agroindustrial wastewaters:

A new olive oil production scheme with almost zero wastes

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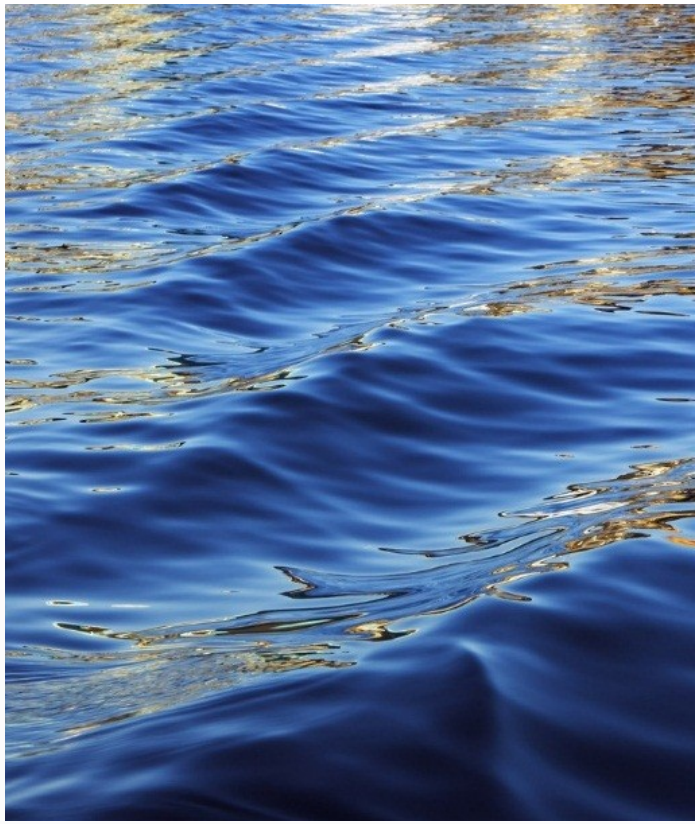


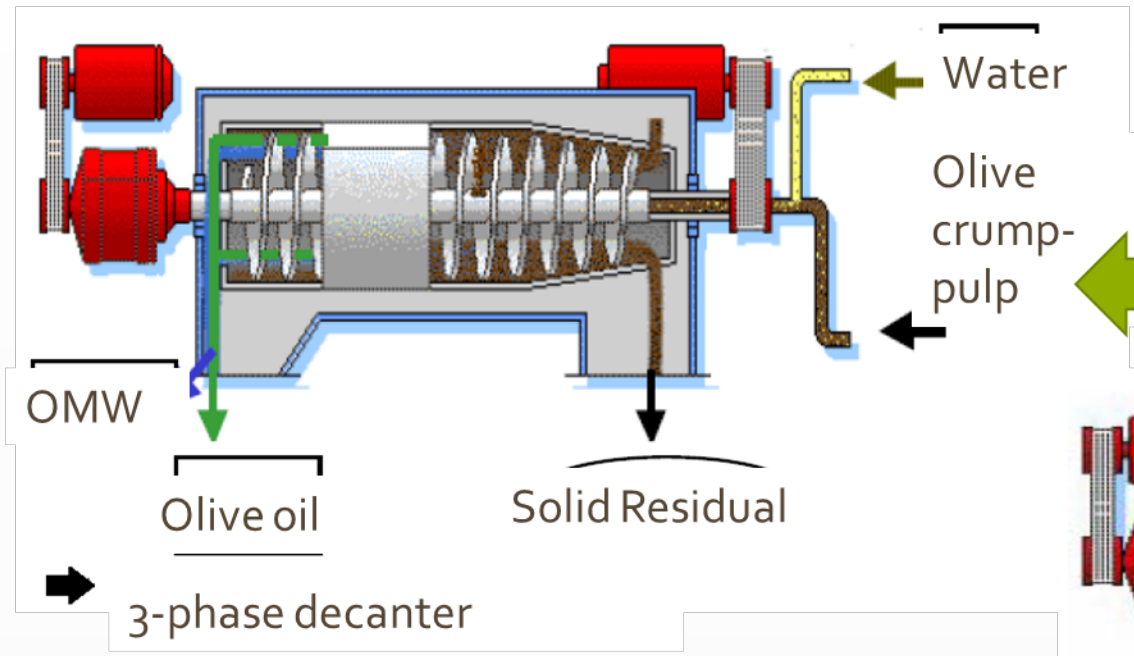
Olive oil extraction processes to produce extra virgin olive oil

ewater + Olive Mill solid wastes

- Olive oil is a major agro-industrial product for all Mediterranean countries
  - Olive fruits
  - Extra virgin olive oil
- Unfortunately, large quantities of olive mill wastewater (OMW) or semi-solid wastes are produced during the olive oil extraction process.
- Treatment of liquid or solid waste is difficult and expensive

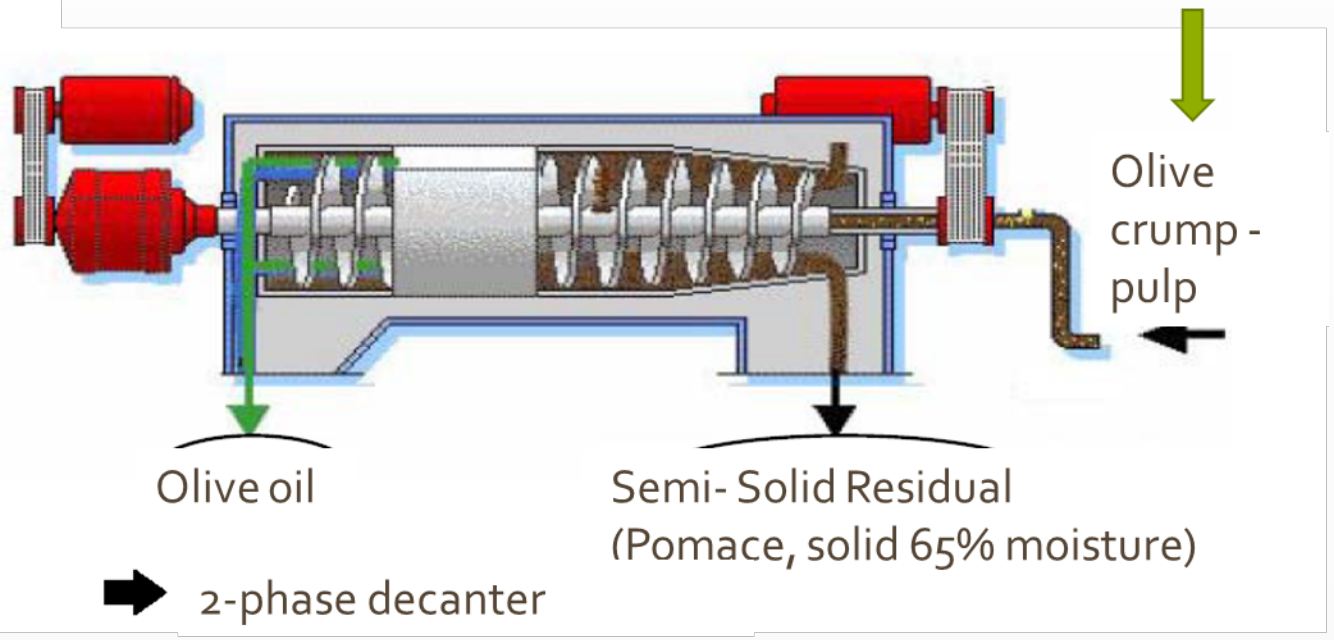
Olive oil semi-solid wastes (pomace or alperujo)

