



*ue fiscodi*



# **Sustainable *A*lternative *F*ood Resources for Future Food by Widening *I*nnovation into New Composites with Improved Health-Promoting *P*roperties (**SAFIR**)**

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Third COST CA22134 FoodWaStop meeting , 5-6 February Zadar, Croatia

## About the project



**Project title:** *Sustainable Alternative Food resources for future food by widening Innovation into new composites with improved health-promoting pRoperties*

(acronym SAFIR)

**Program:** National Research, Development and Innovation Plan for the period 2022 - 2027 (PNCDI IV), Program 5.1. Ideas, Exploratory research projects.

**Project code:** PN-IV-P1-PCE-2023-0129, 9PCE/2025

**Funded by:** The Executive Unit for Financing Higher Education, Research, Development and Innovation (UEFISCDI)

**Implemented by:** "Dunarea de Jos" University of Galati

**Period:** 2025-2027

**Project manager:** Professor Nicoleta STĂNCIUC, PhD

**Budget:** 1 200 000 lei (240 000 euros)

# Current status in Romania



In order to align to the 2030 Agenda for Sustainable Development, as well as the European Union's Sustainable Development Strategy

Department for Sustainable Development by Government Decision 313/2017

<https://dezvoltaredurabila.gov.ro/>

National Strategy for Sustainable Development of Romania 2030

**For example, grape pomace (Order 1562/2014)**

Feed, composting, oil, export, incineration, delivery to an authorized landfill, others.

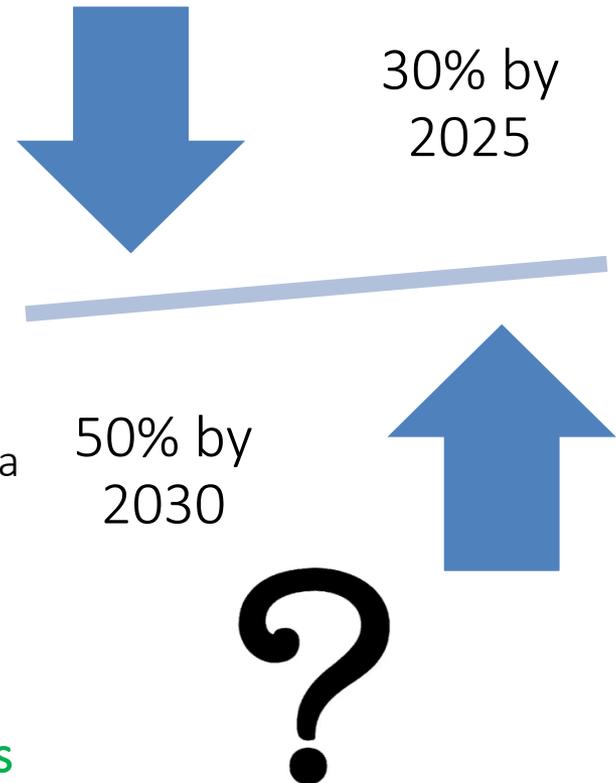
huge gaps between academia and economical practices



**Innovation**

**Increasing the sustainable use of waste and by-products**

**Technological transfer**





- ❑ 1.5 BILLION TONNES OF FRUITS AND VEGETABLES PRODUCED ANNUALLY
- ❑ 0.5 BILLION TONNES ARE EITHER WASTED OR TREATED AS BY-PRODUCTS (PEELS, SEEDS, SHELLS, PODS, POMACE)
- ❑ EFFICIENT FOOD SYSTEMS FOR THE SUSTAINABLE USE AS RESOURCES
- ❑ WASTE TO WEALTH - BY-PRODUCTS VALORIZATION INTO MULTIFUNCTIONAL INGREDIENTS, THROUGH FLEXIBLE AND INTERCONNECTED BIOPROCESSES.
- ❑ TAILORED RECOVERY PROCEDURES



**NATURAL ANTIOXIDANTS, ANTIMICROBIAL AGENTS, VITAMINS, CELLULOSE, STARCH, LIPIDS, PROTEINS, PIGMENTS**



# FOCUS ON FOOD BY-PRODUCTS

GRAPE POMACE

APPLE POMACE

WHEY

BREWERS' SPENT GRAIN

Developing horizontal or 'cross-cutting' actions, which are common across various stages of the food value chain and are needed to achieve the global food loss and waste targets (SDG Target 12.3).

