2024

OPENDISTAL

20 SETTEMBRE

Tecnologie innovative per la valorizzazione di prodotti e sottoprodotti della pesca e dell'acquacoltura

Ana Cristina De Aguiar Saldanha Pinheiro, PhD
*A*ssegnista di ricerca CIRI AGROALIMENTARE
Università di Bologna (UNIBO)

Il pesce fresco *è un'ottima fonte di nutrienti*

I prodotti ittici sono altamente deperibili

La conservazione a freddo e la lavorazione è necessaria per..

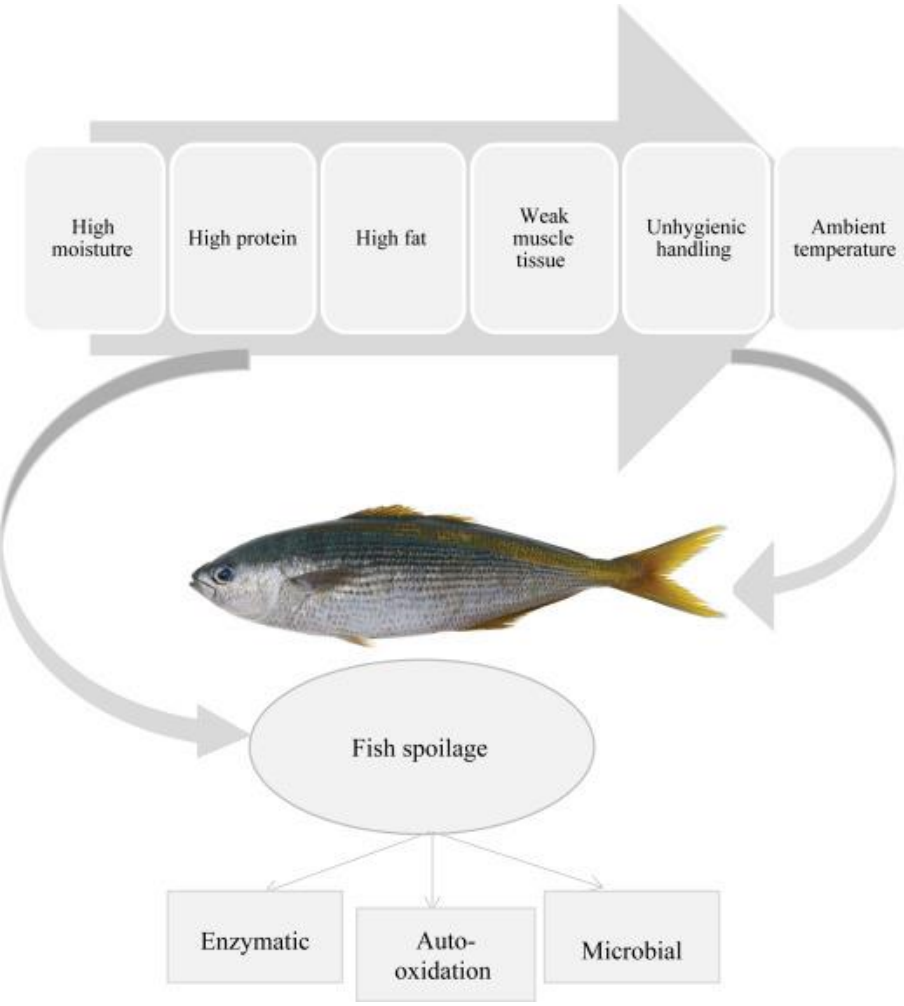
Sicurezza

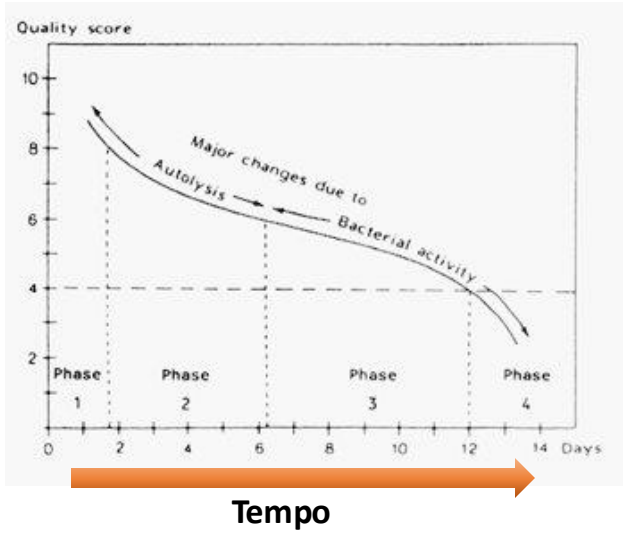
Qualità

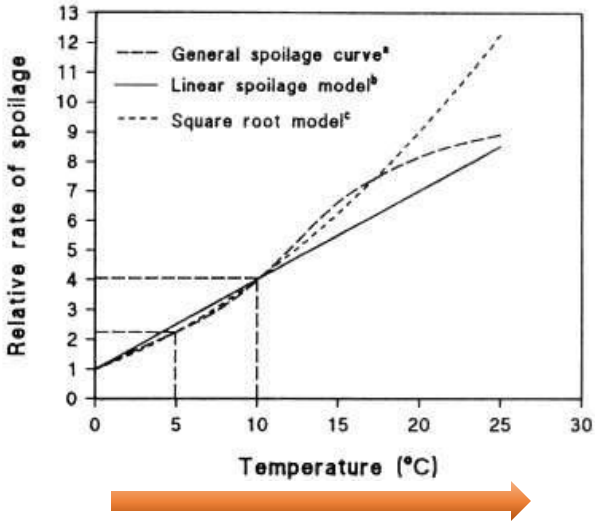
Maggiore Shelf life

Aggiungere valore & creazione di nuovi prodotti

Fattori critici *nella conservazione* ***dei prodotti ittici***







- Enzimi autolitici
- Elevata attività dell'acqua (aw)
- Microbiota
- pH ≈ 6.5 (low acidity)

Perché utilizzare le tecnologie innovative?