Residual from the 2-phase olive oil extraction process
60-70% moisture



Crashing- washing of olive fruits

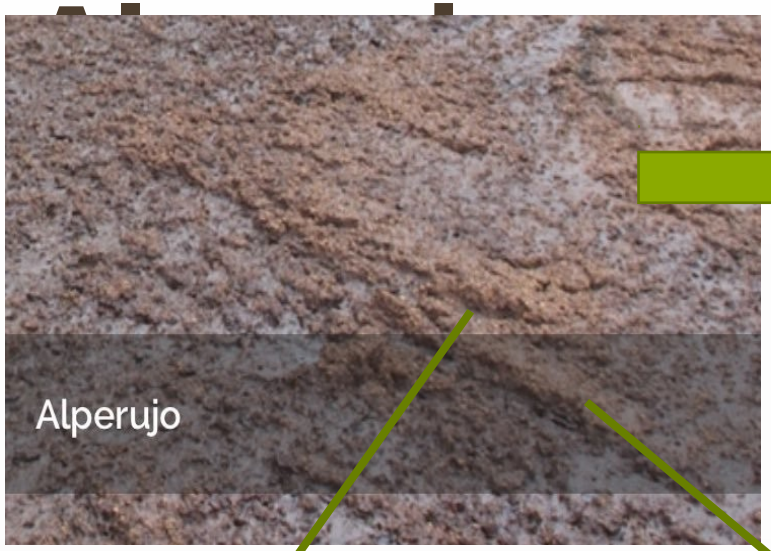
Malaxation



Treatment of the three-phase olive mill wastewater, OMW (or OMWW) ???

Pollution of cultivated or uncultivated fields and of the surface waters (rivers, lakes, sea)

Treatment of the two phase, pomace or

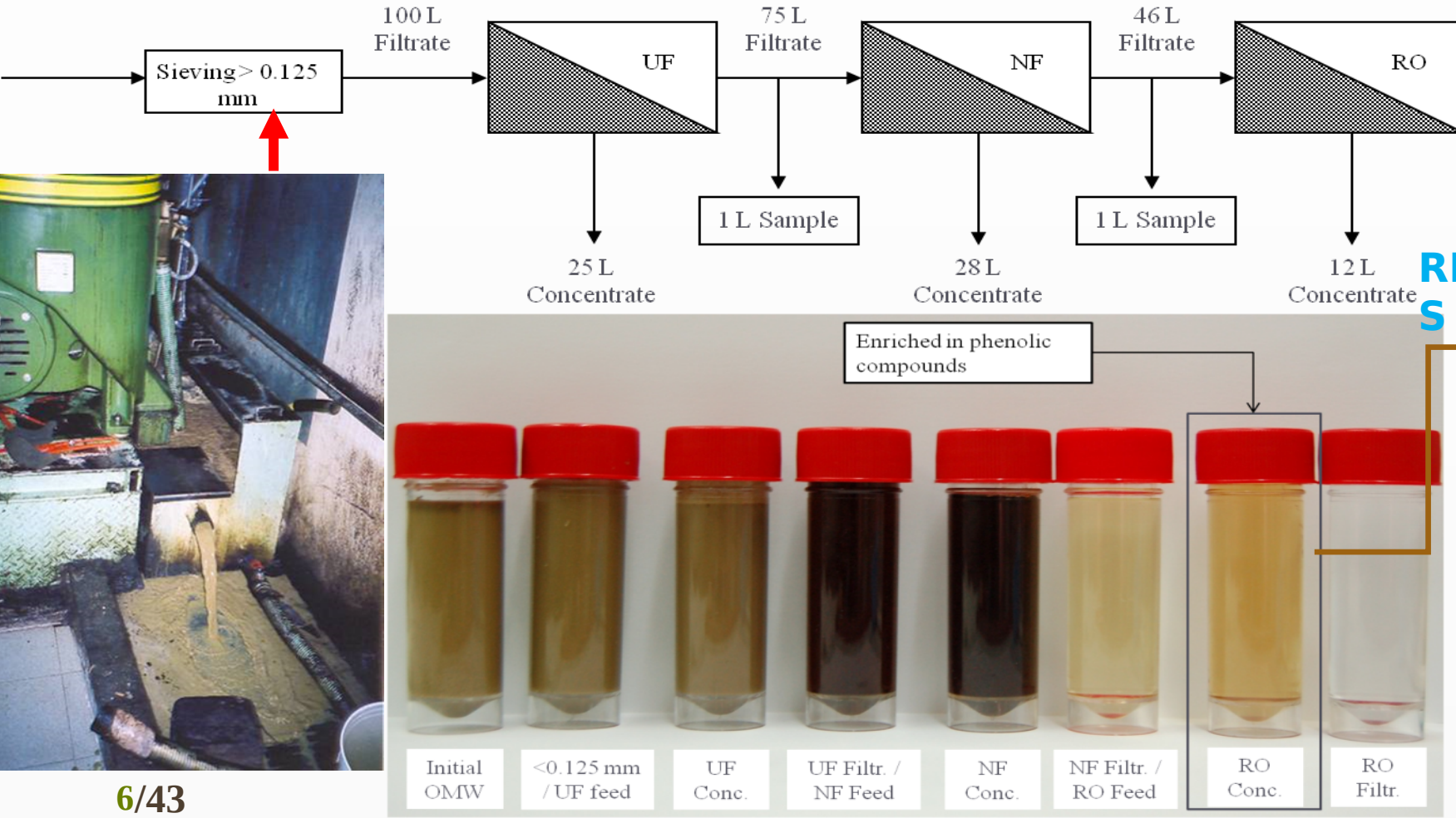


Air pollution

Treatment of Wastewaters and Solid Wastes-

Isolation, Recovery and Purification of phenolic compounds from agricultural by–products (wastes)