EXTRACTION

ENCAPSULATION

DRYING

FERMENTATION

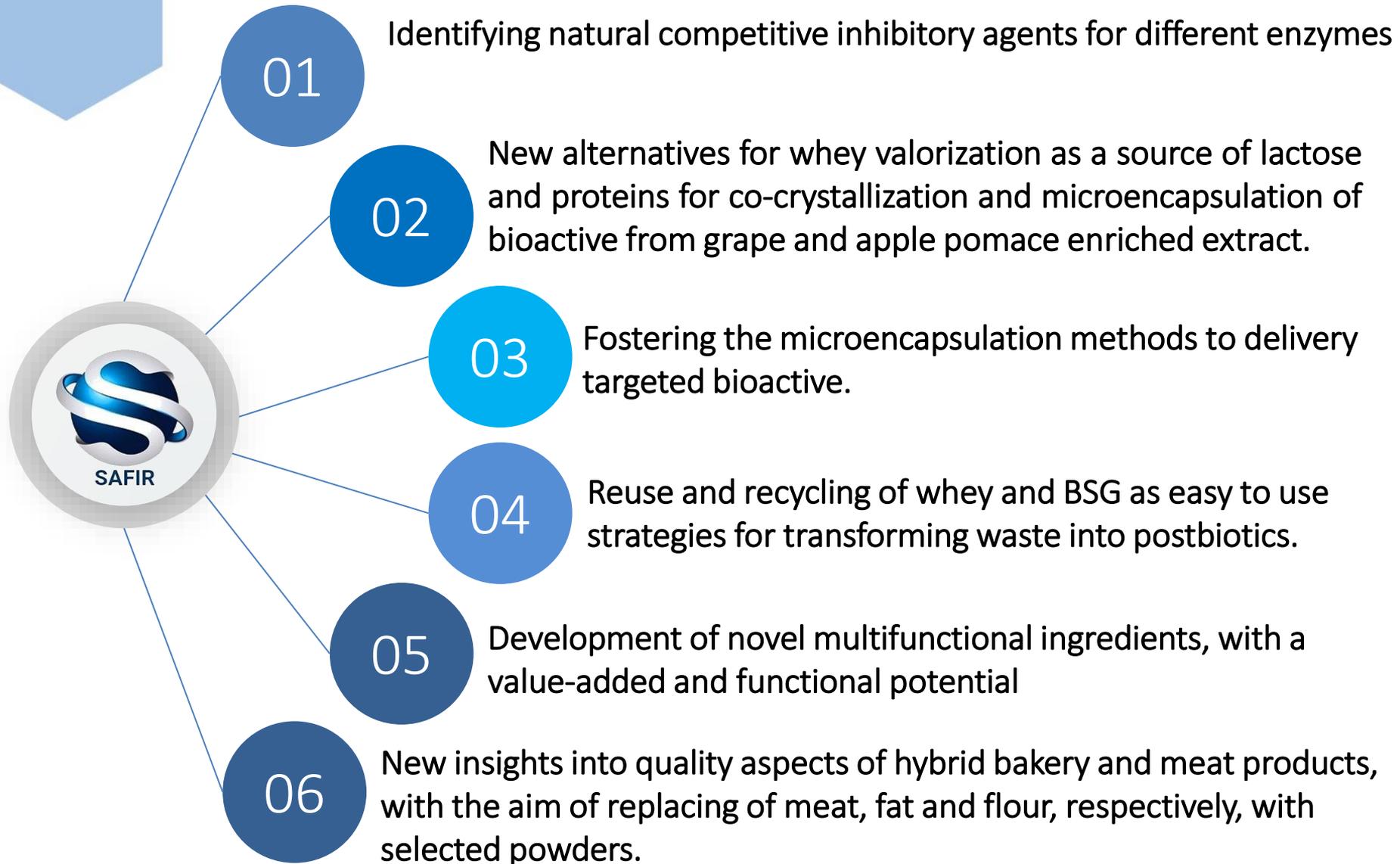
EXTRACTS

TARGETED DELIVERY

POWDERS

HYBRID FOOD

## AT SCIENTIFIC LEVEL:



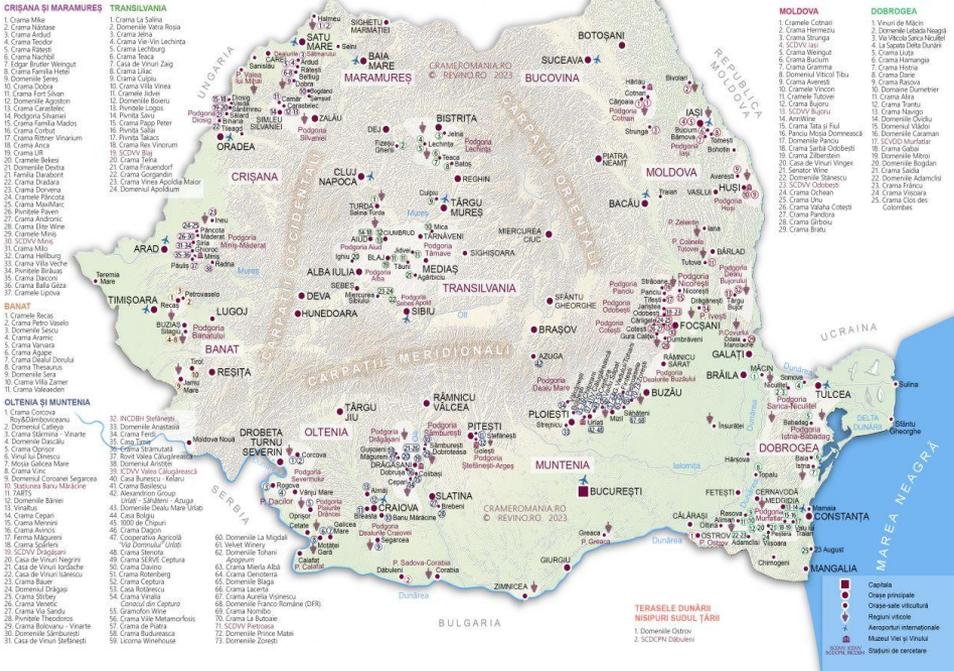
# Recycling food by-products - WINERY



In 2021, there were **611 companies** in Romania whose object of activity was wine production and/or grape cultivation.