New products
consumer expectation

Food safety

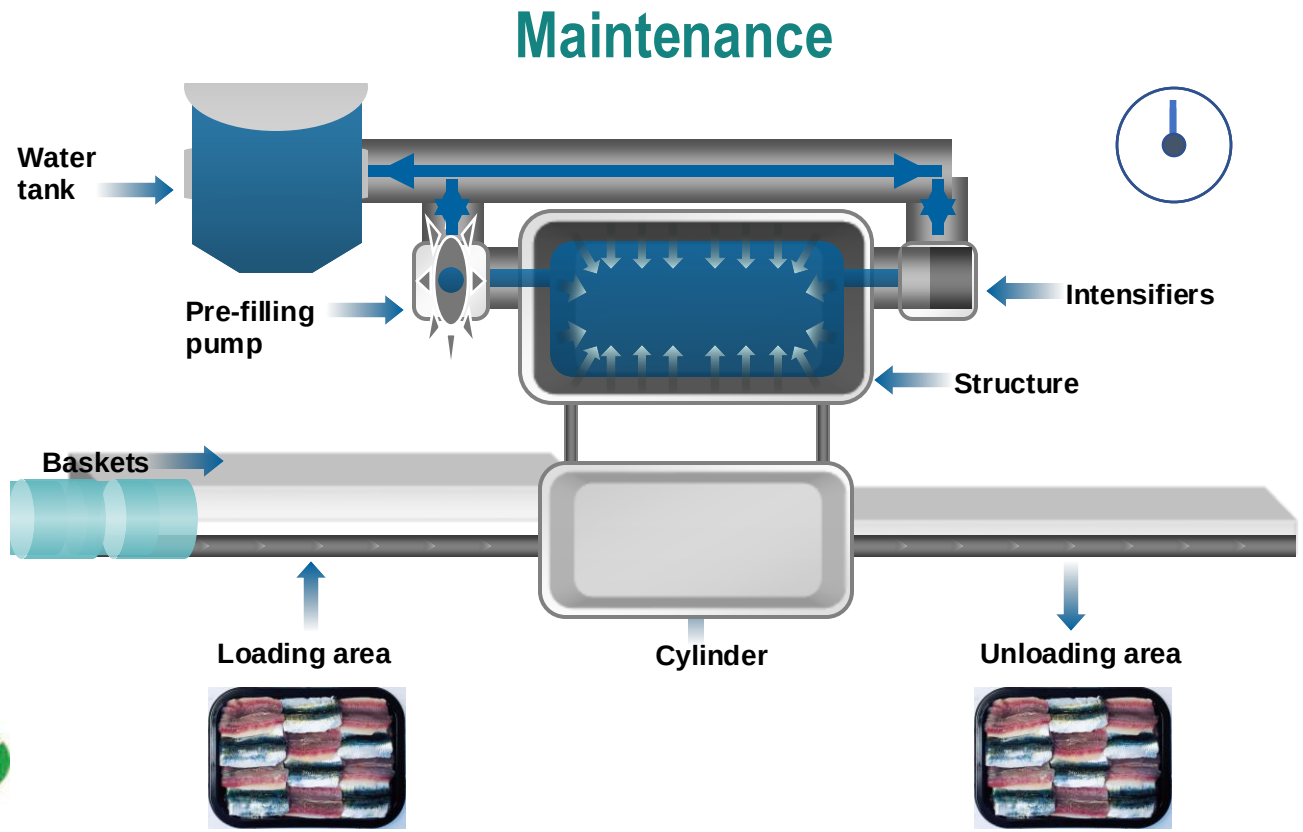
Waste reduction
Reuse/ *Sustainability*

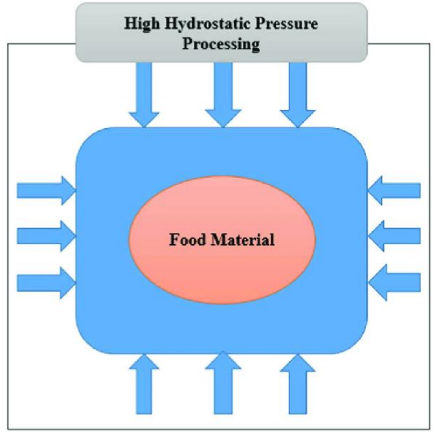
Quality
- health benefits
- sensory attributes

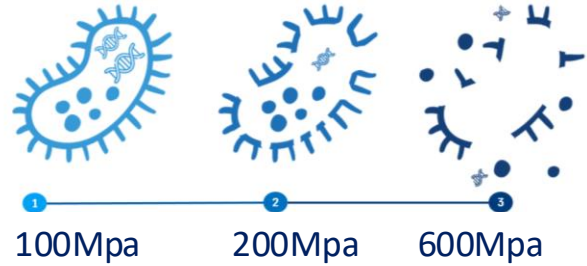
Economic advantage
- cost (energy)
- time
- efficiency

Le tecnologie innovative non termiche *possono contribuire in modo significativo allo sviluppo di prodotti ittici* ***sicuri, salutare e minimamente lavorati***

High-pressure processing (HPP)







HPP induced changes on product quality should be carefully evaluated

High-pressure processing (HPP)

Shrimp sausage

Shrimp sausage + seaweed

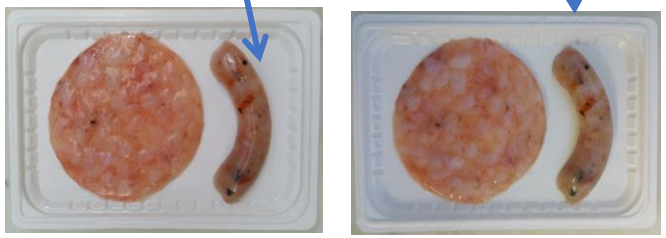
PRE-HPP (SL = 8 d) POST-HPP (SL > 30 d)

No detectable differences!

Prinz Gourmet Italia

Shrimp burger

Shrimp sausage



PRE-HPP (SL = 8 d) POST-HPP (SL > 30 d)

Salmon sausage

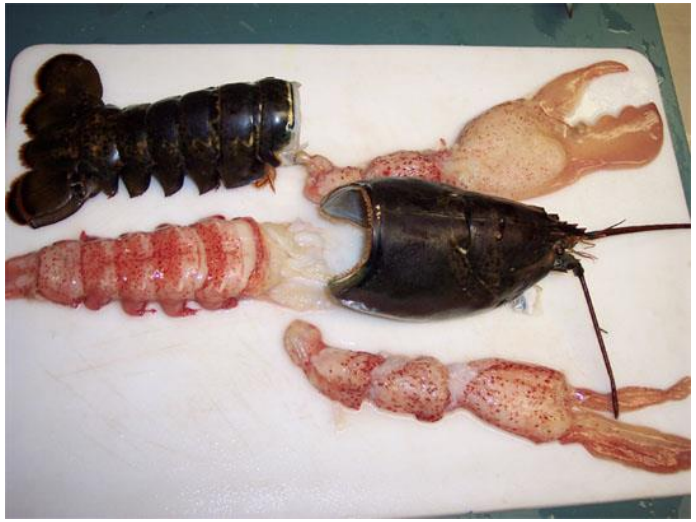
PRE-HPP (SL = 8 d) POST-HPP (SL > 21 d)

Detectable colour modification!

- ✓ Inattivazione di microrganismi
- ✓ Aumento della durata di conservazione del prodotto senza alterarne la composizione

High-pressure processing (HPP)

Separazione della carne e miglioramento della resa



Lobster: Complete flesh separation

THE EASY LOBSTER
...the complete lobster without its jacket!