Membrane Filtration of OMW



- OMW
- POMACE
- Olive leaves
- Coffee residuals
- Winery solid residuals

The final product had a phenols concentration of **378 g/L** in gallic acid equivalents, whereas their initial content in the raw OMW was 2.64 g/L

Scope

The main objective of the present study is to develop a new scheme for olive oil production process with almost zero wastes, utilizing all the ingredients of the olive fruits to produce useful products and by-products, such as

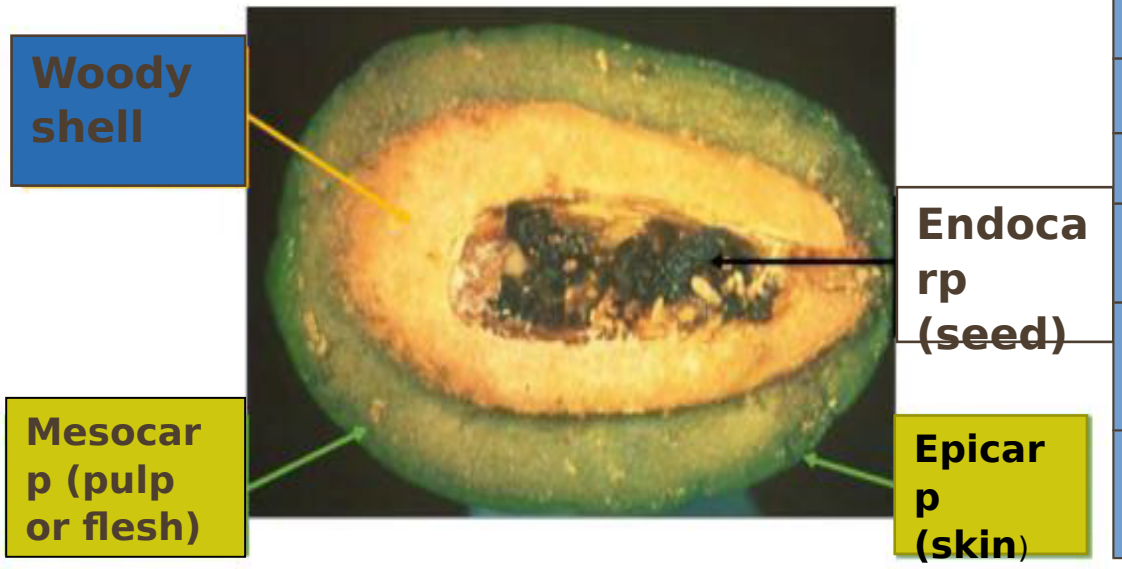
- extra virgin olive oil,
- olive pomace oil,
- various antioxidants,
- animal feed,
- solid fuels
- and water for irrigation.

Olive fruit

Olive fruits can be separated in three parts:

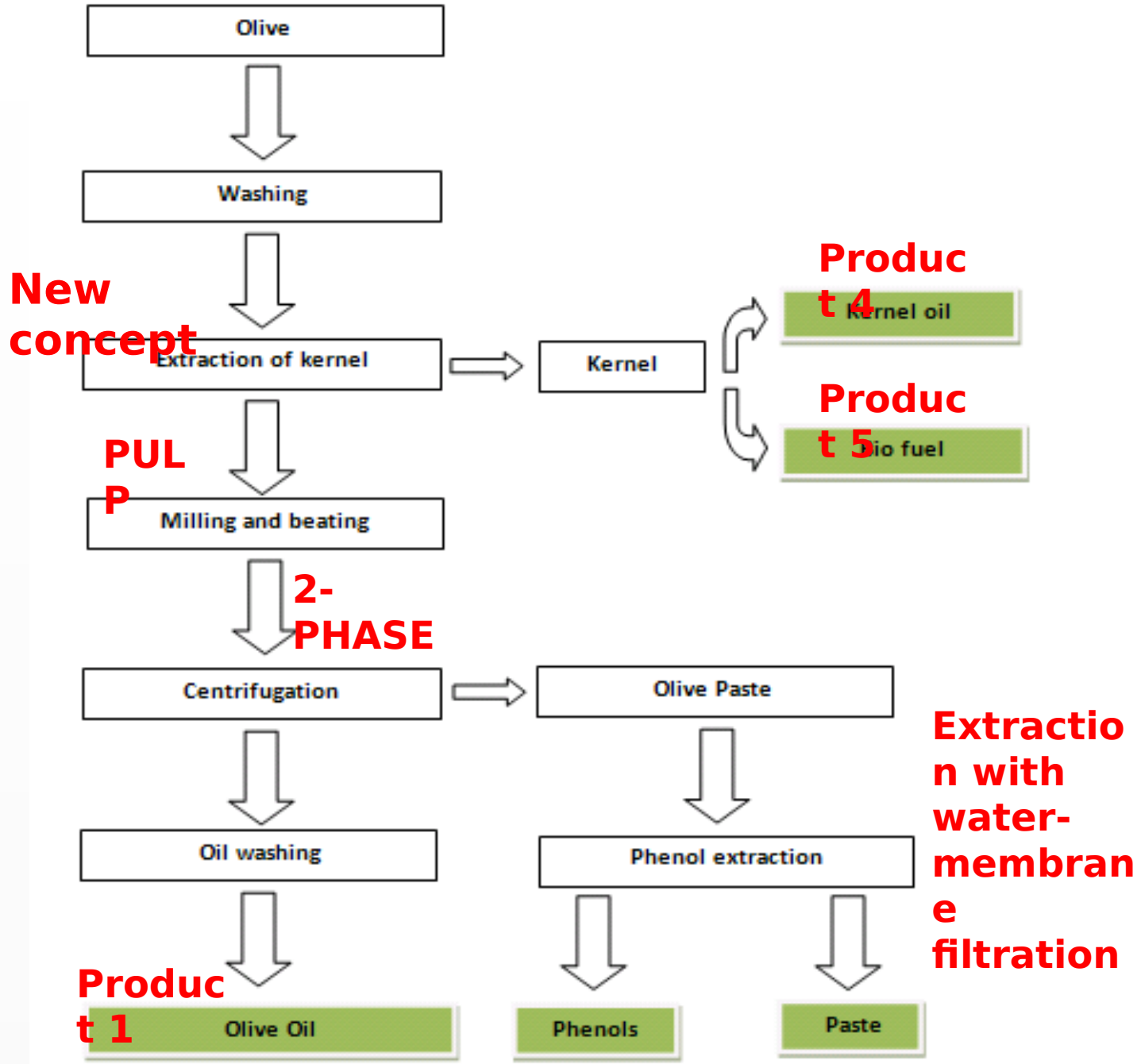
- Kernel
- Pulp
- Skin

If a perfect separation could be made, then each part can be exploited separately