## Wineries in Romania

ROMÂNIA  
HARTA VITICOLĂ



**CRAMELE RECAȘ SA**  
•cotă de piață de 12%

**JIDVEI SRL**  
•cotă de piață de 8,7%

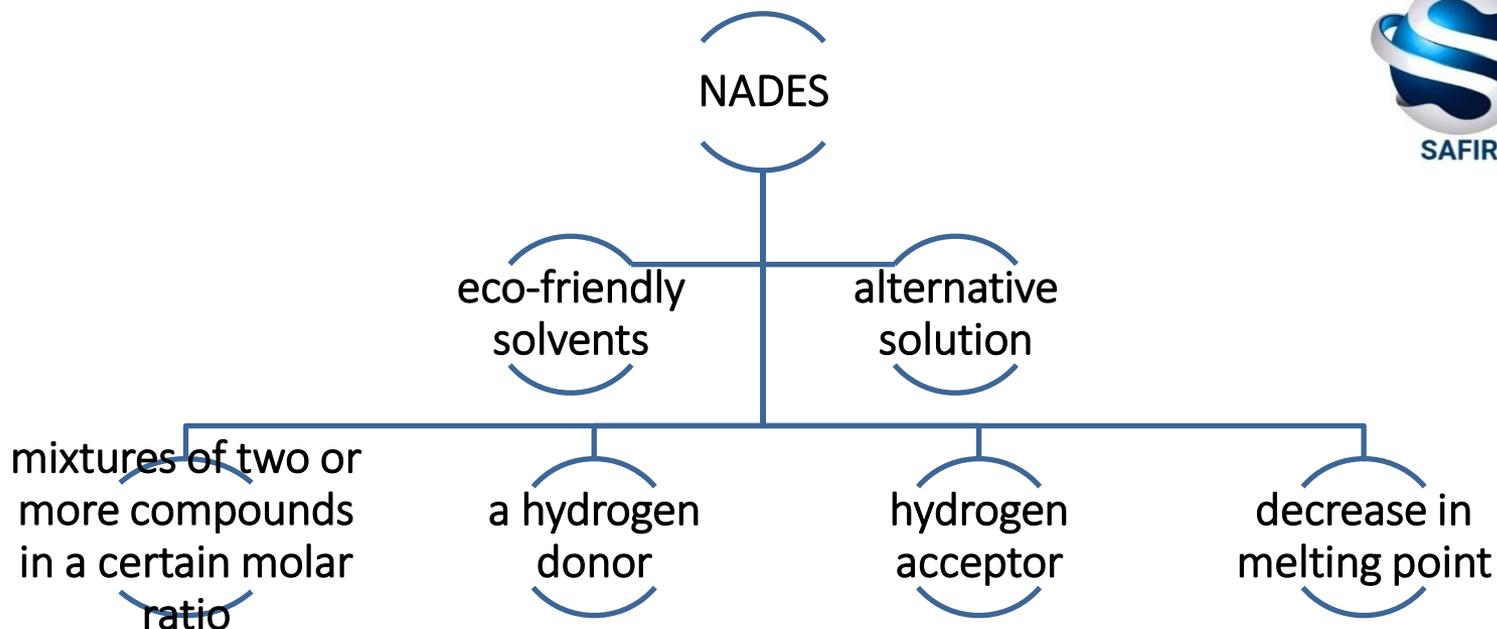
**COTNARI SA**  
•cotă de piață de 7,9%

**ZAREA SA**  
•cotă de piață de 7%

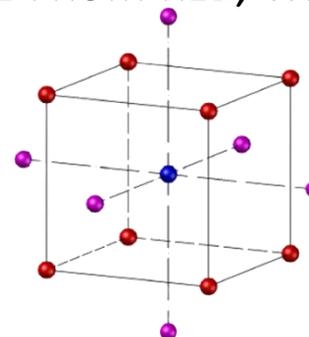
**CRAMA CEPTURA SRL**  
•cotă de piață de 6,9%

The yield of grape production  
**4,879.7 kg/ha.**  
pomace 10 and 30% w/w of the  
initial raw material

# Work package 1: TESTING NEW ALTERNATIVES FOR PHYTOCHEMICALS EXTRACTION



OPTIMIZATION AND VALIDATION OF UAE OF BIOACTIVE FROM RED, WHITE AND APPLE POMACE



*Response Surface Method and Central Composite Design*

ENRICHED EXTRACTS, ESPECIALLY IN PHENOLIC ACIDS

# Red grape pomace as a valuable source of biomolecules with inhibitory effect on pro-inflammatory and metabolic syndrome-associated enzymes



NADES extract

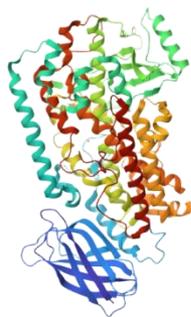
32 polyphenolic compounds

575.58 mg/kg

73% phenolic acids

236.36±2.33 mg/kg vanillic acid

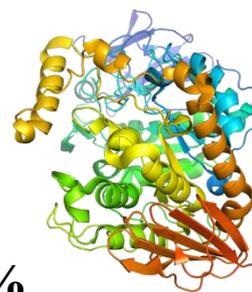
Inhibitory effect



82%

lipoxygenase

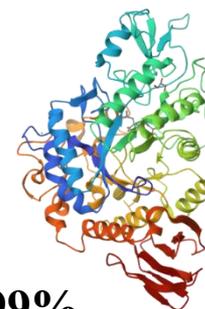
IC<sub>50</sub> 0.06±0.01 mg GAE/mL  
quercetin 5.17±0.07 µg/mL



