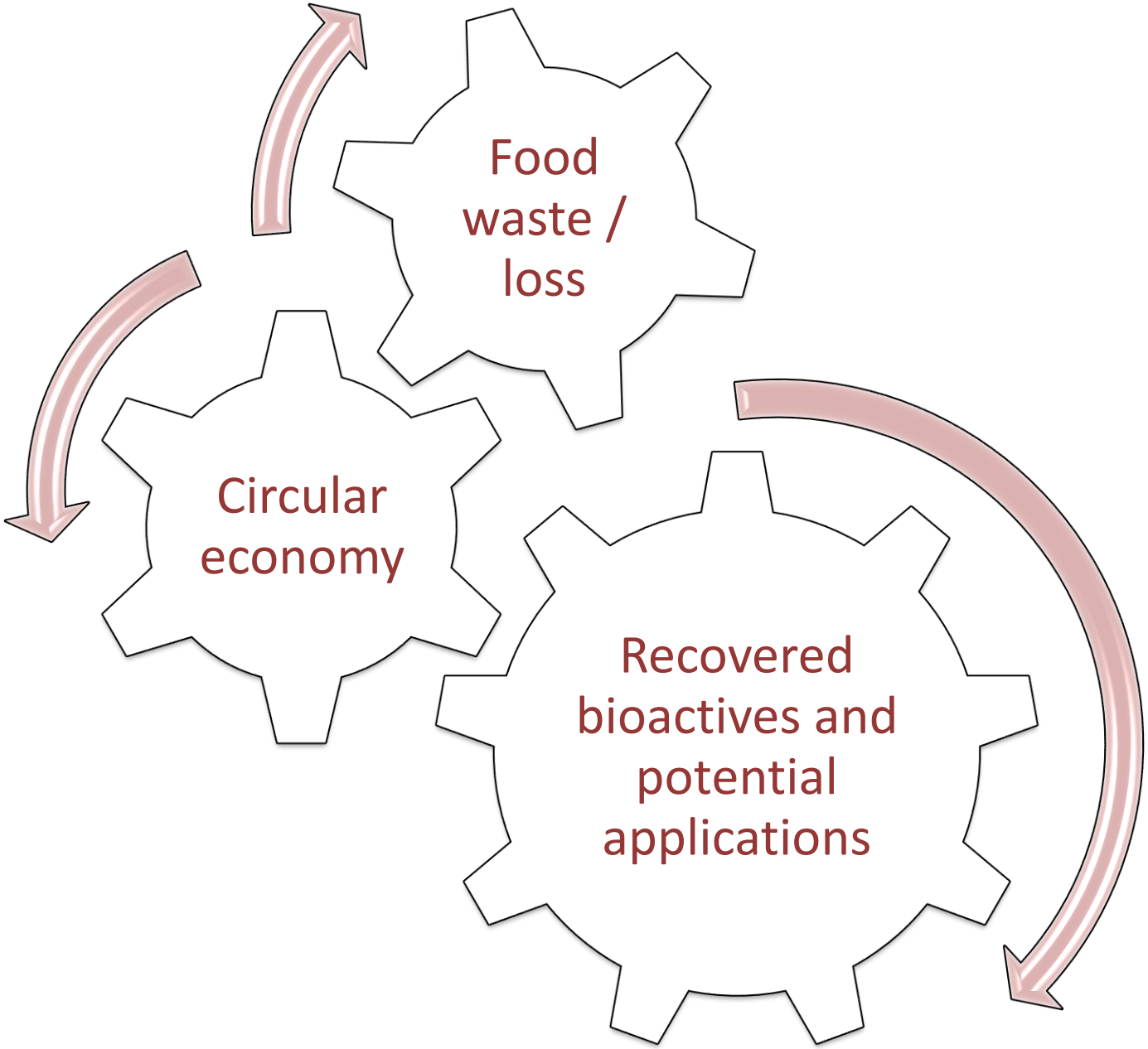
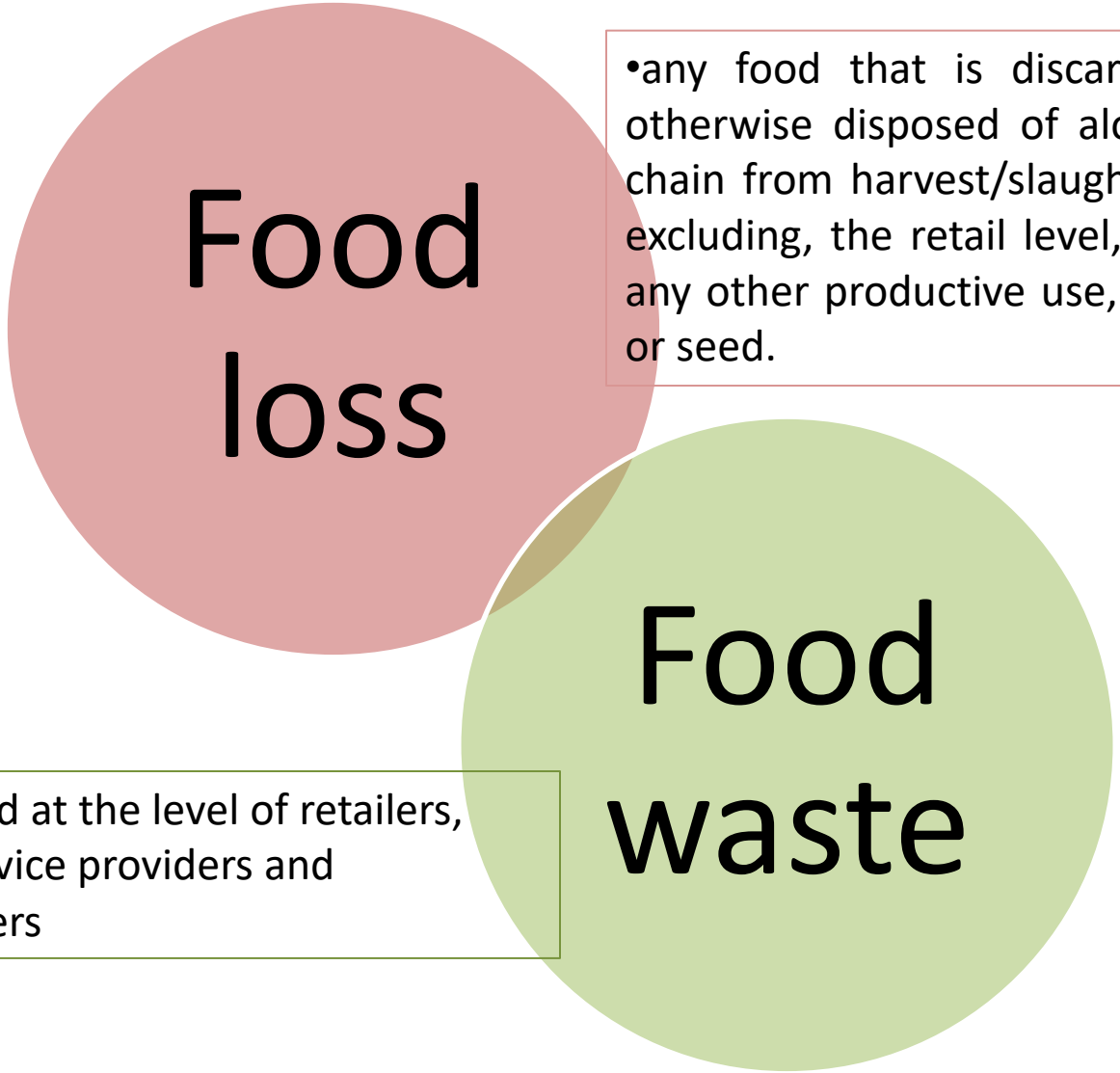

