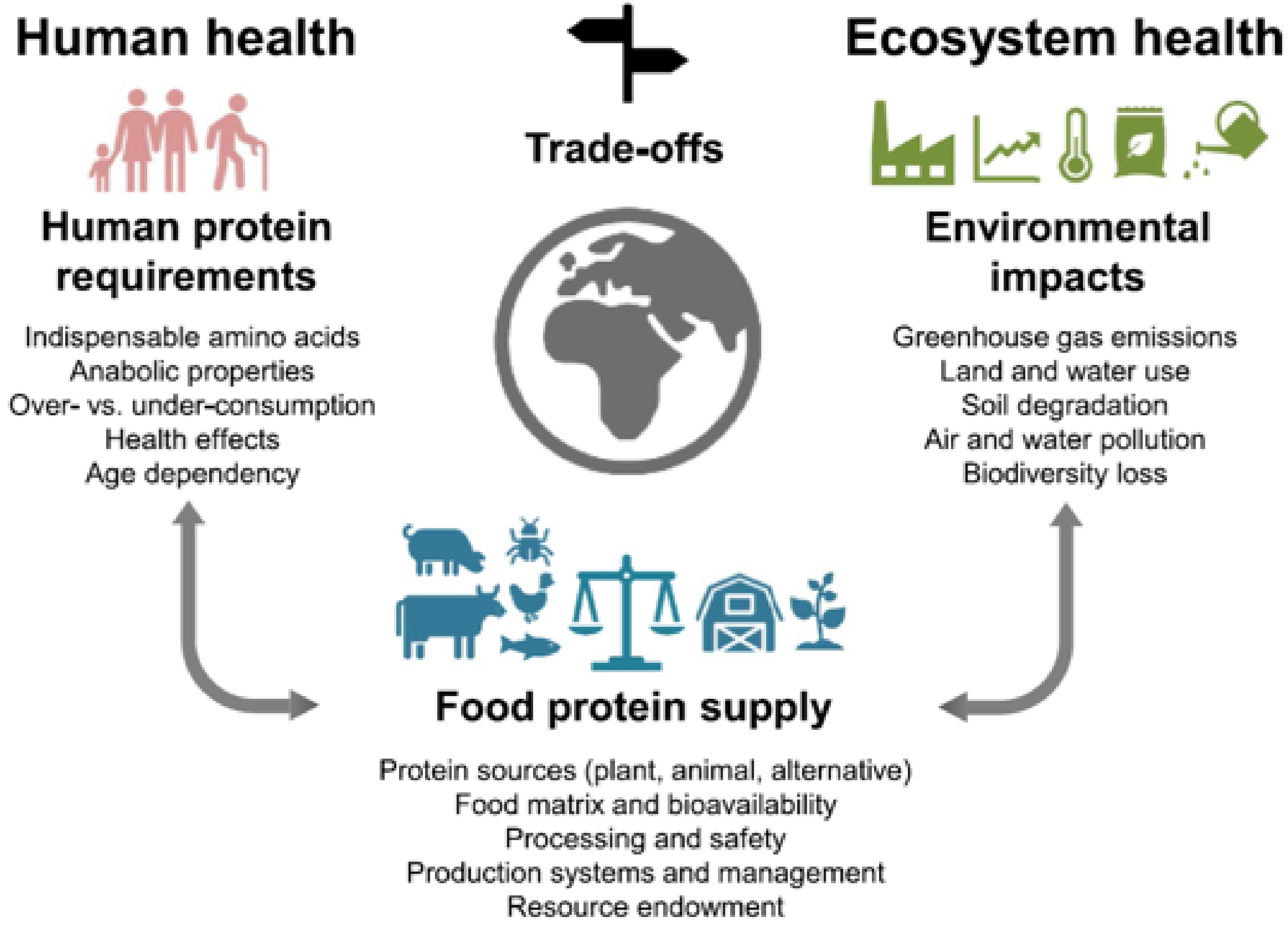

Fig. 1. Sustainable food protein supply at the intersection of human and ecosystem health.

Weindl, I.; Ost; M.; Wiedmer, P.; Schreiner, M.; Neugart, S.; Klopsch, R.; Kühnhold, H.; Kloas, W.; Henkel, I.M. Schlüter, O.; Bußler, S.; Bellingrath-kimura, S.D.; Ma, H.; Grune, T.; Rolinski, S. And Klaus, S. (2020) Sustainable food protein supply reconciling human and ecosystem health: A Leibniz Position. Global Food Security. Volume 25, June 2020, 100367 (https://doi.org/10.1016/j.gfs.2020.100367).

By courtesy of O.Schlüter - ATB

HIGH PRESSURE OF HOMOGENIZATION & CHICKPEA FLOUR: BEHAVIOR OF STARCH AND PROTEIN FRACTIONS

Results: *functional properties*

Sample	WHC [g/g db]	OHC [g/g db]	WAI [g/g db]	WSI [g/100g db]
Control	1.11± 0.02 bc	0.89±0.02 c	5.47±0.07 d	39.95±1.07 b
30 MPa	1.06±0.04 c	1.09±0.06 a	5.59±0.18 cd	43.50±0.38 a
60 MPa	1.11±0.01 bc	1.06±0.06 ab	5.83±0.14 bc	42.70±0.50 a
90 MPa	1.18±0.04 a	0.98±0.02 bc	6.14±0.11 ab	40.07±0.07 b
120 MPa	1.35±0.02 a	0.99±0.01 ab	6.46±0.06 a	39.44±0.15 b

- On flour two main behaviour were observed:
  - Constant increase for WHC and WAI.
  - "Bell shaped" curve for OHC and WSI, with a maximum at 30MPa.