	Olive fruit content per kg of fruit	
	Skin- pulp	**Kernel**
Weight (g)	846	154
Humidity (g)	528	69
Total organic carbon (g)	**231**	69
Total organics (COD) (g)	161	19
Inorganic substances (g)	77	16

New proposed scheme



OLIVE KERNEL REMOVAL

New proposed scheme Step No 1: Extraction of kernels

The produced olive oil produced is 'softer' and tastier, since it does not contain microparticles from the kernel. The microparticles are sites of oxidation of organic

These new devises are machines that remove the pulp from the olives and push the pulp to the malaxation tank to extract the olive oil from the olive pulp

The olives are rubbed in special scrapers until all pulp is removed

6,000-15000 Euros

MODEL	DN.100	DN.200	DN.500	DN.1000	DN1500
Efficiency (kg/hr)	80-120	150-200	400-500	800-1000	1200-500
pump	NO	YES	YES	YES	YES

New proposed scheme Step No 2: Malaxation of the pulp only (30-45 min)

From the grinder, the paste enters a tank for malaxation. Malaxation usually lasts from 30 to 45 minutes depending on the quality of the paste. In the mixture, the olive paste is stirred slowly with paddles and **the small droplets of olive oil are coalesced into larger droplets** to help the oil-paste separation process.

New proposed scheme

Step No 3: Olive oil extraction

Product 1 Extra virgin olive oil

Separation of olive oil is done in seconds in a centrifugal decanter at high speeds where different parts are obtained: solids (heaviest),vegetable water and olive oil (lightest).

The olive oil is pulled out of the decanter and sent for a final cleaning in the vertical separator (polishing) for the

scheme

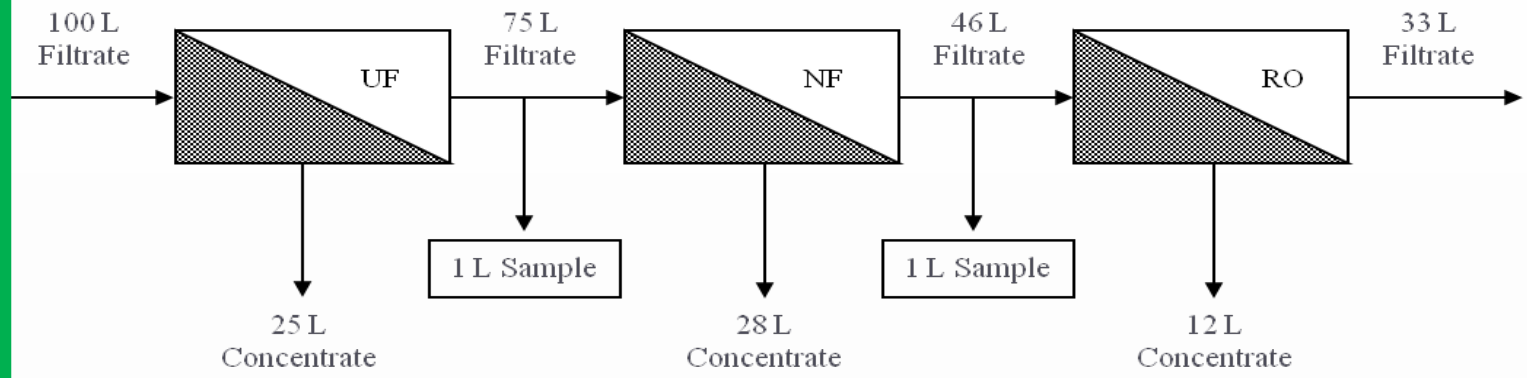
Step No 4: Extraction of phenolics from the rest part of the pulp