# BIOACTIVE COMPOUNDS RECOVERED FROM FOOD WASTE – CHALLENGES AND USES IN FOOD INDUSTRY

**Sonia A. SOCACI**

Faculty of Food Science and Technology,
University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca
3-5 Manastur Street, 400372, Cluj-Napoca, Romania;
sonia.socaci@usamvcluj.ro


Food waste / loss
Circular economy
Recovered bioactives and potential applications




Roughly 1/3 of the food produced in the world for human consumption is lost or wasted

- Latest estimates suggest that around 931 million tonnes of food waste were generated in 2019, out of which:
  - 61% came from households
  - 26% from food service
  - 13% from retail


https://www.unep.org/resources/report/unep-food-waste-index-report-2021

# IN THE EU (Estimates, 2012)

## FOOD IS LOST OR WASTED THROUGHOUT THE ENTIRE SUPPLY CHAIN

from **agricultural production** to final **household consumption**

---

88

million tonnes

or

173

kg per person

**of food are wasted per year**

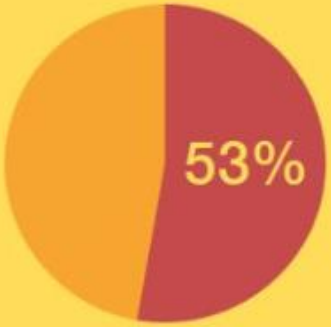
170

million tonnes of $CO_2$

**emitted from production and disposal of EU food waste**

- Estimates show that up to 10% of the 88 million tonnes of food waste that is generated in the EU every year are somehow linked to date labelling:
  - 53% of consumers don't know the meaning of "best before" labelling,
  - 60% of consumers don't know the meaning of "use by" labelling

https://www.fao.org/3/bb144e/bb144e.pdf


**"Best before"** labelling indicates the date after which an item of food may still be eaten but may not be at its best in terms of quality