Easy to get the full lobster-meat in 3 steps…

Put lobster | **step 1** and ready..! For bake, grill, steamed, | **step 2** | **step 3**

- ✓ Separazione della carne dei crostacei
- ✓ Nei molluschi bivalvi usata per la rapida separazione della carne dalle conchiglie (separazione del muscolo adduttore)

Effects of HPP on different seafood products intended for the raw consumption

Material and methods

Mechanically deboned / shell removed manually → Cut manually → Vacuum packaged → HPP 400, 500, 600 MPa → Storage 4°C

Mullet

Striped prawn

Rose shrimp

6 single portions (15-20 g each)

* Analytical determinations

Colour and Texture
pH and moisture content
Peroxide value (PV)
Microbiological analysis

Italian Journal of Food Science, 2023; 35 (3): 99–114

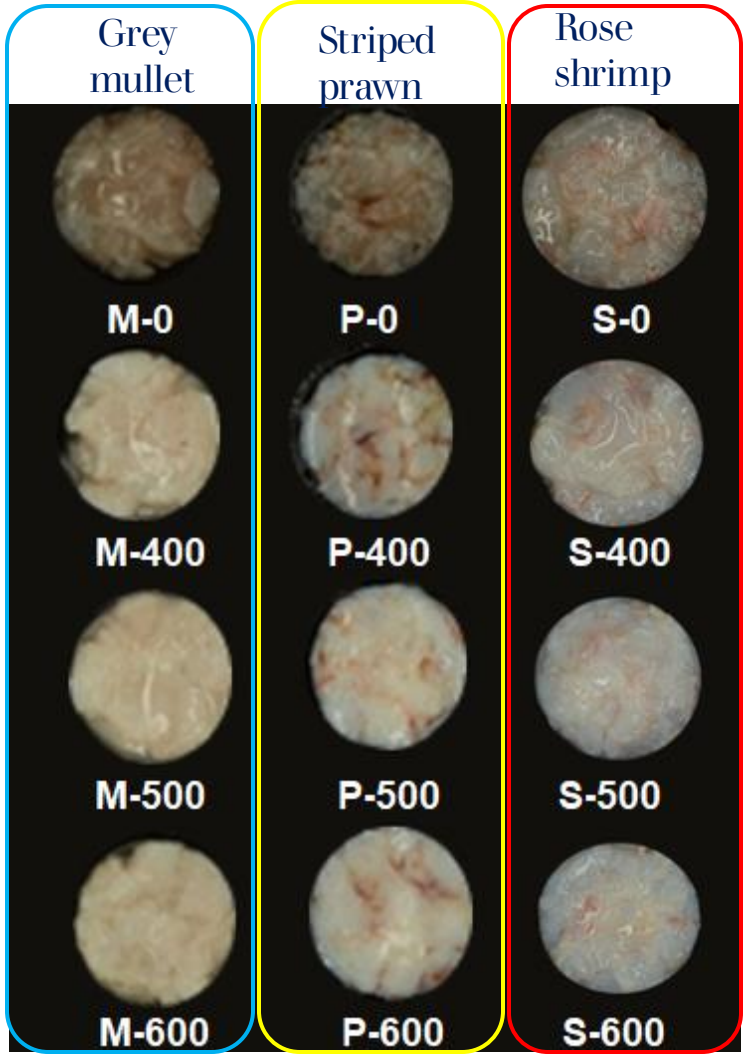
Quality and stability of different seafood products treated with high hydrostatic pressure (HPP) intended for raw consumption

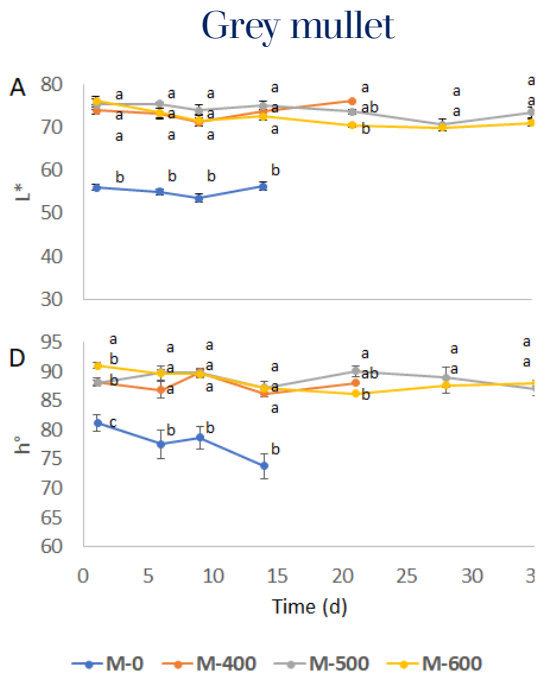
Ana Cristina de Aguiar Saldanha Pinheiro[1], Silvia Tappi[1,2*], Giacomo Braschi[1,2], Jessica Genovese[1], Francesca Patrignani[1,2], Pietro Rocculi[1,2]

[1]Department of Agricultural and Food Science, Alma Mater Studiorum, University of Bologna, Campus of Food Science, Piazza Goidanich 60, Cesena (FC), Italy; [2]Interdepartmental Centre for Agri-Food Industrial Research, Alma Mater Studiorum, University of Bologna, Campus of Food Science, Via Ravennate 933, Cesena (FC), Italy

Effects of HPP on different seafood products intended for the raw consumption

* Color coordinates of lightness (L*) and hue angle (h°)





- ✓ HHP treatments increased the microbiological shelf life of all products tested
- ✓ The inactivation effect became more pronounced with increasing pressure

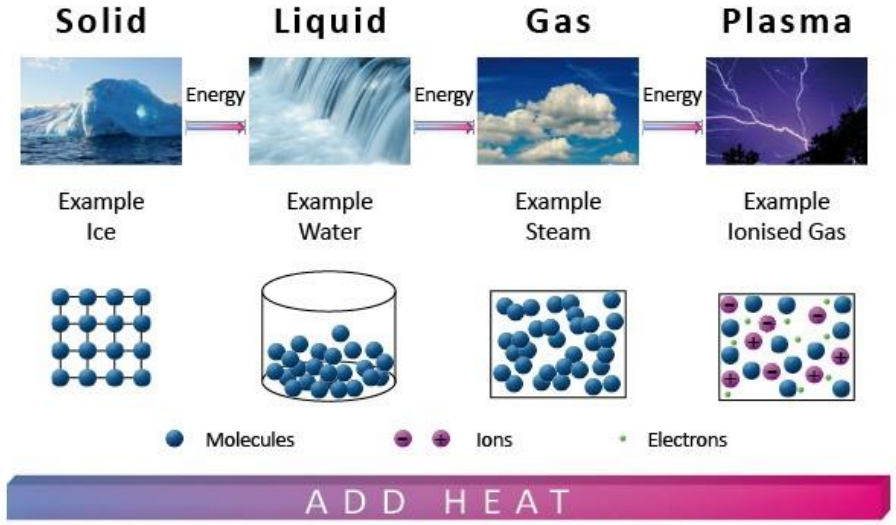
Specie/treatment	Shelf-life (days)			
	Control (untreated)	400 MPa	500 MPa	600 MPa
Grey Mullet (*Mugil cephalus*)	6	12	32	>32
Striped prawn (*Penaus kerathurus*)	6	19	19	>32
Rose shrimp (*Parapenaeus longirostris*)	6	12	19	>28