99%

α-amylase

IC<sub>50</sub> 1.12±0.12 mg GAE/mL  
acarbose 0.14±0.01 mg/mL



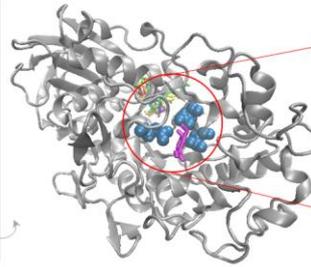
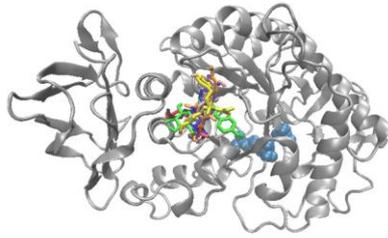
99%

α-glucosidase

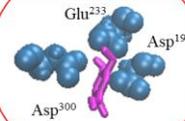
IC<sub>50</sub> 0.47±0.03 mg GAE/mL  
acarbose 0.72±0.01 mg/mL

# In silico investigations

## $\alpha$ -amylase



### Vanillic acid

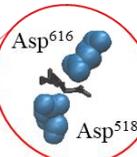
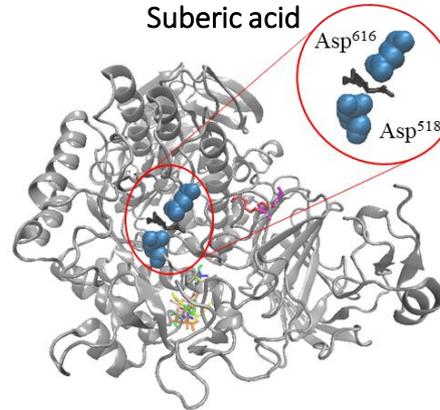


**Interfacing residues** Trp<sup>58</sup>, Tyr<sup>62</sup>, Leu<sup>162</sup>, Arg<sup>195</sup>, Asp<sup>197</sup>, Ala<sup>198</sup>, His<sup>201</sup>, Glu<sup>233</sup>, Ile<sup>235</sup>, His<sup>299</sup>, Asp<sup>300</sup>, Gly<sup>306</sup>

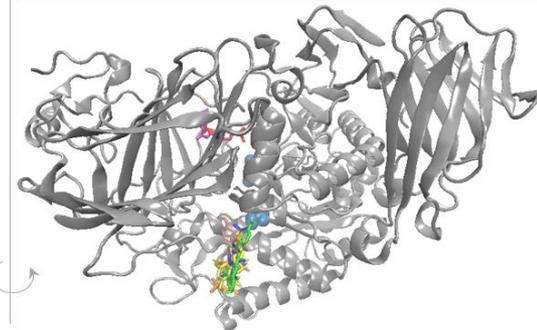
**Amino acids interacting with vanillic acid**  
 H bonds: Arg<sup>195</sup>, Glu<sup>233</sup>  
 Ionic interaction: His<sup>305</sup>  
 HyC: Trp<sup>58</sup>  
 $\pi$ -stating interaction: Tyr<sup>62</sup>

<b>Interfacing residues</b>	Trp <sup>376</sup> , Asp <sup>404</sup> , Ile <sup>441</sup> , Trp <sup>481</sup> , Trp <sup>516</sup> , Asp <sup>518</sup> , Met <sup>519</sup> , Arg <sup>600</sup> , Trp <sup>613</sup> , Asp <sup>616</sup> , Asp <sup>645</sup> , Phe <sup>649</sup> , His <sup>674</sup>
<b>Amino acids interacting with Suberic acid</b>	H bonds: His <sup>674</sup> Hydrophobic contacts: Trp <sup>376</sup> , Phe <sup>649</sup>