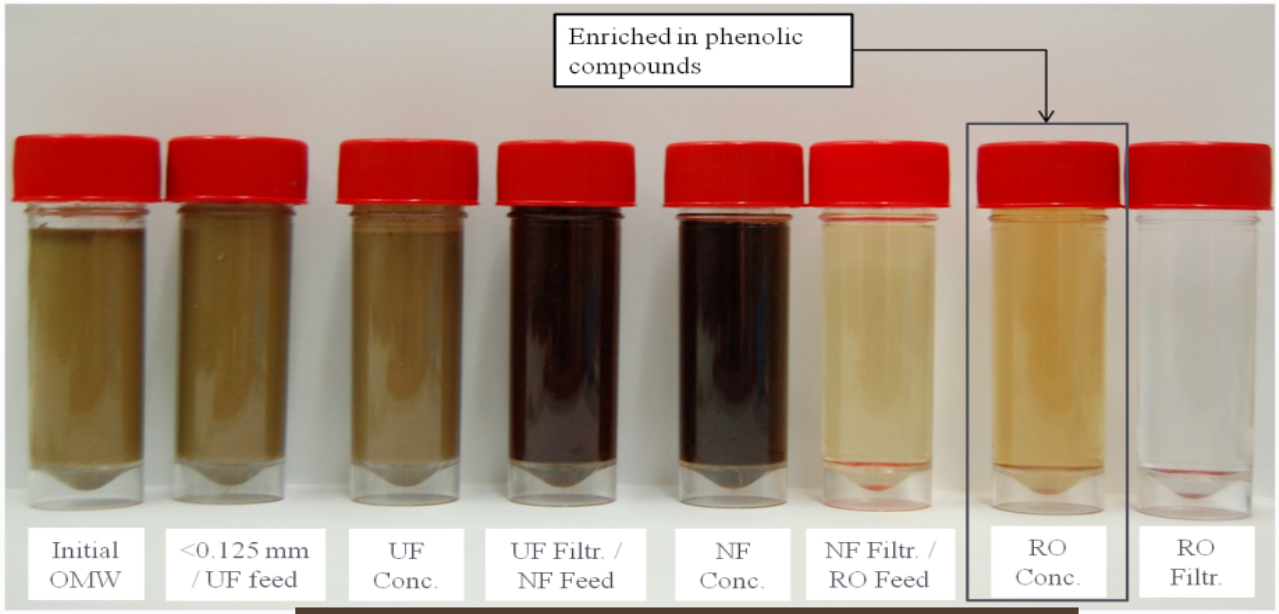
Product 2 Phenolic compounds

Phenolics
~ 380 g/L

Resins/adsorption/desorption

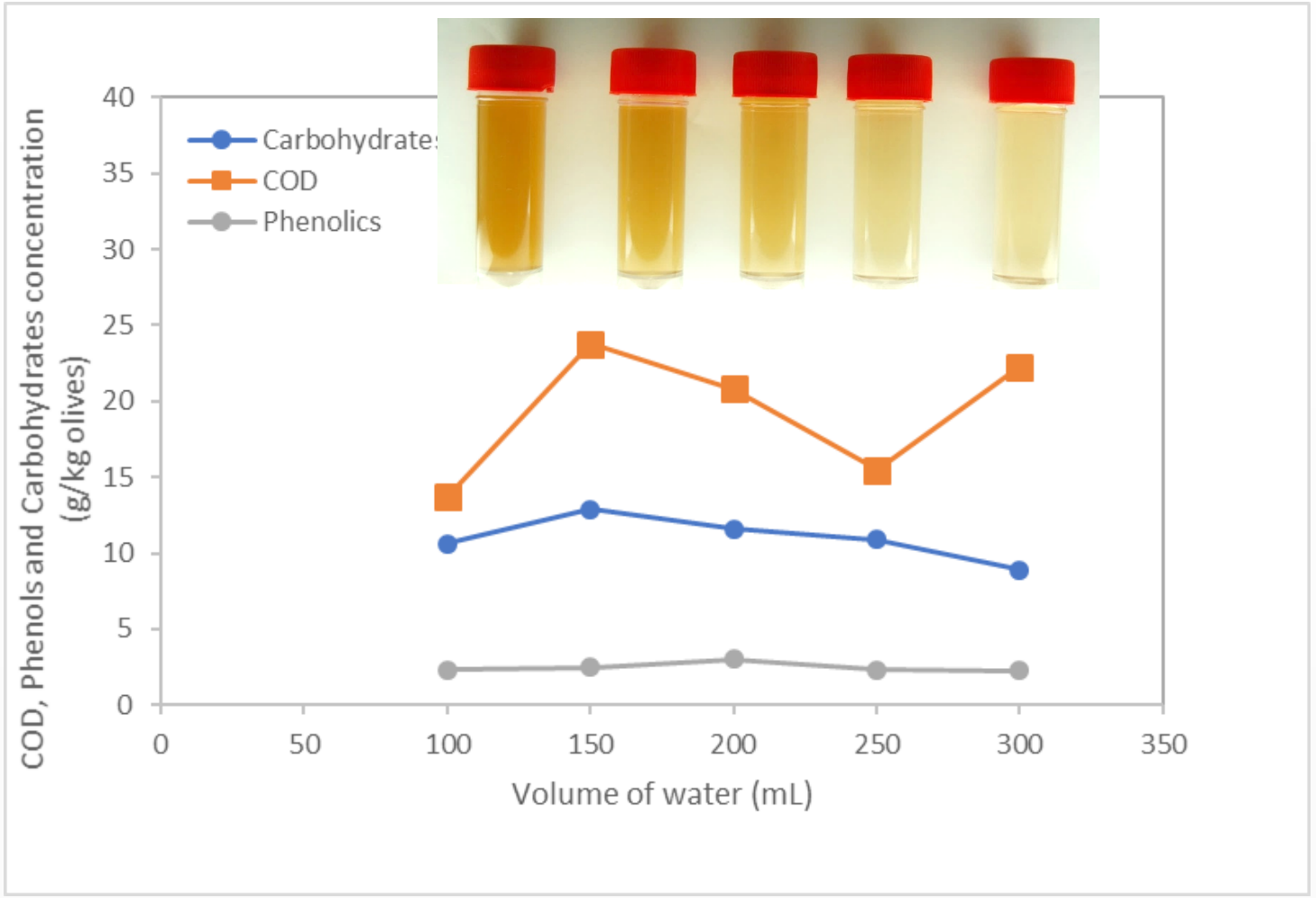
Extraction of phenolics from the rest of the pulp, with water as solvent





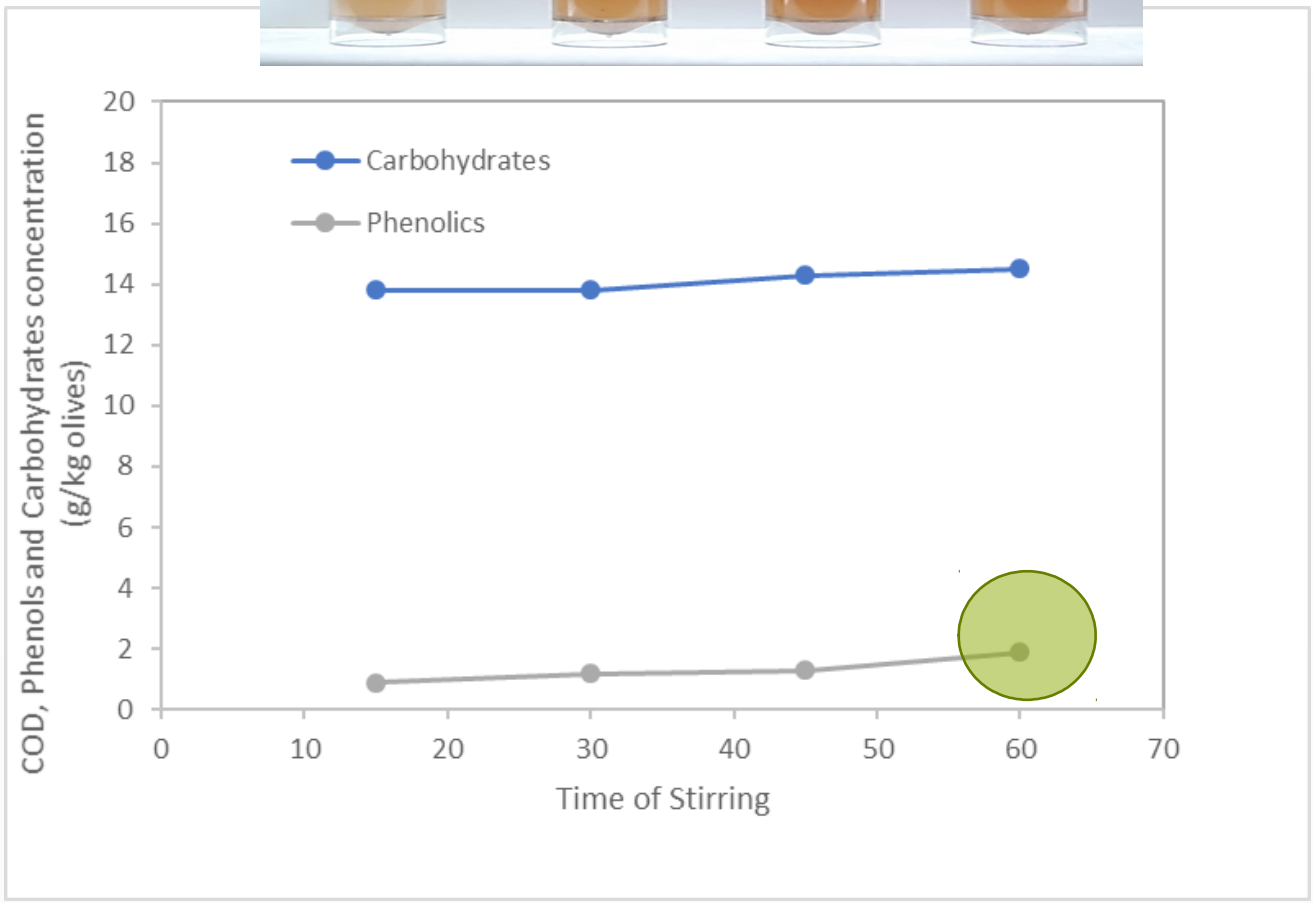
New proposed scheme, Step No 4: Extraction of phenolics