Atmosphere cold plasma (CP)

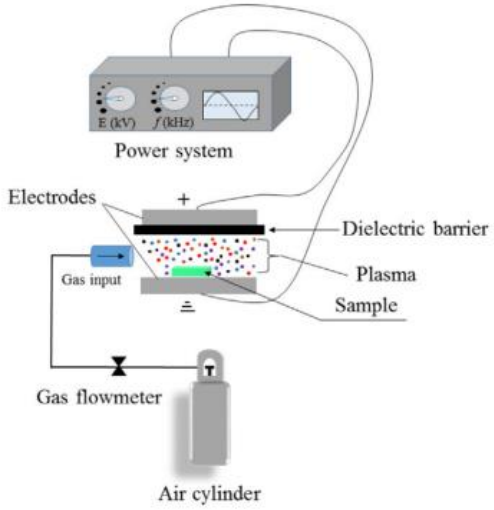
How is plasma obtained?

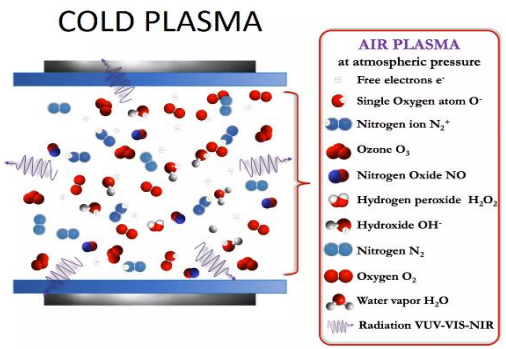
Application of electrical energy to a gas carrier

Transition from the gaseous state to an ionized gas state



Plasma
4th state of matter





Why is it used?

Microbial disinfection

Enzymes inactivation

Pesticide and allergen degradation

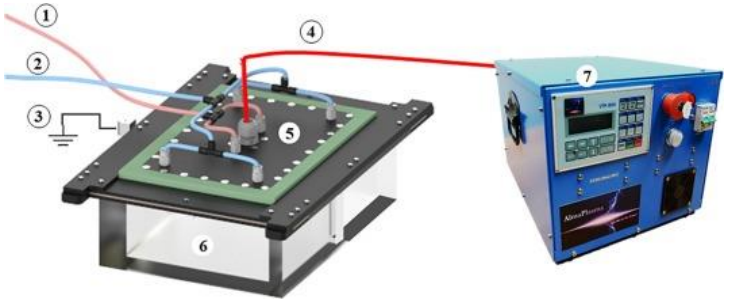
Improving nutritional aspects and packaging modification

Optimization of plasma processing parameters

NewTechAqua
Innovation in seafood processing and quality assessment

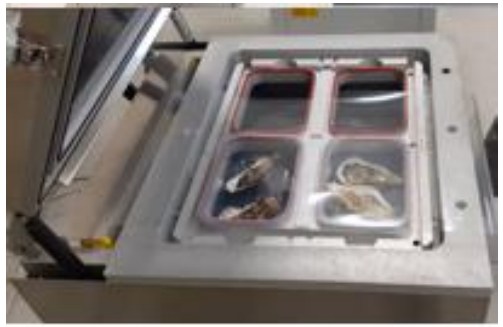
Pacific oyster
(*Crassostrea gigas*)