### Suberic acid



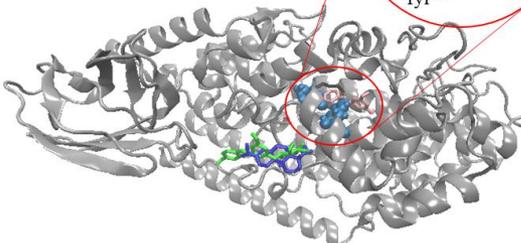
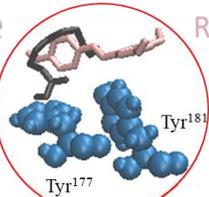
## $\alpha$ -glucosidase



## Lipoxygenase

### Suberic acid

### Resveratrol



<b>Interfacing residues</b>	Phe <sup>177</sup> , His <sup>367</sup> , Leu <sup>368</sup> , His <sup>372</sup> , Ala <sup>410</sup> , Leu <sup>414</sup> , Ile <sup>415</sup> , Leu <sup>607</sup> , Ile <sup>673</sup> , Fe
<b>Amino acids interacting with suberic acid and resveratrol</b>	Tyr <sup>181</sup> , Gln <sup>363</sup> , His <sup>367</sup> , Leu <sup>368</sup> , His <sup>372</sup> , Ala <sup>410</sup> , Leu <sup>414</sup> , Ile <sup>415</sup> , Phe <sup>421</sup> , Asn <sup>425</sup> , Ala <sup>603</sup> , Leu <sup>607</sup> , Fe Ionic interactions: (2) His <sup>367</sup> , His <sup>372</sup> Hydrophobic contacts: Gln <sup>363</sup> , Leu <sup>368</sup> , Leu <sup>414</sup> , Ile <sup>415</sup> , Phe <sup>421</sup> , Ala <sup>410</sup> H bonds: His <sup>600</sup> Hydrophobic contacts: Tyr <sup>181</sup> , Leu <sup>368</sup> , Leu <sup>414</sup> , Phe <sup>421</sup> , Ala <sup>603</sup> , Leu <sup>607</sup>

# White grape pomace as a valuable source of biomolecules with inhibitory effect on polyphenols oxidase

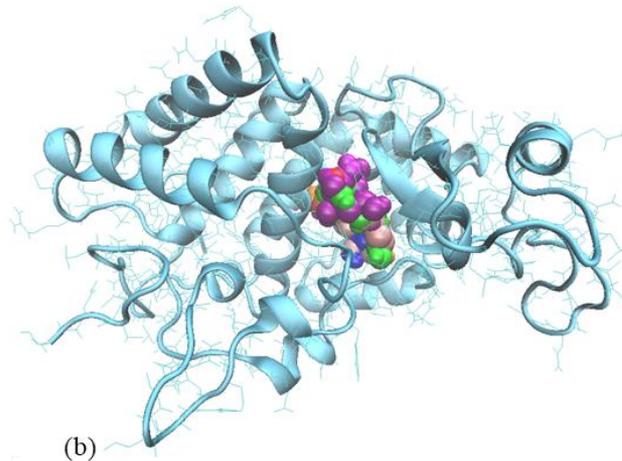
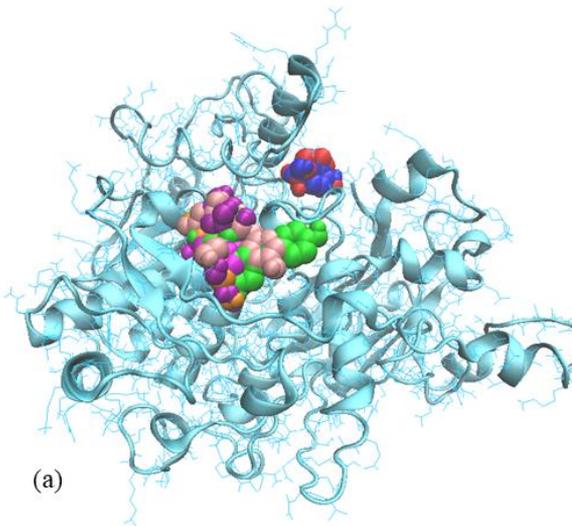