Higher pressures tend to lower peak and final viscosity, with an effect also on **pasting** temperature. **Texture and rheological properties driven process**

Drudi Federico, Gebremical Gebremedhin, Rossi Samantha, Tappi Silvia, Dalla Rosa Marco, Patrignani Francesca, Harasym Joanna, Tylewicz Urszula

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More sustainable Proteic sources

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Potential of *Yarrowia lipolytica* and *Debaryomyces hansenii* strains to produce high quality food ingredients based on cricket powder

Francesca Patrignani[a,b], Luigi Parrotta[c], Stefano Del Duca[b,c], Lucia Vannini[a,b], Lucia Camprini[a], Marco Dalla Rosa[a,b], Oliver Schlüter[d,**], Rosalba Lanciotti[a,b,*]

great potential of all the yeast strains used to produce cricket based food ingredients endowed with improved safety, functionality, sensory and technological properties related to Texture and rheological properties

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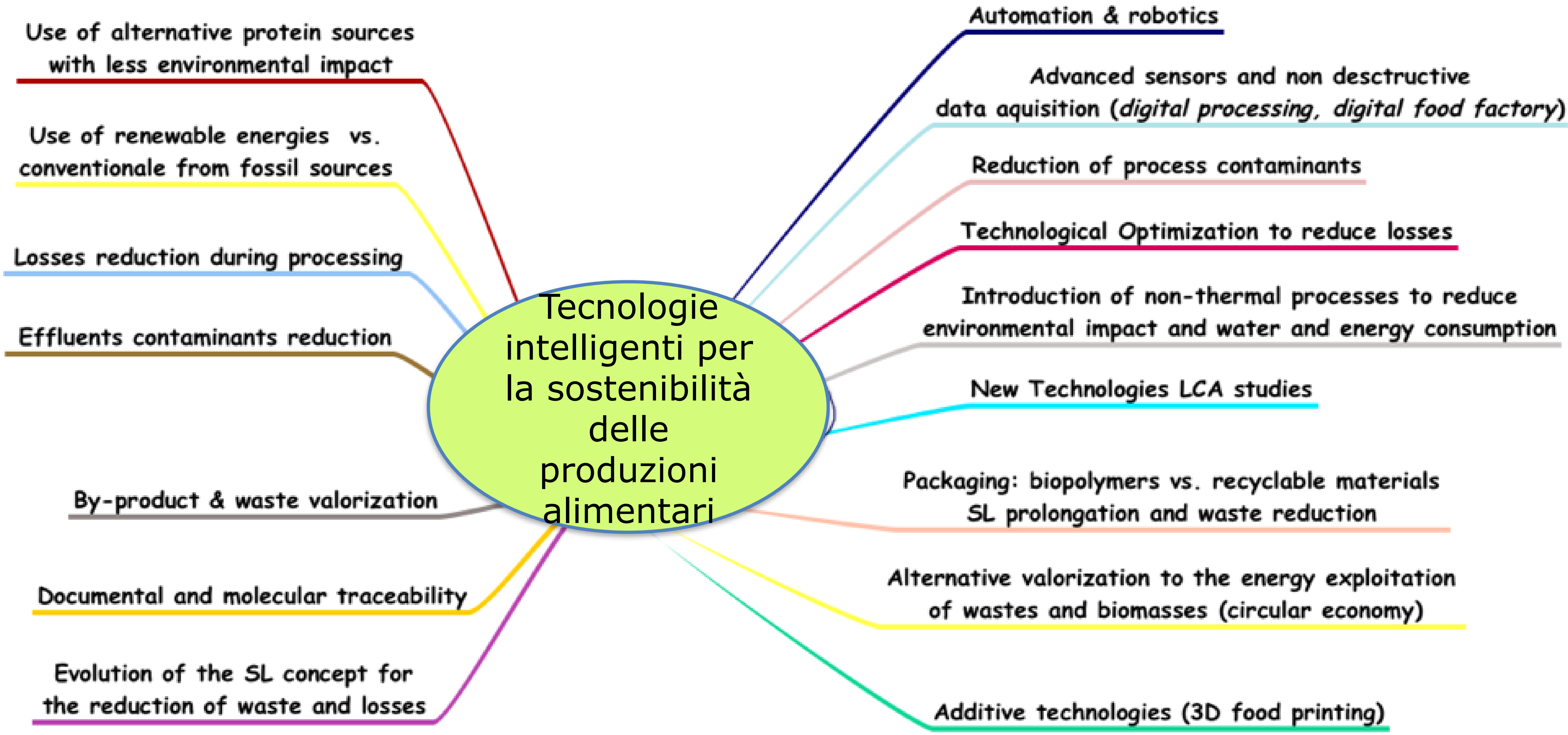
Tecnologie intelligenti per la sostenibilità delle produzioni alimentari
Use of alternative protein sources with less environmental impact
Use of renewable energies vs. conventionale from fossil sources
Losses reduction during processing
Effluents contaminants reduction
By-product & waste valorization
Documental and molecular traceability
Evolution of the SL concept for the reduction of waste and losses
Automation & robotics
Advanced sensors and non desctructive data aquisition (*digital processing, digital food factory*)
Reduction of process contaminants
Technological Optimization to reduce losses
Introduction of non-thermal processes to reduce environmental impact and water and energy consumption
New Technologies LCA studies
Packaging: biopolymers vs. recyclable materials SL prolongation and waste reduction
Alternative valorization to the energy exploitation of wastes and biomasses (circular economy)
Additive technologies (3D food printing)

Tecnologie intelligenti per la sostenibilità delle produzioni alimentari

Grazie per l'attenzione

Marco Dalla Rosa

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