Product 2: Phenolic compounds



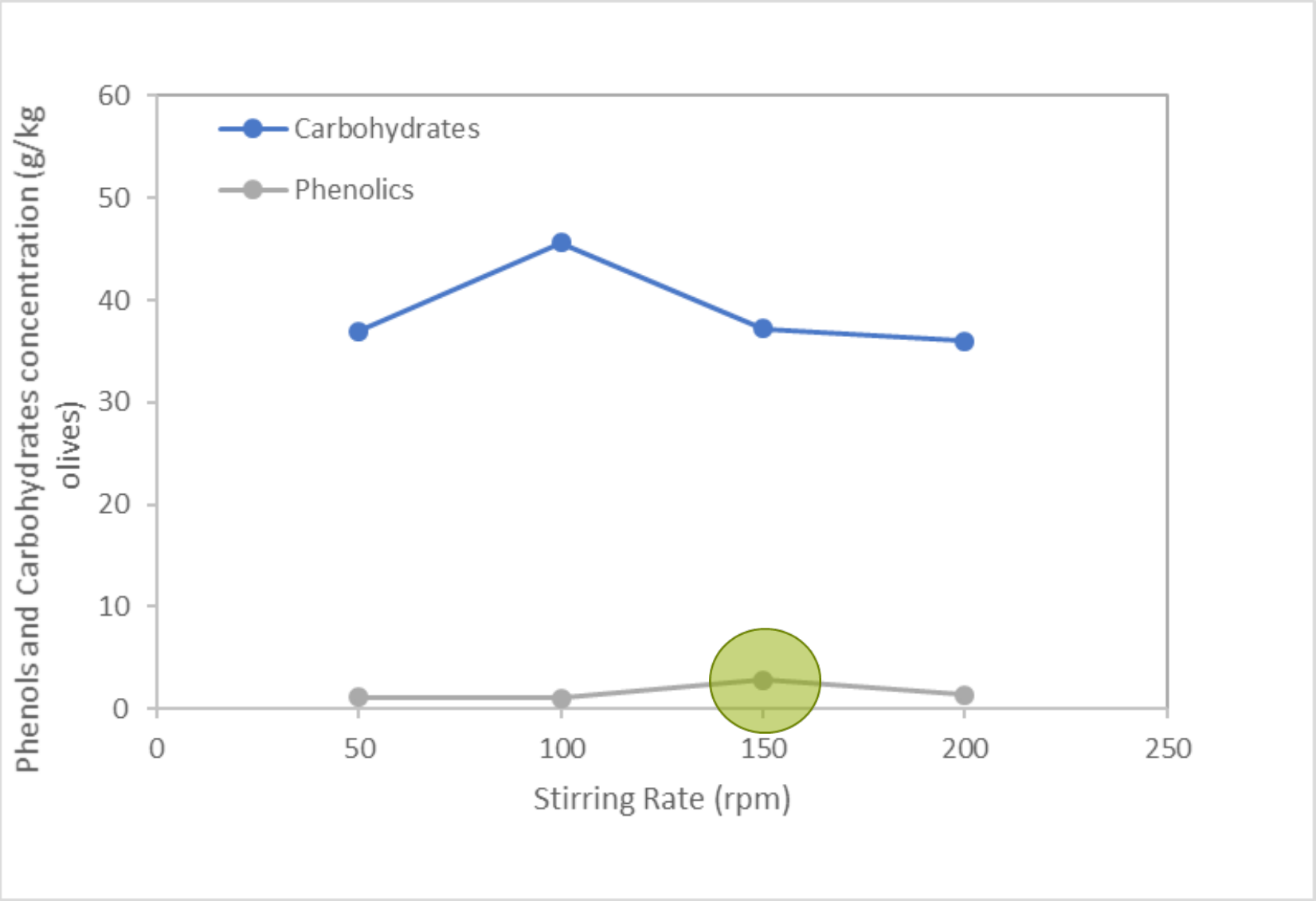
Phenols, Carbohydrates and COD concentrations as a function of volume of water used during the extraction of 10 g olive pulp.