## NaDES (ChCl:La (1:2)) extract

23 identified compounds, of which approximately 70% are phenolic acids

Inhibitory activity  $40.51 \pm 6.74\%$

PPO can bind one molecule of vanillic or suberic acid and one of cis-polydatin, phlorizin, azelaic acid, chlorogenic acid, or t-resveratrol.



Overlapped models of the complexes between polyphenol oxidase (a) or peroxidase (b) represented in cyan in New Cartoon style and the following phytochemical compounds identified the white grape pomace: vanillic acid (blue), cis-polydatin (green), phlorizin (pink), azelaic acid (magenta), chlorogenic acid (purple), t-resveratrol (orange) and suberic acid (red).

# Apple pomace as a source of valuable phenolic: From drying kinetics to optimization of ultrasound assisted extraction using conventional and alternative solvents



Hot-air convection (CA) and infrared (IR) were used to dry the fresh apple pomace and to evaluate their effects on drying kinetics, color parameters, and polyphenolic content.

The Midilli model showed the best-fitting model to describe the drying kinetics.

NaDES (choline chloride and glycerol, 1:1 molar ratio)

flavan-3-ols (catechin and epigallocatechin), followed by phenolic acids, mainly protocatechuic acid.



AP\_50\_CA



AP\_60\_CA



AP\_70\_CA



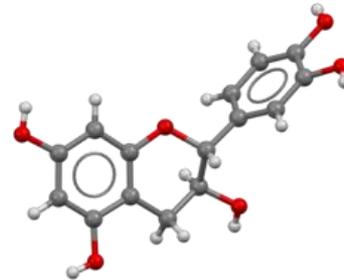
AP\_50\_IR



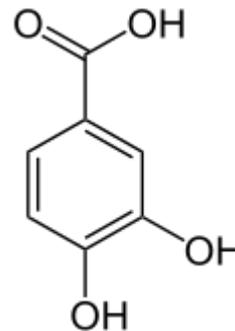
AP\_60\_IR



AP\_70\_IR



$98.24 \pm 5.93$  mg/100 g AP



$48.44 \pm 1.24$  mg/100 g AP

# CURRENTLY:

Combinations of red grape pomace and apple pomace dried by hot air convection (CD) and infrared (IR) at different temperatures.



25:75 RGP:AP 50\_CD



25:75 RGP:AP 50\_IR



14.28:85.72 RGP:AP 50\_CD



14.28:85.72 RGP:AP 50\_IR



10:90 RGP:AP 50\_CD



10:90 RGP:AP 50\_IR



25:75 RGP:AP 60\_CD



25:75 RGP:AP 60\_IR



14.28:85.72 RGP:AP 60\_CD



14.28:85.72 RGP:AP 60\_IR



10:90 RGP:AP 60\_CD



10:90 RGP:AP 60\_IR



25:75 RGP:AP 70\_CD



25:75 RGP:AP 70\_IR



14.28:85.72 RGP:AP 70\_CD



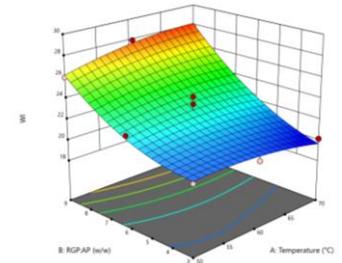
14.28:85.72 RGP:AP 70\_IR



10:90 RGP:AP 70\_CD



10:90 RGP:AP 70\_IR



*Response Surface Method*

*1:3 ratio, 70 °C, CD*

**Bioaccessibility index: ~ 68% anthocyanins, 50% polyphenols and 39% flavonoids**

NEXT...