prototype #1: air & Argon



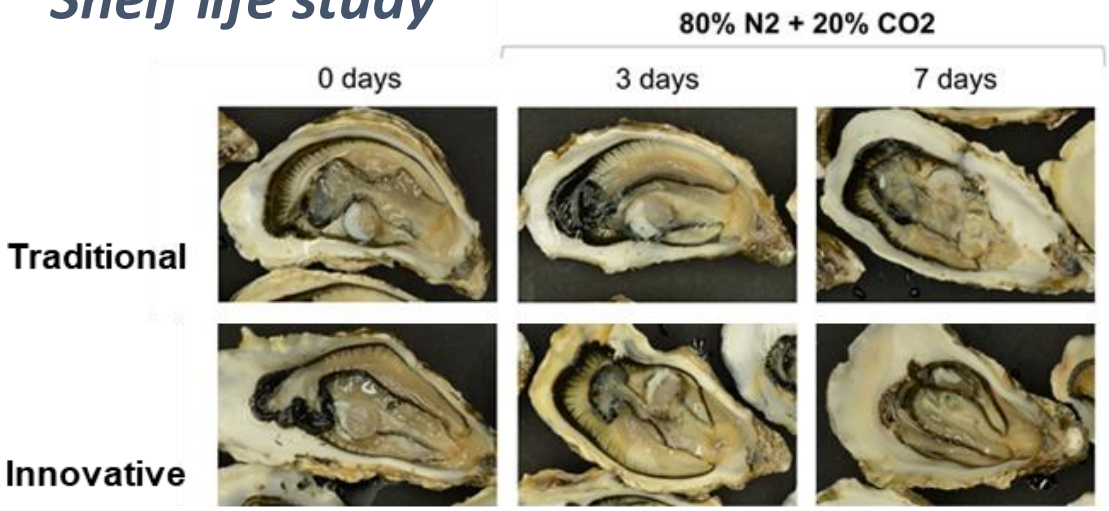
prototype #2: NOx & O_3

MAP Packaging



20% CO2 + 80% N2

Shelf life study



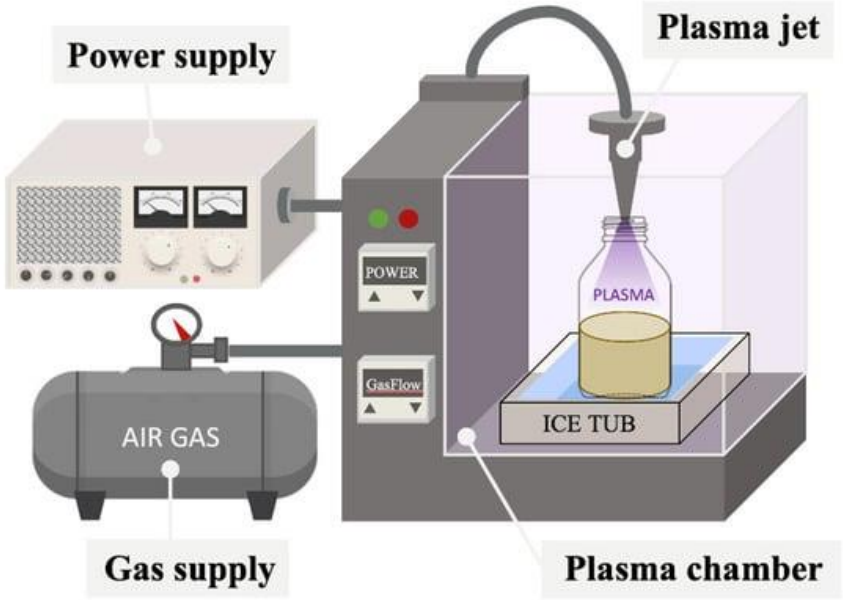
Benefits

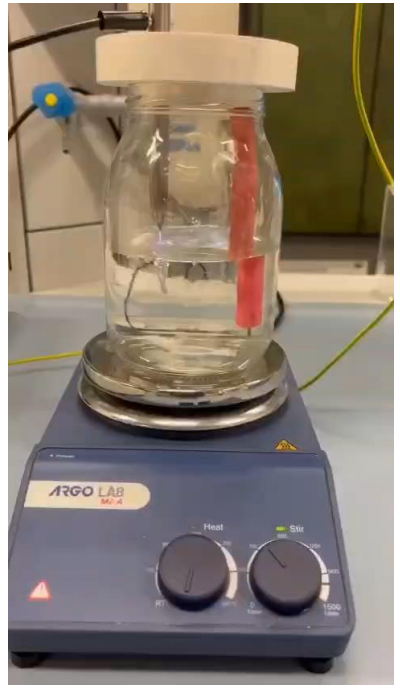
- ✓ Improved the microbial quality and stability of the fresh oysters
- ✓ Reduction of volatile nitrogen values (triethylamine content)

Plasma Activated Water (PAW) and Plasma Activated Ice (PAI)

Plasma atmosferico freddo (CAP)

Acqua attivata dal plasma (PAW)

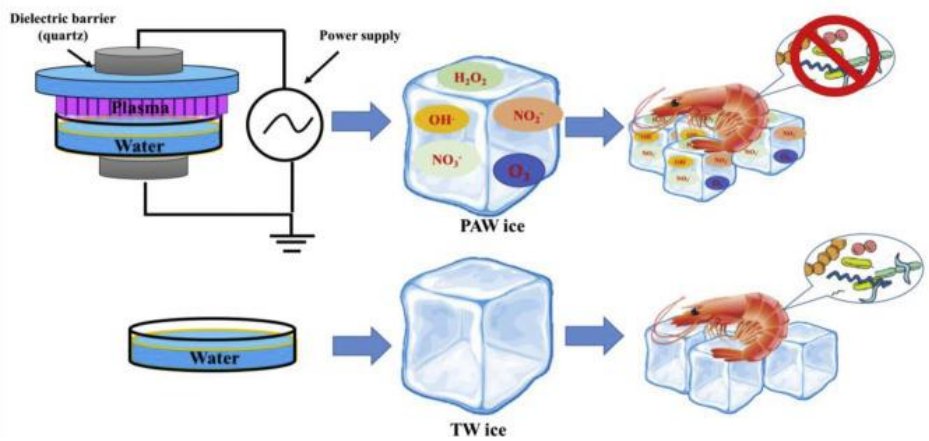




mixture of electrons, neutral molecules and ions charged reactive species

Plasma Activated Ice (PAI)

Ghiaccio attivato con plasma atmosferico freddo come mezzo di raffreddamento con proprietà antimicrobiche



- ✓ ha ritardato significativamente la crescita microbica nei gamberi freschi
- ✓ ha ritardato la progressione della melanosi nei gamberi
- ✓ non ha avuto effetti negativi sulla qualità dei gamberi

Table 4 (*continued*)

Food source	Quality changes	Reference
Yellow river carp fillets	PAW treatment increased the L^* value and decreased a^* value, and no significant changes were observed in b^* value, texture attributes, and sensory properties in PAW-treated samples.	Liu et al. (2021)
Mackerel fillets	No significant differences were observed on a^*, b^*, L^*, and peroxide value in samples after PAW and PAW-ultrasound treatment. TBARS values of 0.1 mg of MDA/kg lipid was observed on PAW-ultrasound treated samples and the control.	Zhao et al., 2021a
Grass carp	PAW-treated samples showed a significant increase in lipid oxidation, total volatile basic-nitrogen, fatty acid, and protein degradation, but the values were well within the acceptable limit. The PAW-ultrasound treatment was more effective for maintaining hardness, while the color was significantly affected and whiteness increased.	Esua et al. (2021)
Shrimp	PAW-treated samples could remain pH below 7.7 during storage, and the changes in color, firmness, and lipid oxidation were delayed. The TVB-N value of PAW-treated samples was significantly lower than other treatments and did not result in adverse effects on proteins.	Liao et al. (2018)

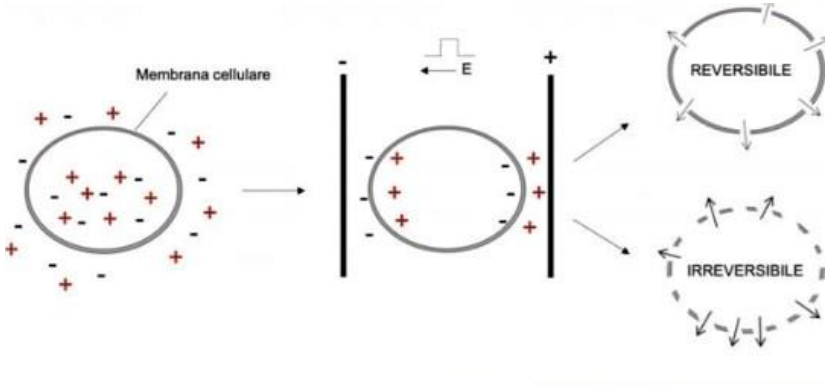
- ✓ riduzione di 1.03 log10 CFU/g dopo 6 minuti di trattamento
- ✓ aumento della ossidazion lipidica

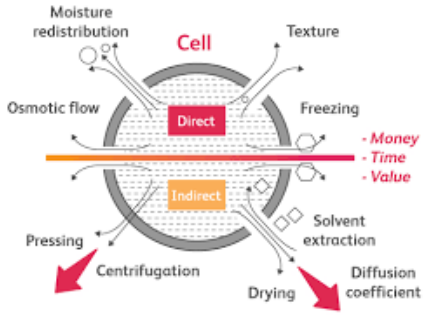
Han *et al.*, 2023

Pulsed Electric Fields (PEF)