2: Phenolic compounds



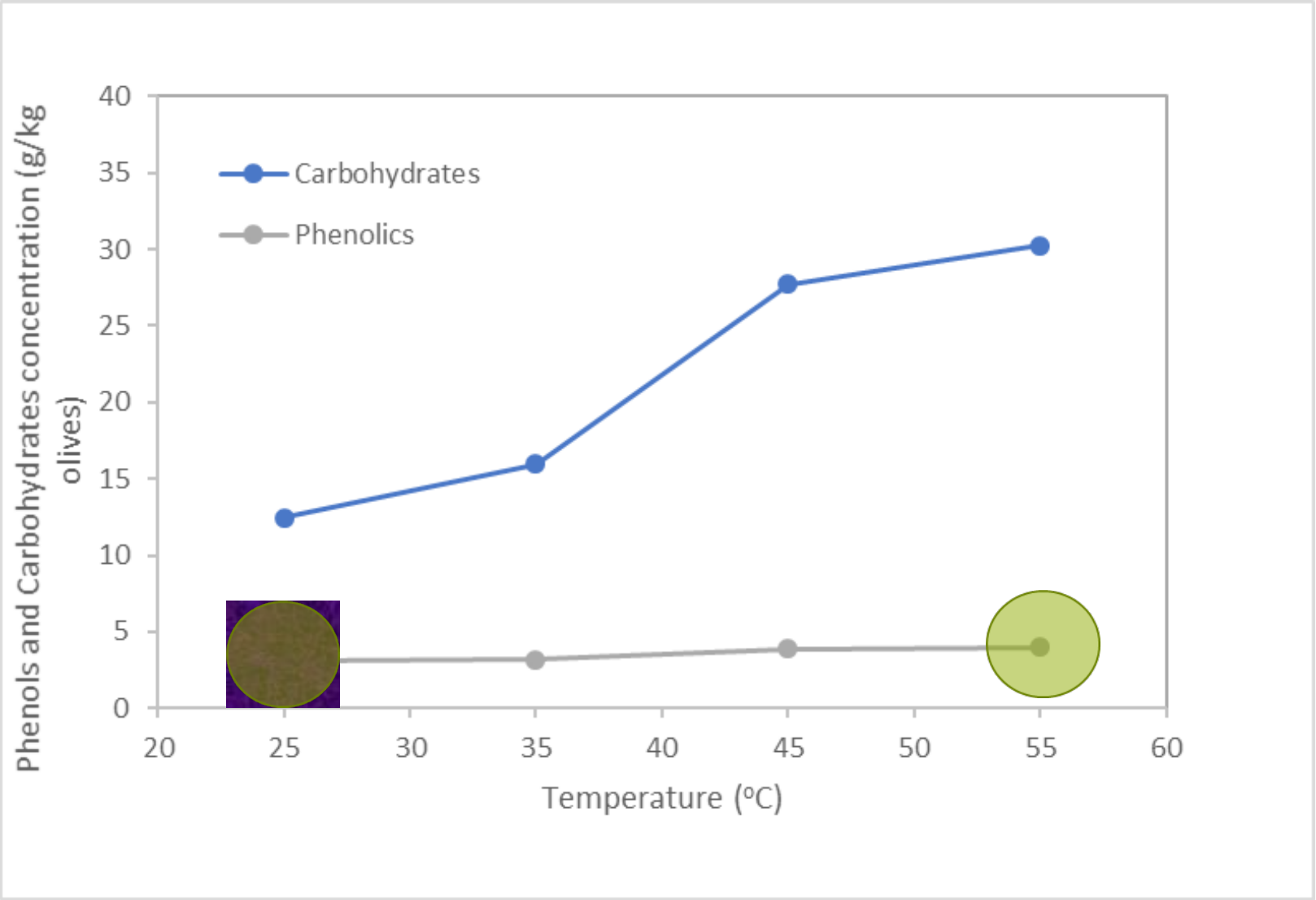
Concentrations of phenols and carbohydrates and COD as function of stirring duration used for the extraction of 20g of olive pulp in 200mL of water

New proposed scheme, Step No 4: Extraction of phenolics, Product 2: Phenolic compounds



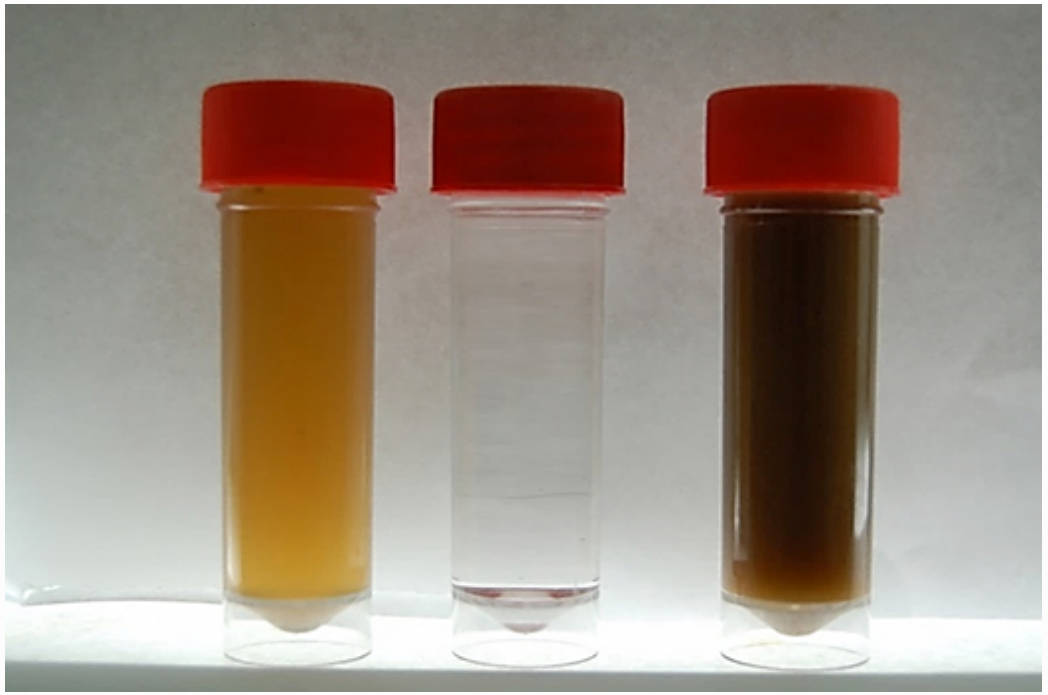
Concentrations of phenolics and carbohydrates obtained from the extraction of 20g of olive pulp using 200mL of distilled water at 150 rpm for stirring rates ranging between 50 and 200rpm.

New proposed scheme, Step No 4: Extraction of phenolics, Product 2: Phenolic compounds



Concentrations of carbohydrates, phenolics and COD as function of temperature for the range 25-60 °C

New proposed scheme, Step No 4: Extraction of phenolics, Product 2: Phenolic compound



Samples from the (a) extracted (2gr/L), (b) distillate and (c) concentrated solutions (50 gr/L) after rotary evaporation

Phenolics obtained in the form of powder after the freeze drying of the concentrate (10 % Ph, 20 % sugars, 65% different organics and inorganics)