**of consumers do not know the meaning of "best before" labelling**

---

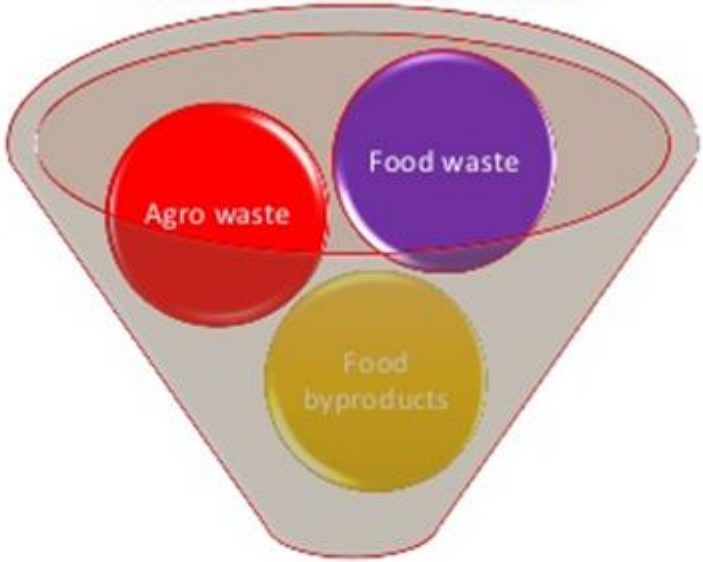


**"Use by"** labelling indicates the date after which an item of food is no longer safe to eat

**of consumers do not know the meaning of "use by"**

The problem:

waste management





A possible solution:

high added-value compounds recovery

zero waste

Textile industry

pharma

Food industry

Agriculture

others

cosmetics

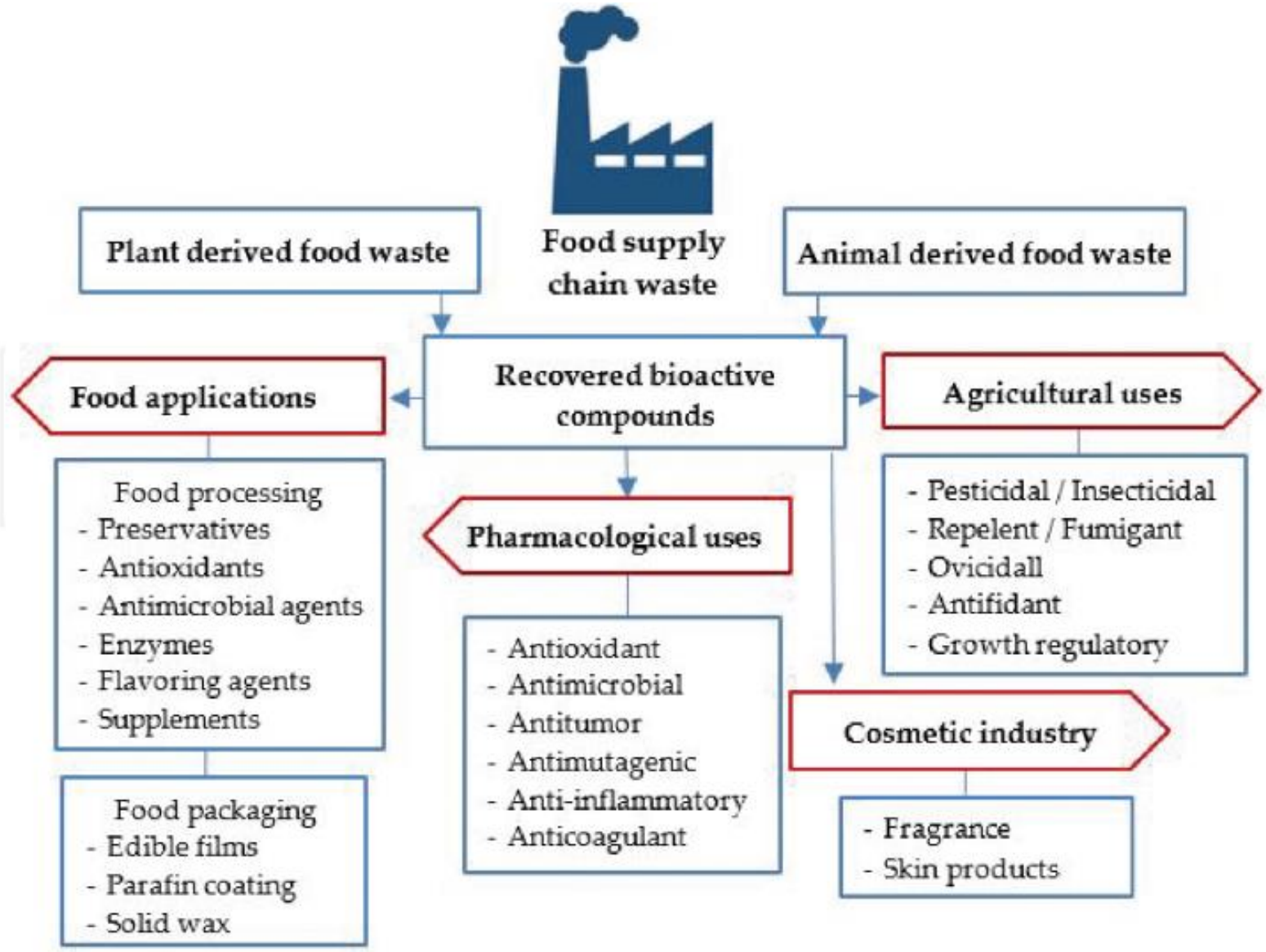
Health benefits

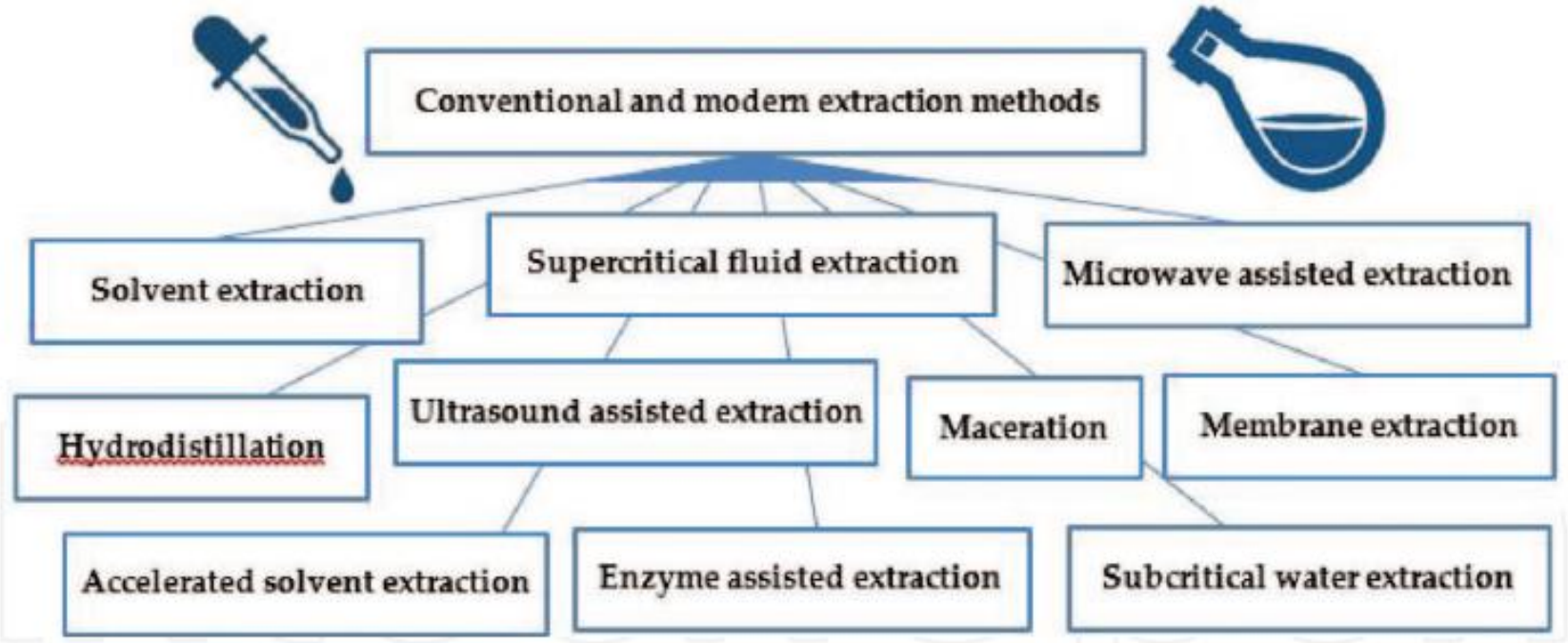
Manifold uses

Bioactive compounds

sources

Extraction methods


Food supply chain waste
Plant derived food waste
Animal derived food waste
Recovered bioactive compounds
Food applications
Agricultural uses
Pharmacological uses
Cosmetic industry
Food processing
- Preservatives
- Antioxidants
- Antimicrobial agents
- Enzymes
- Flavoring agents
- Supplements
Food packaging
- Edible films
- Parafin coating
- Solid wax
- Antioxidant
- Antimicrobial
- Antitumor
- Antimutagenic
- Anti-inflammatory
- Anticoagulant
- Pesticidal / Insecticidal
- Repelent / Fumigant
- Ovicidall
- Antifidant
- Growth regulatory
- Fragrance
- Skin products