PEF *What is this?*

Application of short high voltage electric pulses to the biological material that causes a phenomenon known as **“electroporation”** related to the formation of pores in the cell membrane- ***Improving the mass transfer process***





Benefits PEF in Fish Processing

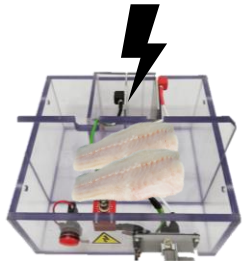
Faster drying, brining, and marinating
Enhanced brine and marinade absorption in fish tissue
Improved water binding through protein, salt, and phosphate interaction
Increased extraction of specific components from seafood by-products (e.g.pigments and proteins)

Optimal PEF pre-treatment for the sea bass salting process

NewTechAqua
Innovation in seafood processing and quality assessment

Modular laboratory scale equipment (UNIBO)

Electric field strength
E =0.3, 0.9, 1.5kV/cm



treatment chamber

10% NaCl solution
sample/brine ratio 1:10 (w/w)

Stored at 5°C

Time (h) necessary to reach the 80% of the process (end point)

Sample	Newton	Weibull	Fick
Control	101	109	114
0.3kV/cm	**89**	**101**	**101**
0.9kV/cm	101	106	111
1.5kV/cm	101	105	111

Benefits

- ✓ An improvement of the mass transfer process was obtained applying the lower voltage 0.3kV / cm
- ✓ Increase mass transfer rate (12%)
- ✓ Reduction of 12 hours in the time needed to reach the end of the marinating process (80% end point)

Strategie per la valorizzazione dei sottoprodotti dell'industria ittica

Metodologie innovative per la lavorazione e conservazione del prodotto ittico

Formulazione di nuovi prodotti derivati dei sottoprodotti

Formulazione di nuovi prodotti derivati dei sottoprodotti

- .

Tecnologie non termiche innovative

- ✓ **Estrazione con fluido supercritico (SFE)**
- ✓ **Trattamento ad Alta Pressione (HPP)**
- ✓ **Estrazione assistita da campi elettrici pulsati (PEF)**
- ✓ **Estrazione assistita da ultrasuoni (UAE)**

Vantaggi

- ✓ ridurre i tempi di processo
- ✓ ridurre il consumo di energia
- ✓ ridurre il consumo di sostanze chimiche
- ✓ aumentare le rese di recupero
- ✓ migliorare la qualità del prodotto finale
- ✓ migliorare la funzionalità degli estratti

Open Access Review

Innovative Non-Thermal Technologies for Recovery and Valorization of Value-Added Products from Crustacean Processing By-Products—An Opportunity for a Circular Economy Approach

by Ana Cristina De Aguiar Saldanha Pinheiro [1], Francisco J. Martí-Quijal [2], Francisco J. Barba [2,*], Silvia Tappi [1,3] and Pietro Rocculi [1,3]

[1] Department of Agricultural and Food Science, Campus of Food Science, Alma Mater Studiorum, University of Bologna, Piazza Goidanich, 60, 47522 Cesena, FC, Italy
[2] Department of Preventive Medicine and Public Health, Food Science, Toxicology and Forensic Medicine, Faculty of Pharmacy, Universitat de València, Avda. Vicent Andrés Estellés, s/n, 46100 Burjassot, València, Spain
[3] Interdepartmental Centre for Agri-Food Industrial Research, Alma Mater Studiorum, University of Bologna, Via Quinto Bucci, 336, 47521 Cesena, FC, Italy
* Author to whom correspondence should be addressed.

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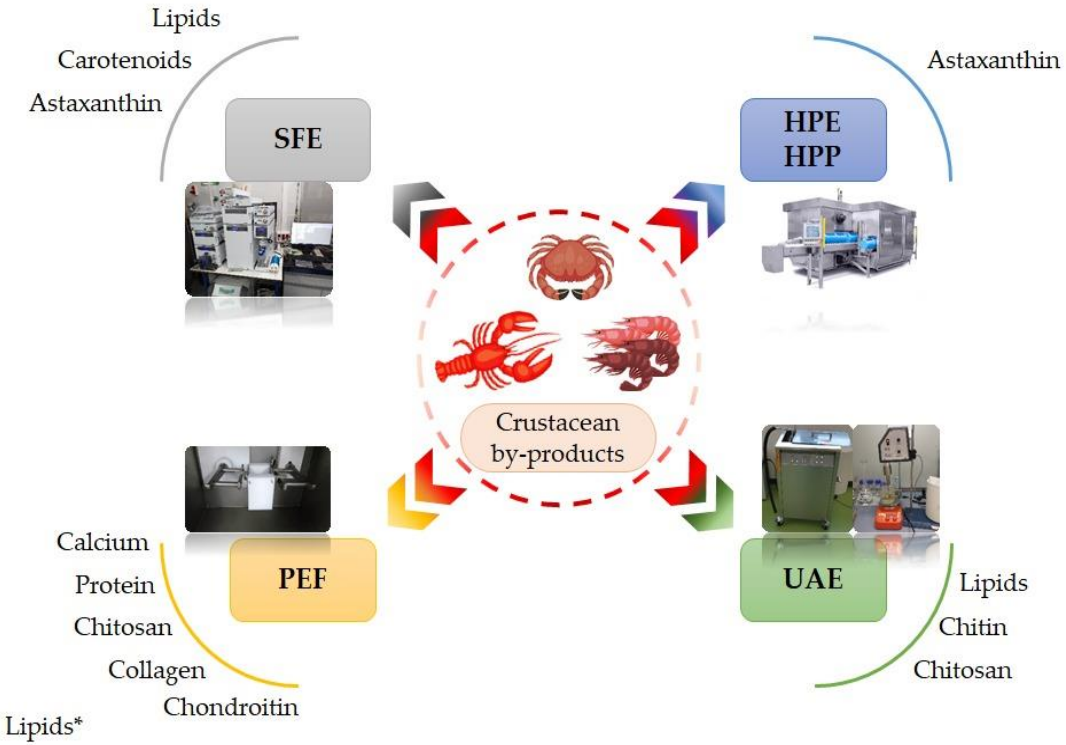
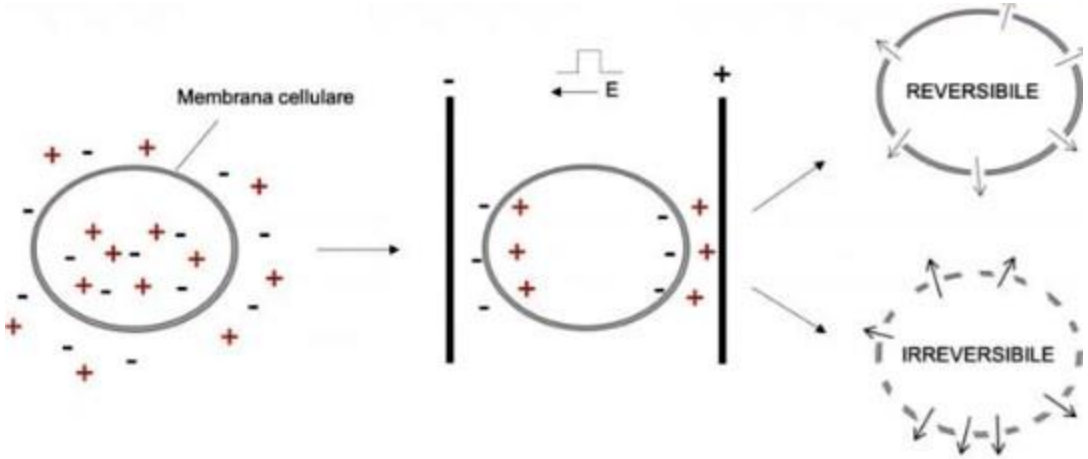
Foods **2021**, *10*(9), 2030; https://doi.org/10.3390/foods10092030