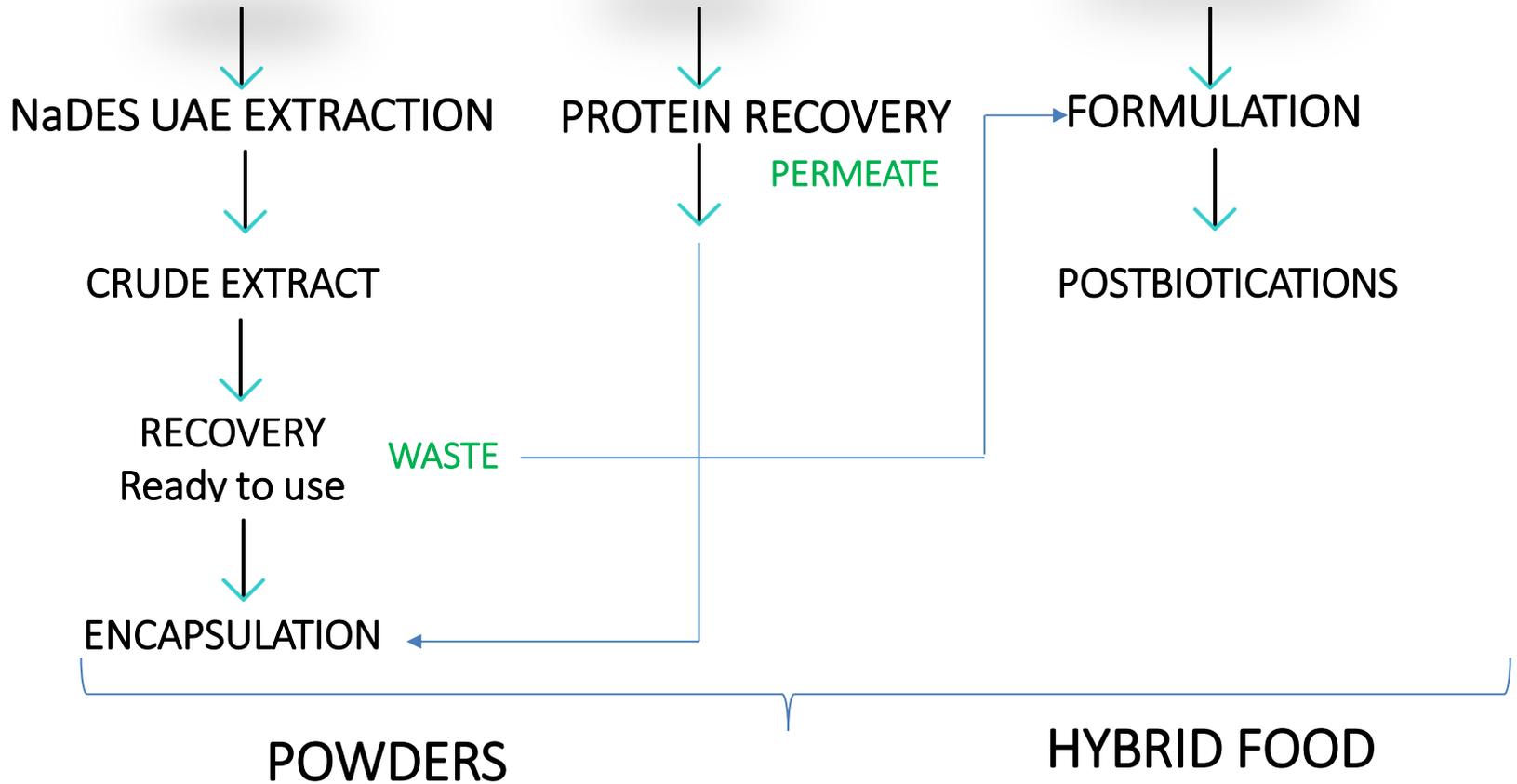
Pomaces



Whey



Brewery spent grains





THANK YOU FOR  
YOUR ATTENTION!

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