Farcas et al., 2020. Introductory Chapter: From Waste to New Resources DOI: http://dx.doi.org/10.5772/intechopen.89442

# Ultrasound assisted extraction

intensification →

**Classical**

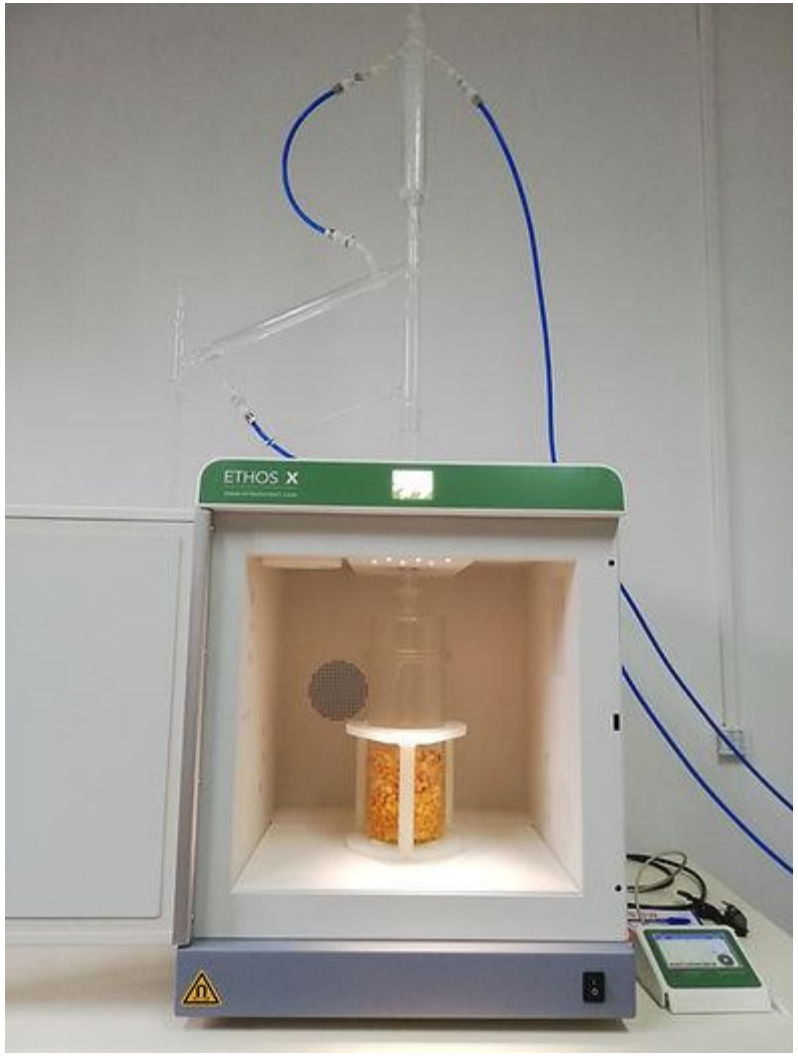
- Yield of extraction
- Type of metabolites
- Selectivity

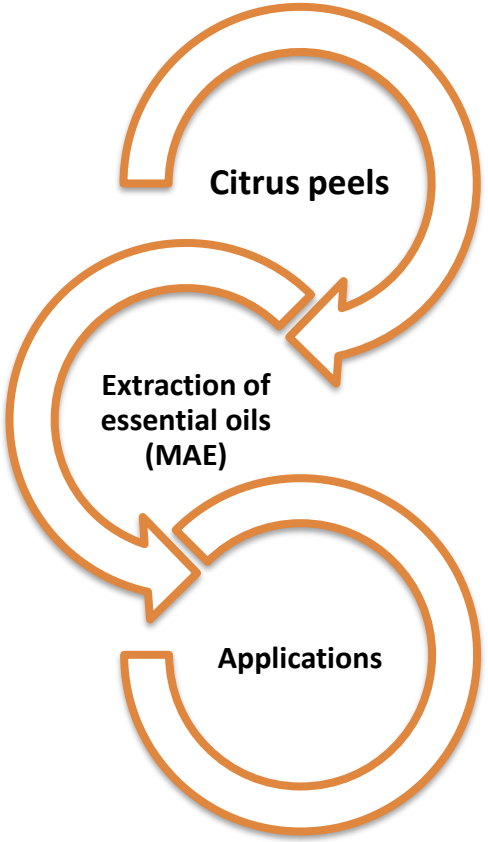
**Today's**

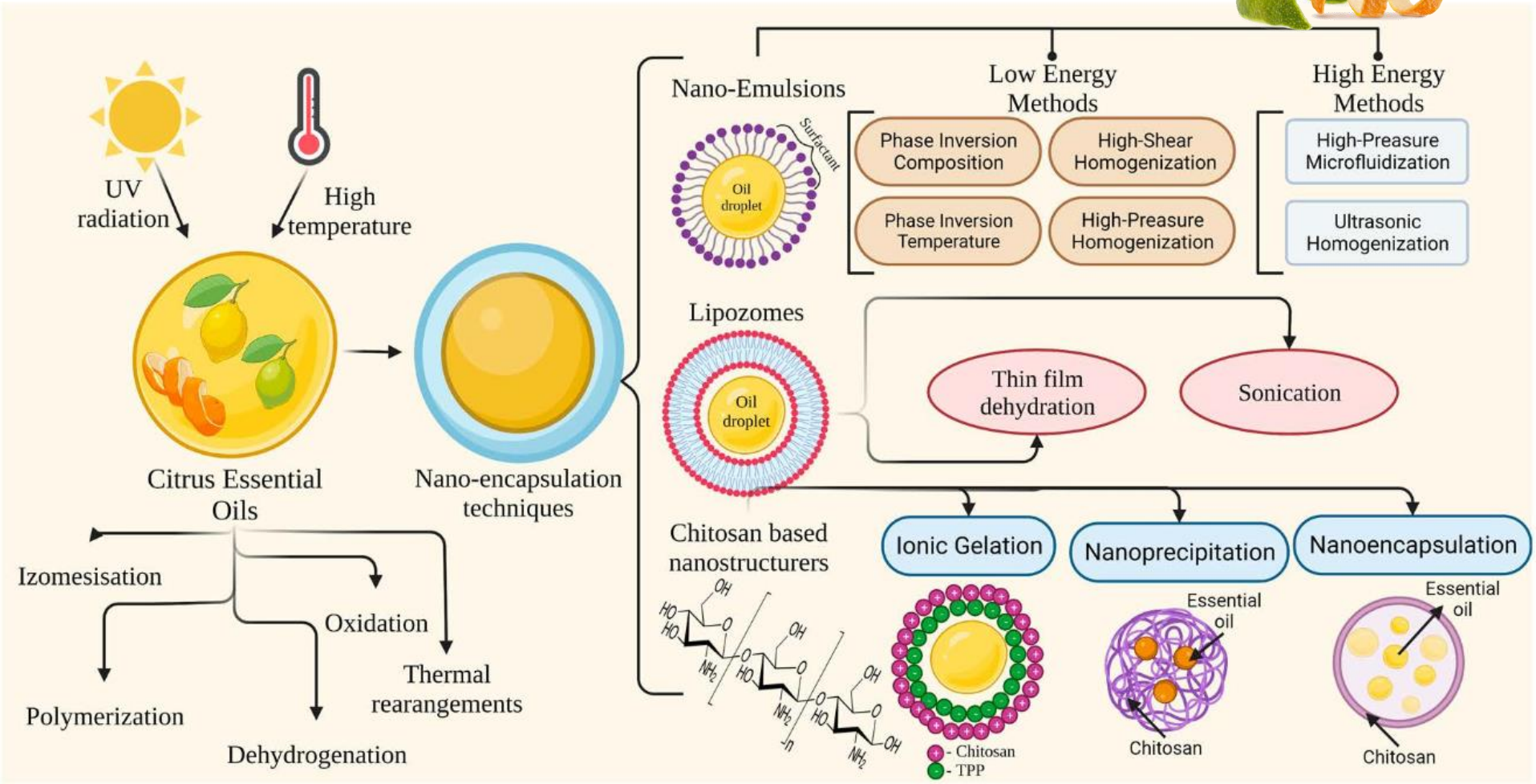
- Reduction of solvent used
- Reduction of unit operations
- Reduction of extraction time
- Reduction in energy used
- Use of renewable plant resources
- Security and safety
- Environmental impact
- Rapid return of investment (ROI)

**Fig. 1.** Ultrasound-assisted extraction: evolution or revolution.

# Microwave assisted extraction






Oprea I, Fărcaș AC, Leopold LF, Diaconeasa Z, Coman C, Socaci SA, 2022, Nano-Encapsulation of Citrus Essential Oils: Methods and Applications of Interest for the Food Sector, Polymers 14 (21), 4505

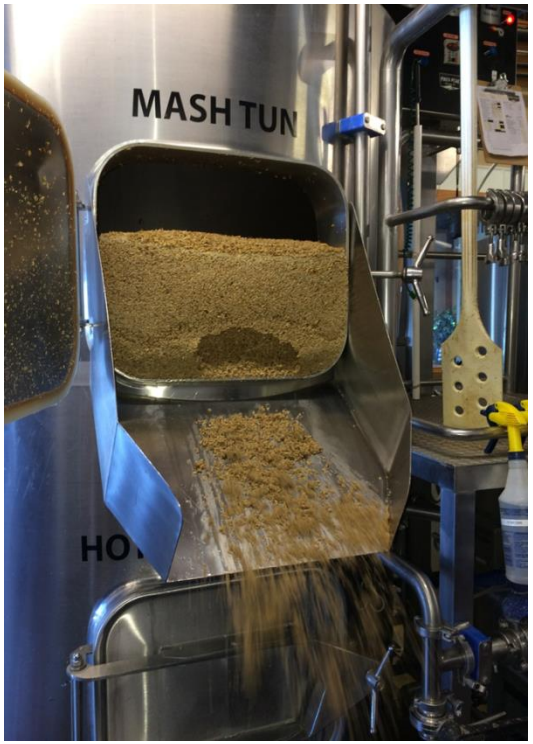
## The main wastes with a relative high content of **Polysaccharides**

The fruits and vegetables processing sector produces wastes (**peels, pulp and seeds**) that are rich, low-cost and sustainable sources of polysaccharides.


Ranges between 20-30% of citrus peel dry weight

Physicochemical and functional properties: gelling, emulsifier, thickening agents, film forming, water holding, prebiotic activities - Essentials for food industry

# BREWERS' SPENT GRAIN (BSG)




Up to 85% of the brewing by-products

European Union
$3.4 \times 10^6$ t / year

Globally
$38.6 \times 10^6$ t/year

200 tons BSG / 10.000 hl beer

# BSG VALORISATION

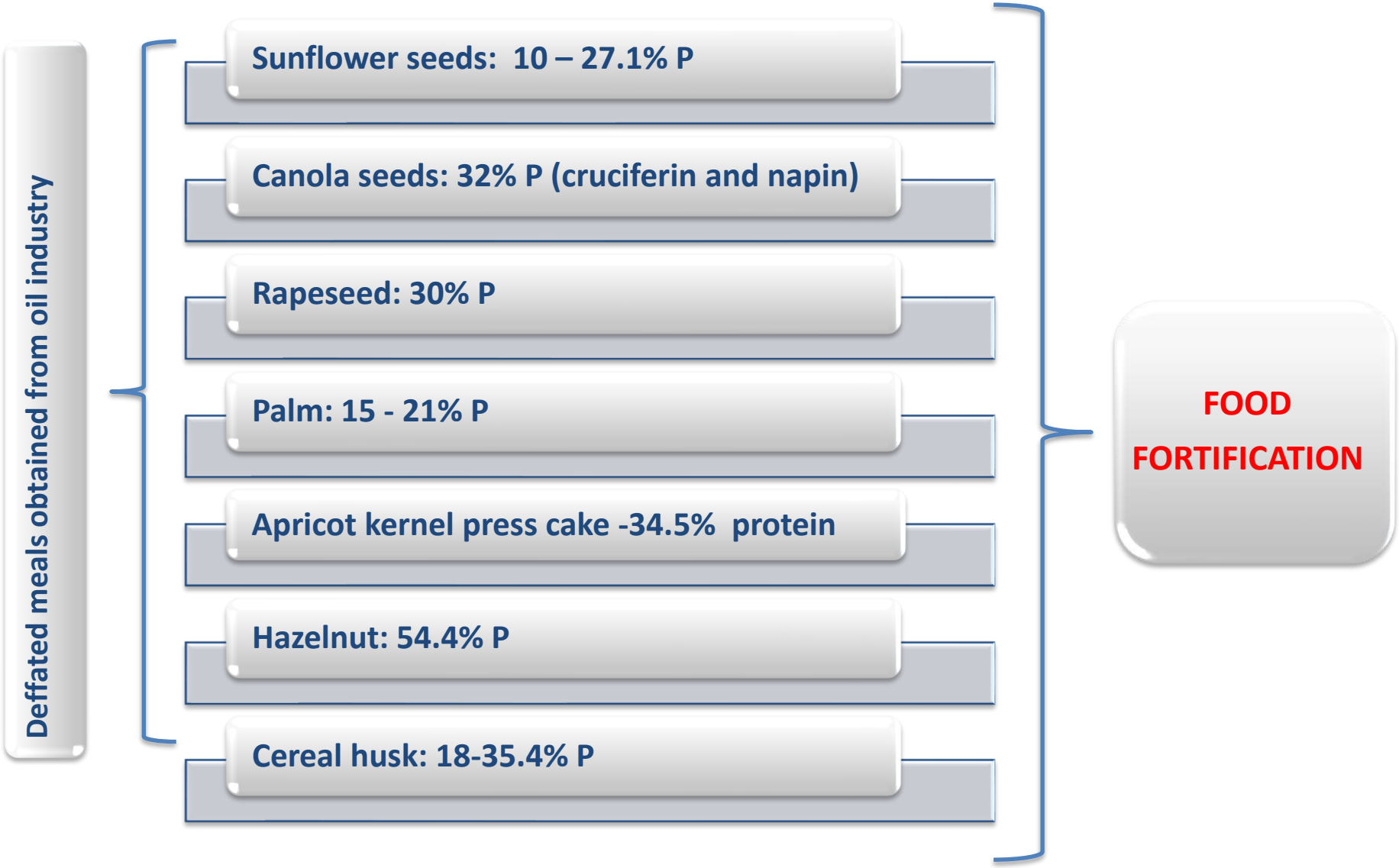
- **Protein – Fiber - Minerals**

| | Wheat flour | Brewers' spent grain |
|---|---|---|
| **Moisture, %** | 12.1 | 5.7 |
| **Protein, %** | 13.3 | 18 |
| **Fiber, %** | 0.6 | 41.28 |
| **Starch, %** | 81.06 | 10.1 |
| **Sugars, %** | 0.22 | 16.11 |
| **Fat, %** | 0.59 | 6,61 |
| **Minerals, %** | 1.7 | 3.82 |
| **Energy, cal/100g** | 335.43 | 228.6 |

*Fărcas et. al. / Journal of Agroalimentary Processes and Technologies 2014*

| Compound class | Waste origin | By-product source | Extraction techniques |
|---|---|---|---|
| Proteins | Cereals | Brewers' spent grain | Ultrasonic-assisted extraction |
| | | | Sequential extraction of proteins and arabinoxylans |
| | | | Enzymatic assited extraction |
| | Oil crops | Rapeseed meal | Ultrasound assited aqueous extraction |
| | | Sunflower meals | Alkaline solubilization and acid precipitation |
| | | Hazelnuts meal | Solvent extraction (water, acetone) |
| | | Canola meals | Alkaline solubilisation and acid precipitation (Isoelectric precipitation) |
| | | | Electro-activated solutions (non-invasive extraction method) |
| | | | Salt precipitation |
| | | Palm kernel cake | Enzymatic hydrolysis |
| | Fruits and vegetable | Apricot kernel cake | Alkaline solubilisation and acid precipitation |
| Polysaccharides (pectin, cellulose, hemicellulose) | Cereals | Brewers' spent grain | Enzymatic hydrolysis |
| | | | Sequential extraction of proteins and arabinoxylans |
| | | | Acid hydrolysis |
| | Oil crops | Olive pomace | Sequential extraction |
| | Fruits and vegetables | 26 different wastes (e.g. orange peel, grape pomace, tomato skin, berries, apple pomace, seabuckthorn pulp and seeds, parsely, hop, etc.) | Sequential extraction |
| Lipids | Cereals | Brewers' spent grain | Soxhlet extraction |
| Polyphenols | Cereals | Brewers' spent grain | Alkaline hydrolysis |
| | Oil crops | Rapeseed | Ultrasound assisted aqueous extraction |
| | Fruits and vegetables | Tomato pomace and skin | Enzymatic assisted extraction |
| | | | Solvent extraction |
| | | Potato peels and tubers | Pressurized liquid extractor |
| | | | Solvent extraction (stirring) |
| | | | Ultrasound extraction |

# The main wastes with a relative high content of Protein

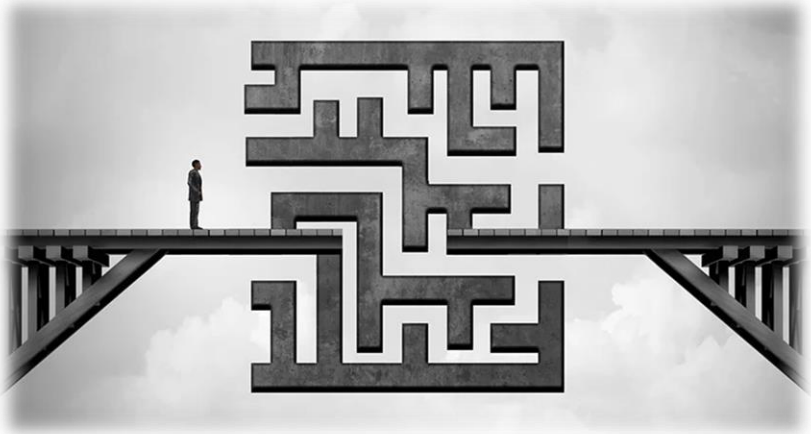


## Microbial-processing of fruits and vegetables wastes in order to obtain valuable **Enzymes** and **Organic Acids**

- **Amylolytic** enzymes from banana waste, mango kernels
- **Pectinolytic** enzymes from orange peel, lemon peel
- **Tannase** from grape seeds
- **Protease** from mango peel, potato peel
- **Lipase** from coconut cake, lemon peel
- **Invertase** from orange peel, banana peel
- **Lactic, citric, succinic, acetic** acids from potatoes, banana, mango, apple, and pineapple wastes

# Current challenges

- Susceptibility of thermosensitive compounds
- Non-uniformity of extraction in large-scale industries
- expensive extraction and purifcation processes
- varying stability and loss of activity of bioactive compounds
- bioavailability, bio accessibility, safe and “green” production practices, safety, and toxicology, must be considered as well




Thank you!