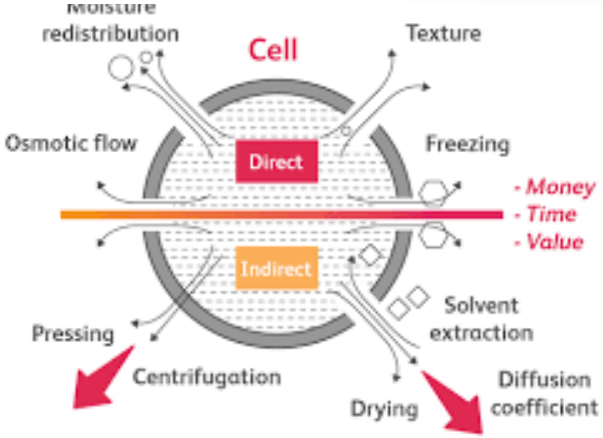


Definire la tecnologia di estrazione appropriata per ogni composto target

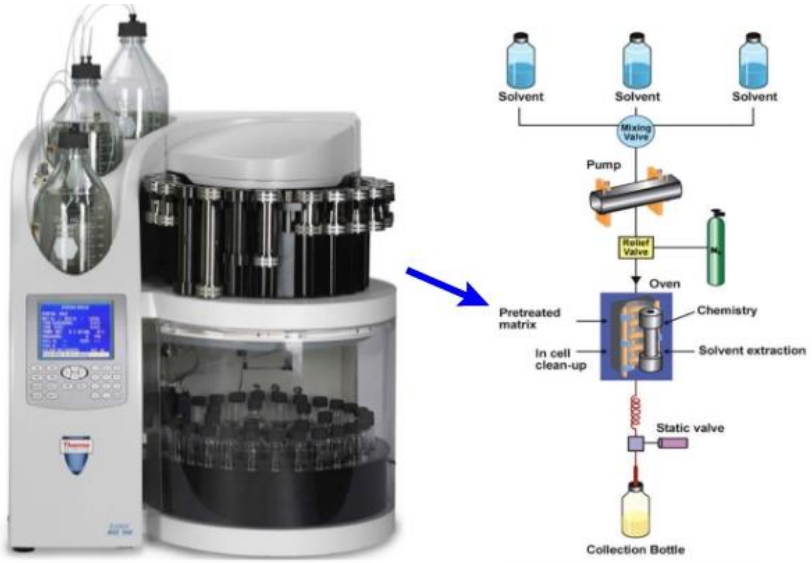
Innovative non-thermal technologies for crustacean by-products valorization

Pulsed electric field (PEF)





Accelerate solvent extraction (ASE)



antioxidants

MDPI

Article

Pulsed Electric Fields (PEF) and Accelerated Solvent Extraction (ASE) for Valorization of Red (*Aristeus antennatus*) and Camarote (*Melicertus kerathurus*) Shrimp Side Streams: Antioxidant and HPLC Evaluation of the Carotenoid Astaxanthin Recovery

Ana Cristina De Aguiar Saldanha Pinheiro [1], Francisco J. Martí-Quijal [2], Francisco J. Barba [2,*], Ana M. Benítez-González [3], Antonio J. Meléndez-Martínez [3,*], Juan Manuel Castagnini [2], Silvia Tappi [1,4] and Pietro Rocculi [1,4]

Process description

2 shrimp species

Camarote (Melicertus kerathurus)

Red (Aristeus antennatus)

Fresh shrimp by-products (head and shells)

2 Organic Solvents

Dimethylsulfoxide (DMSO)

Ethanol (EtOH)

PEF pre-treatment

Freeze-dried for 72h

Freeze-dried for 72h

I

II

III

IV

ASE

Conventional extraction

PEF + ASE

PEF + Solvent

Astaxanthin recovery

Analytical determinations

chitosan recovery

chitosan recovery

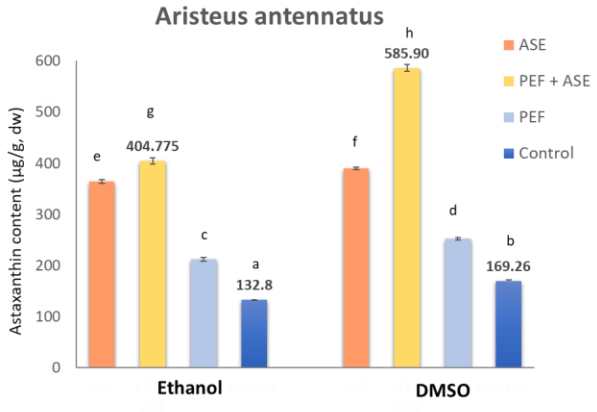
Valorizzazione tramite l'estrazione di composti

Tecnologie innovative non termiche per la valorizzazione dei sottoprodotti di gamberi

Estrazione del pigmento Astaxantina

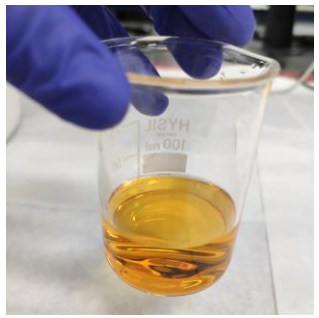
Campi eletrici pulsati (PEF)
Estrazione accelerata con solvent (ASE)

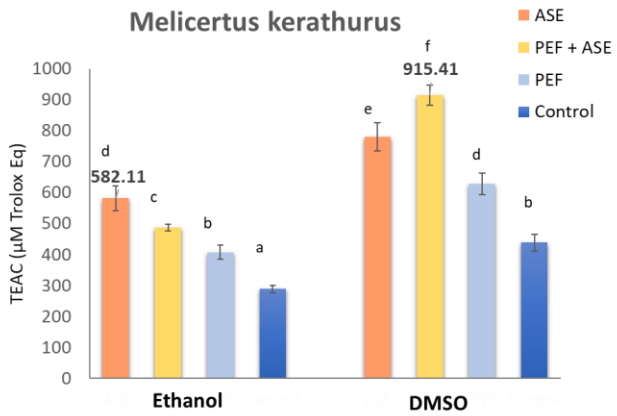
Aristeus antennatus



Estratti con un contenuto molto elevato di astaxantina

Melicertus kerathurus





Estratti con elevata attività antiossidante

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Esempi di valorizzazione

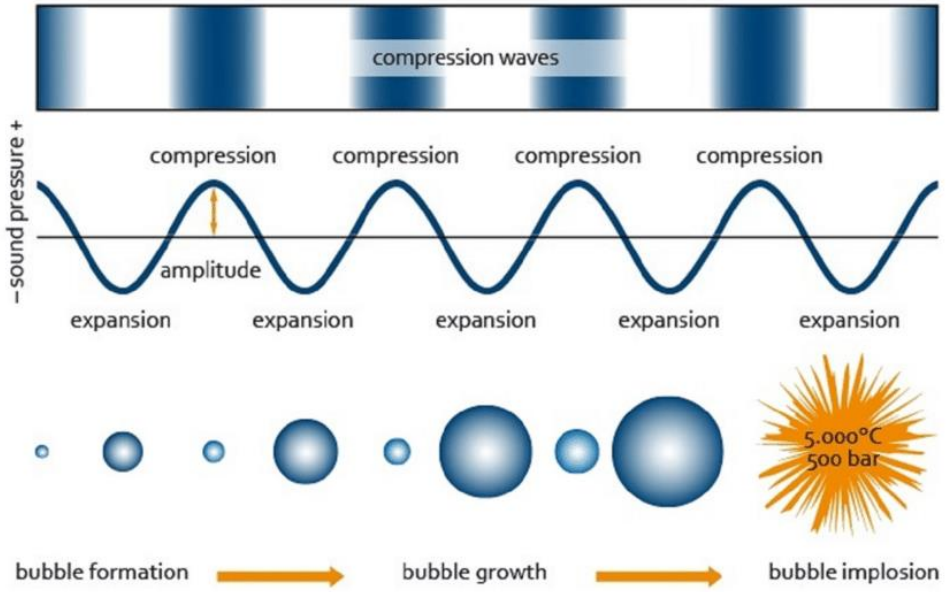
Chitosano
ingredienti
funzionale

canocchia

Polpa

Polpa
commerciale

Processo di estrazione assistita da ultrasuoni (UAE) e il fenomeno della cavitazione



Carapace

Demineralization

Deproteinization ⇐ US ⇒

Chitin

Deacetylation ⇐ US ⇒

Chitosan ⇐ US ⇒

AIM:

- Reducing solvent and extraction time
- Increase efficiency of further deacetylation

- Increase efficiency of deacetylation

- Decrease MW

Valorizzazione tramite l'estrazione di ingredienti funzionale

Ottimizzazione del processo di estrazione di Chitina e Chitosano da sottoprodotti derivati dalla lavorazione della canocchia (Squilla mantis)

Valutazione del uso degli Ultrasuoni sia per la deacetilazione della chitina sia per la modulazione del peso molecolare del chitosano per migliorare le proprietà bioattive

Trattamento a Ultrasuoni
400 W, 24 Hz, pulsed irradiation

Table1. The intrinsic viscosity, average molecular weight and yield of chitosans produced by *S. mantis*

Sample	[η] (dL/mg)	Mv (KDa)	Yield(%)*
CH	5.08	64.24	-
CH70°C	4.21	49.54	87.4
CH US 70°C	1.66	13.67	86.4

* amount of chitosan recovered in relation to the weight of the chitin previously deacetylation.

Peso molecolare inferiore e maggiore attività antiossidante

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UNIVERSITÀ DI BOLOGNA
CENTRO INTERDIPARTIMENTALE
DI RICERCA INDUSTRIALE AGROALIMENTARE

ECONOMIA DEL MARE

Interreg
Italy - Croatia
PRIZEFISH

EUROPEAN UNION

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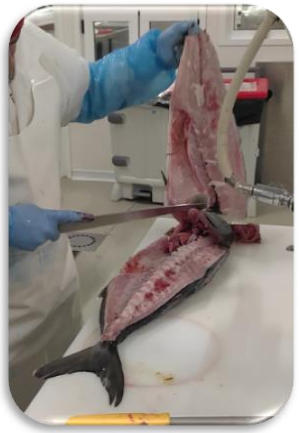
Amberjack fish flesh obtained through mechanical separation

ECOPESCE
Fish processing company



Fileting

Trimmings

Belt-drum separator

Amberjack meat

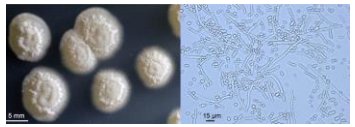
Frozen
at -40°C

Laboratory of food technology (UNIBO)

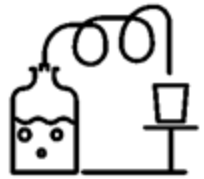
Fish protein hydrolysate development

Selected base on functional and flavour properties

Mullet by-products



Yarrowia lipolytica (YL2)



Fermentation process

FPH
(Freezer dried)

Food Microbiology Laboratory

Innovative amberjack fish-balls

NewTechAqua
Innovation in seafood processing and quality assessment

*Preparation and packaging in **MAP (80% N_2 and 20% CO_2)***

Storage 4°C

Addition of fish protein hydrolysed to the fish ball formulation

- ✓ improved microbiological stability from 8 to 12 days
- ✓ delayed the accumulation of histamine during the shelf-life
- ✓ fish balls showed lower water activity than the conventional fish balls;

Benefits

- ✓ *Creation of healthy and **innovative ready-to cook** fish product on the market*
- ✓ *Reduction of waste and by-products*
- ✓ *Contributes to the sustainability of fish processor*

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Strategies for the valorization of fish by-products: Fish balls formulated with mechanically separated amberjack flesh and mullet hydrolysate

Ana Cristina De Aguiar Saldanha Pinheiro[a], Maria Alessia Schouten[b], Silvia Tappi[a,b,*], Davide Gottardi[a,b], Federica Barbieri[a], Marianna Ciccone[a], Solidea Amadei[a], Urszula Tylewicz[a,b], Francesca Patrignani[a,b], Pietro Rocculi[a,b]

[a] Interdepartmental Centre for Industrial Agri-Food Research (CIRI), University of Bologna, Via Quinto Bucci 336, 47521, Cesena, Italy
[b] Department of Agricultural and Food Sciences (DISTAL), University of Bologna, Piazza Goidanich 60, 47521, Cesena, Italy




Thanks for your attention !

anacristin.deaguiar2@unibo.it

https://www.unibo.it/sitoweb/anacristin.deaguiar2