With membrane filtration, resin adsorption/desorption, evaporation,

New proposed scheme
Step No 5: Exploitation of the remaining pulp

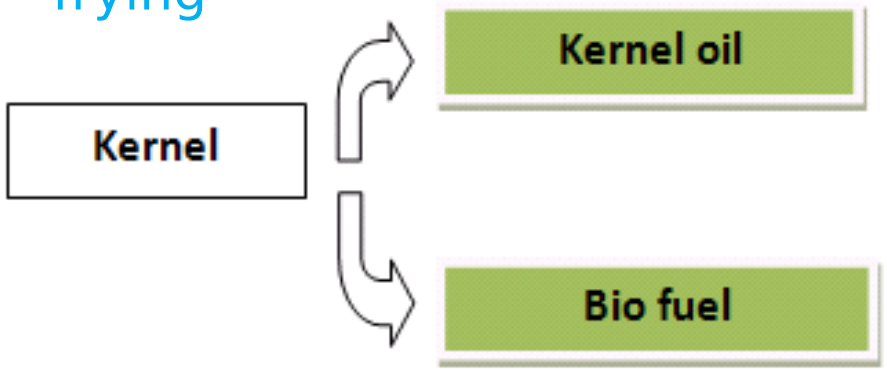
- Olive paste is a smooth puree made from ground olives frequently dressed with an extra virgin olive oil and offered with herbs and spices or plain (spread on melted cheese sandwich, toasted slices of baguette etc).
- Olive paste can also be used as animal feed

Step No 6: Exploitation of kernel residuals

Product no 4: Pomace oil

Product no 5: Pellets and briquettes

Extraction of pomace olive oil with hexane
(in extraction and distillation units)
This pomace olive oil is suitable for frying

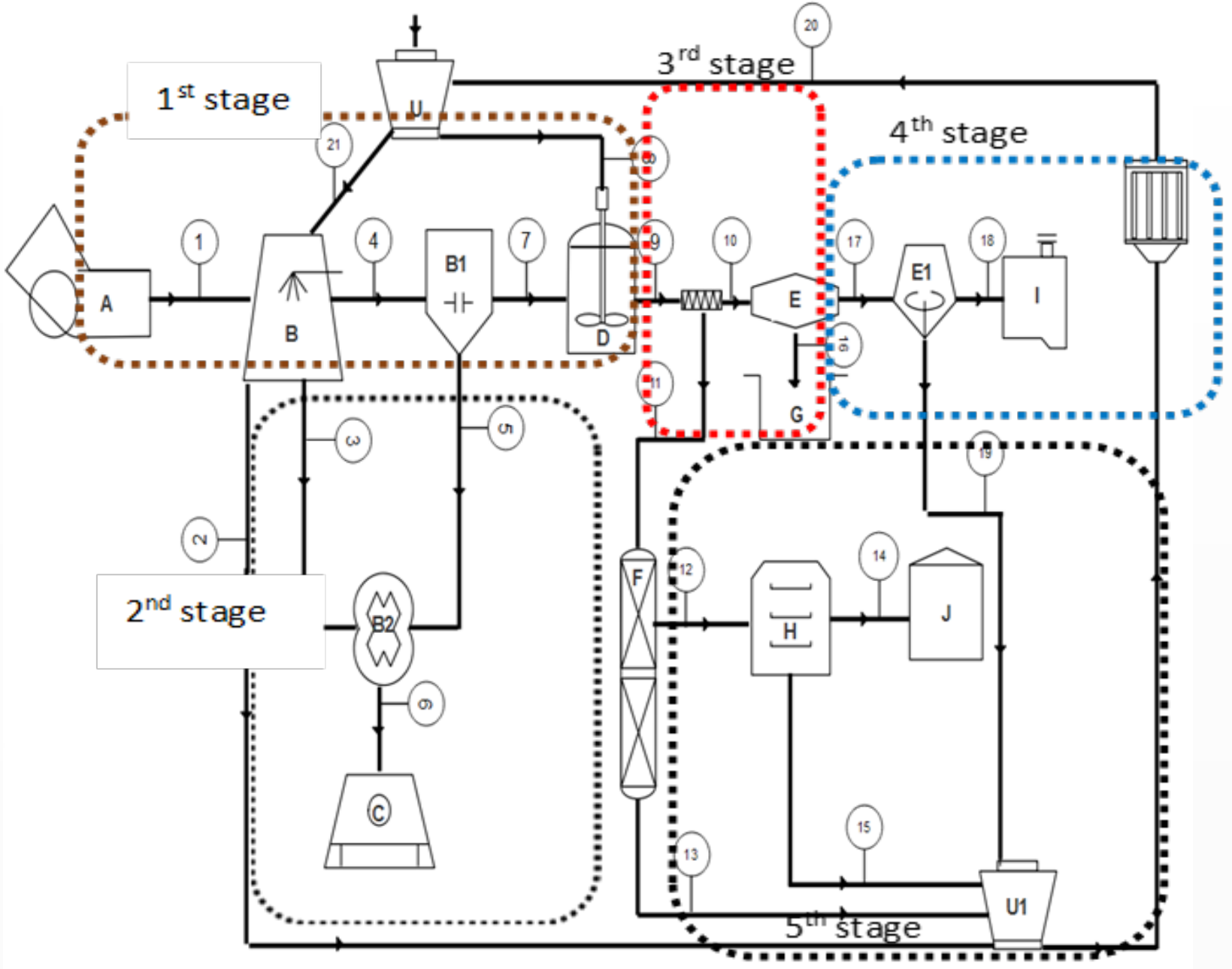


Conclusions

Solid/water	Extraction time	Temperature	Re-extraction	RPM
1:10	60 min	25°C	1	150

Olive fruits: 1000 kg				
Olive oil: 200kg				
	Olive fruit	Pulp	Kernel	2-phase semi solid waste
Weight kg	1000	810	190	800
TOC kg	300	231	69	200 (25%)
Humidity kg	607	538	69	480 (60%)
Phenols kg	6.3	4.7	1.6	4 (0.5%)

Separation			
Pulp + skin	Olive oil	organics	200 kg
	Phenols		5 kg
	Animal feed Edible paste	organics	25 kg
		inorganics	580 kg
Kernel	Pellet Pomace oil	organics	70 kg
		inorganics	120 kg



Process Flow Diagram (PFD)of the proposed scheme for the complete exploitation of olive fruits with almost zero wastes. Techno economical study and

Thank you for your attention

Acknowledgements

We acknowledge support of this work by the project “Innovative Actions in Environmental Research and Development (PErAn)” (MIS 5002358) which is implemented under the “Action for the Strategic Development on the Research and Technological Sector”, funded by the Operational Programme "Competitiveness, Entrepreneurship and Innovation" (NSRF 2014-2020) and co-financed by Greece and the European Union

Ευρωπαϊκή Ένωση
Ευρωπαϊκό Ταμείο Περιφερειακής Ανάπτυξης

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ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ ΕΠΑνΕΚ

ΕΠΑνΕΚ 2014-2020
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ΕΣΠΑ 2014-2020
ανάπτυξη - εργασία - αλληλεγγύη

Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης