

Impact of polyphenol content and gelator type on the structure of extra virgin olive oil-based oleogels

Ciuffarin Francesco*, Marilisa Alongi, Paolo Lucci, Sonia Calligaris, Maria Cristina Nicoli

E-mail: ciuffarin.francesco@spes.uniud.it

Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine



Oleogel

Oleogelation, is defined as process able to convert a liquid oil into an anhydrous, viscoelastic self-standing material called **oleogel**.

The final macroscopic structure is a gel-like material with functionalities comparable to those of plastic fats.

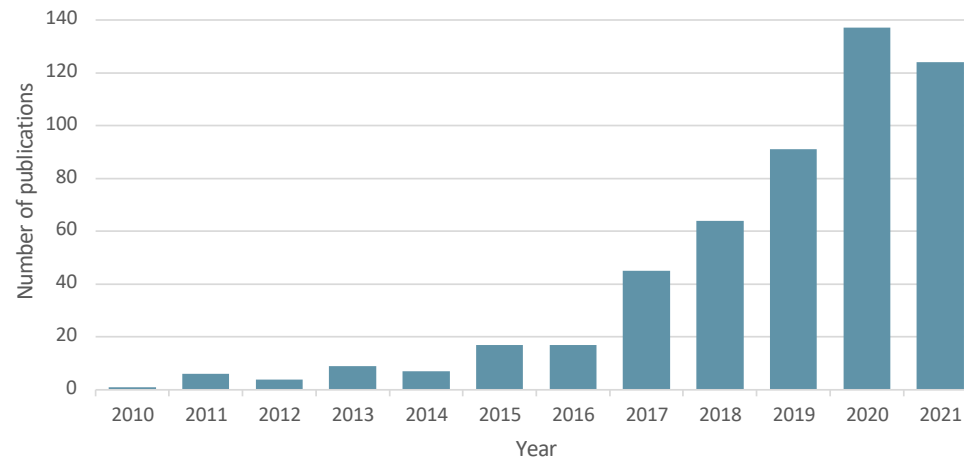


Background



Oleogel

The interest on this novel technology has increased over the last decade.



Articles containing the word "Oleogel" or "Organogel" in the title

Source Web of Science Core Collection

Background



Fat

Bioactive Molecules

Oleogel Functionalities

Technological

Nutritional

Substitution of saturated and trans fat while maintaining technological functionalities

Better sat / unsat fat intake

Modulation of lipolysis in intestinal phase

Protection and delivery of lipophilic molecules

Modulation of the release and enhancement of bioaccessibility

Background

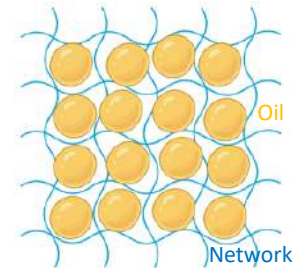
Oleogel Formulation

Direct method

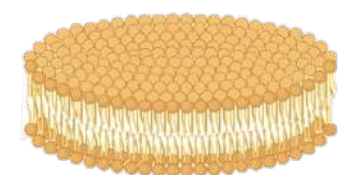


MACRO-structure

- LIPIDS**
 - Monoglycerides
 - Waxes
 - Phytosterols
 - Mixtures
- HYDROPHOBIC POLYMERS**
 - Ethylcellulose
 - Chitin



MICRO-structure



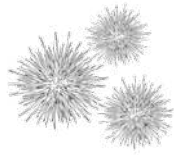
NANO-structure

Background



Liquid oil

+

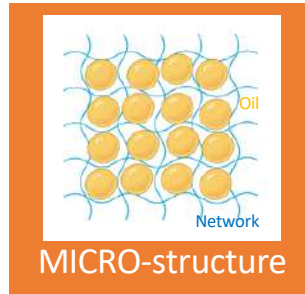


Gelator

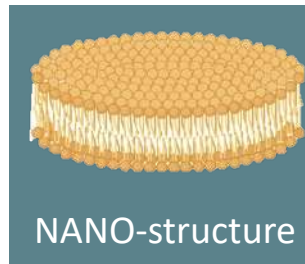
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MACRO-structure



MICRO-structure



NANO-structure

Oleogel Formulation

Direct method

Influenced by:

Composition variables

- Gelator Type
- Oil Composition
- Minor Components

Process variables

- Cooling Temperature
- Stirring during Cooling

Background

Extra Virgin Olive Oil

Is widely consumed within the Mediterranean diet

Represents an excellent fat source:

- Optimally balanced fatty acid profile
- Presence of minor components, such as polyphenols

Possible strategy to increase its use in foods, as well as modulate its digestibility behavior



Background



To investigate the possibility to gel EVOO.

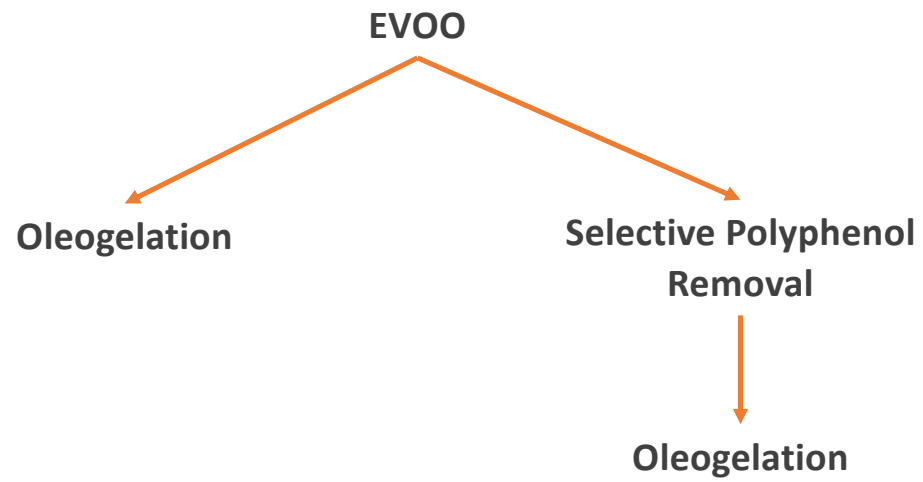
Aim



To investigate the possibility to **gel EVOO**.

Understand the **role of polyphenols on the structural and rheological properties** of oleogels.

Aim



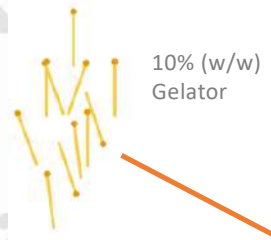
Experimental Design



EVOO

Oleogelation

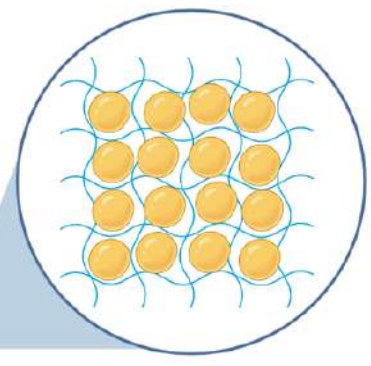
- Monoglycerides (MG)
- Rice Wax (RW)
- Sunflower Wax (SW)
- Phytosterols mixture (PS)



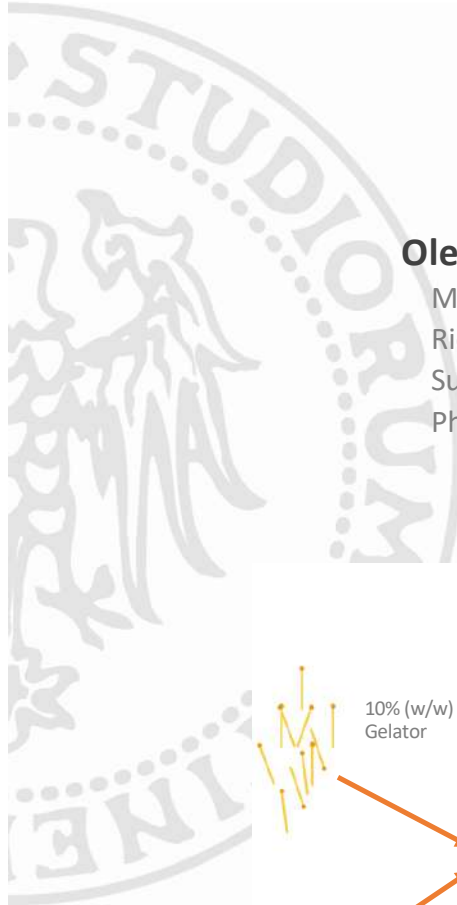
80 °C MG, RW, SW
90 °C PS



25 °C MG, RW, SW
4 °C PS



Material & Methods



EVOO



Oleogelation

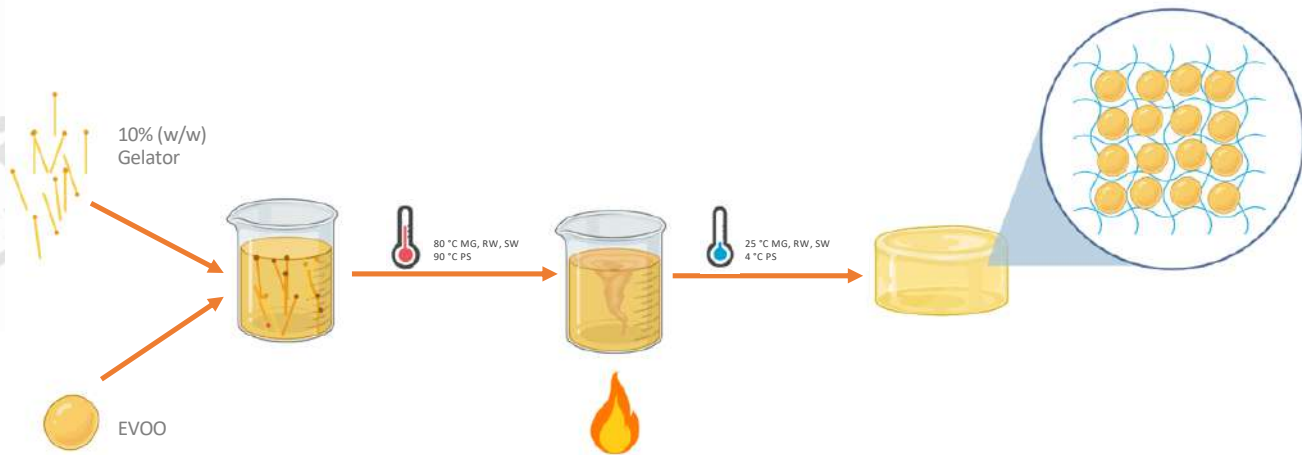
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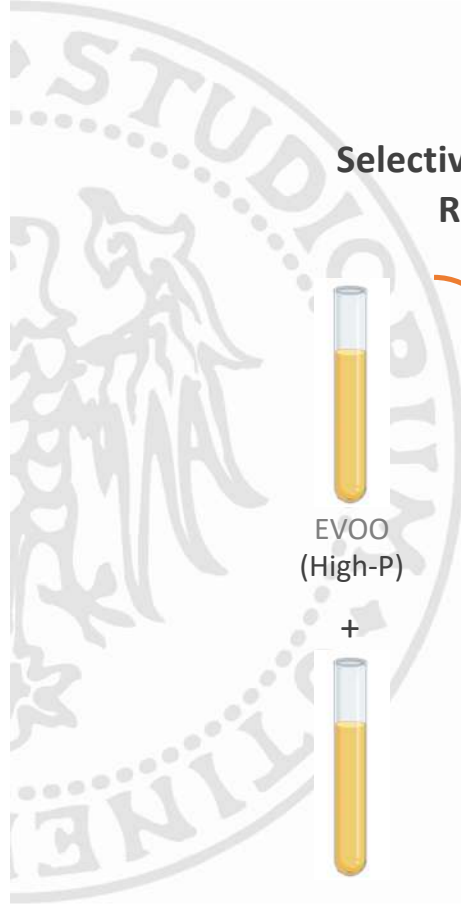
Physical Properties

- Macroscopic Appearance
- Polarized light microscopy

Mechanical Properties

- Oil binding capacity
- Rheological measurement
- Thermal Analysis





EVOO



Selective Polyphenol Removal



EVOO (High-P)

+



No-Polyphenol EVOO (No-P)

1:1



Medium-Polyphenol EVOO (Medium-P)



Oil Characterization

- Polyphenol Content
- 1,2/1,3 DAGs
- Tocopherols
- K232 – K270
- Peroxide Value
- Acidity
- Viscosity







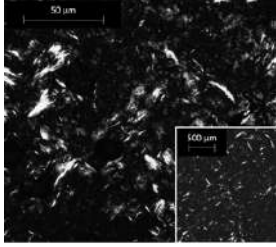
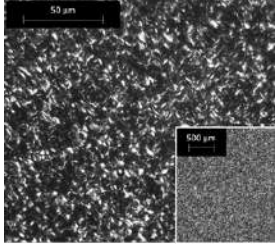
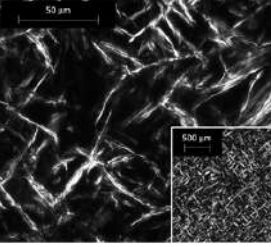

Material & Methods



On the possibility to gel EVOO.

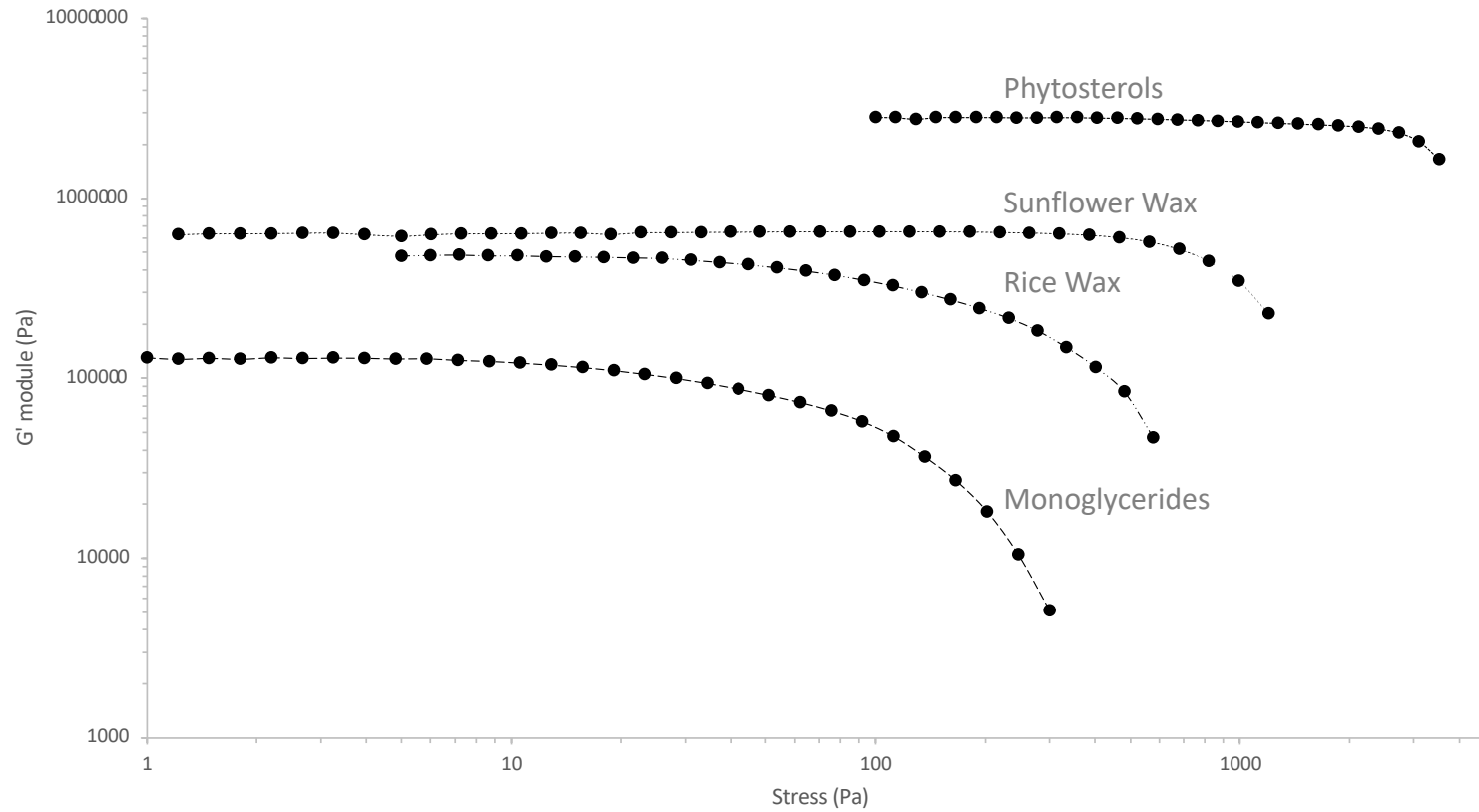
Results

Appearance

	MG Monoglycerides	RW Rice Wax	SW Sunflower Wax	PS Phytosterols
Macroscopic Appearance				
Microscopic Appearance				



Rheological Parameters



Great differences can be seen between different microstructures



On the **structural effect** of polyphenols.

Results

Oil chemical and physical profile

Oil Sample	Polyphenol Content (mg/kg)	1,2/1,3 DAGs	Tocopherols (mg/kg)	K232 (mg/kg)	K270 (mg/kg)	PV (mEq O ₂ /kg)	Acidity	Viscosity (Pa)
High-P (control)	322.9 ± 10.7 ^a	1.25 ^a	354.59 ± 2.13 ^a	2.24 ± 0.08 ^a	0.06 ± 0.01 ^a	7.6 ± 0.1 ^b	0.41 ± 0.01 ^a	0.077 ± 0.001 _a
Medium-P	173.0 ± 9.3 ^b	1.31 ^a	340.87 ± 2.31 ^b	2.13 ± 0.11 ^{ab}	0.04 ± 0.01 ^a	8.9 ± 0.1 ^a	0.32 ± 0.01 ^b	0.078 ± 0.002 _a
No-P	n.d.	1.39 ^b	340.80 ± 3.26 ^b	1.84 ± 0.06 ^b	0.06 ± 0.01 ^a	9.1 ± 0.2 ^a	0.24 ± 0.02 ^c	0.074 ± 0.003 _a

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Macroscopic Appearance

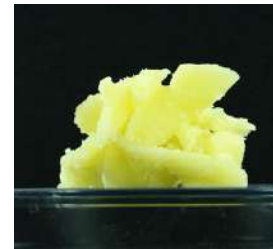
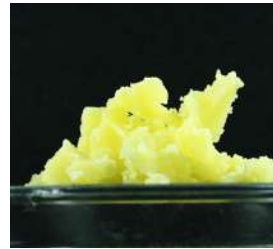
MG
Monoglycerides

RW
Rice Wax

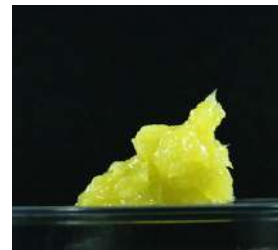
SW
Sunflower Wax

PS
Phytosterols

High-P
Control



Medium-P



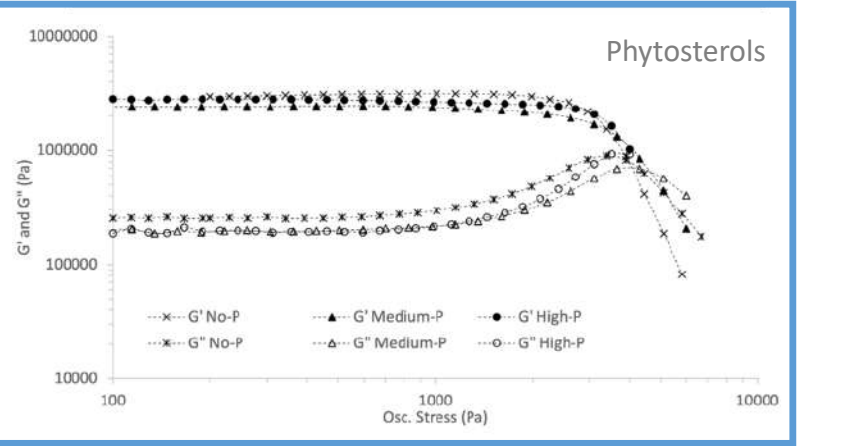
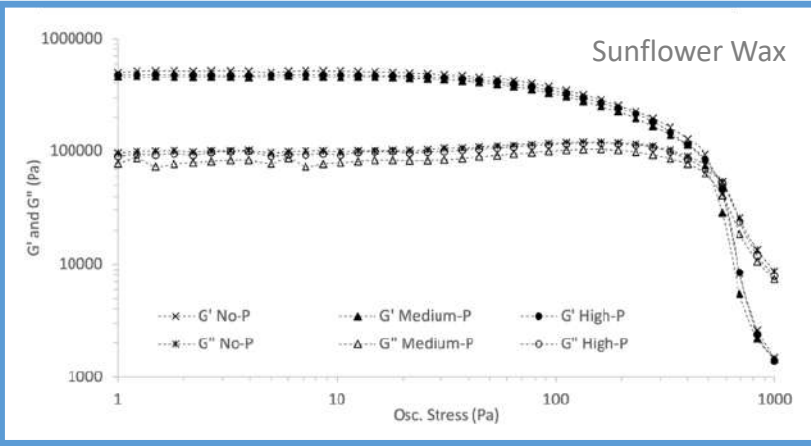
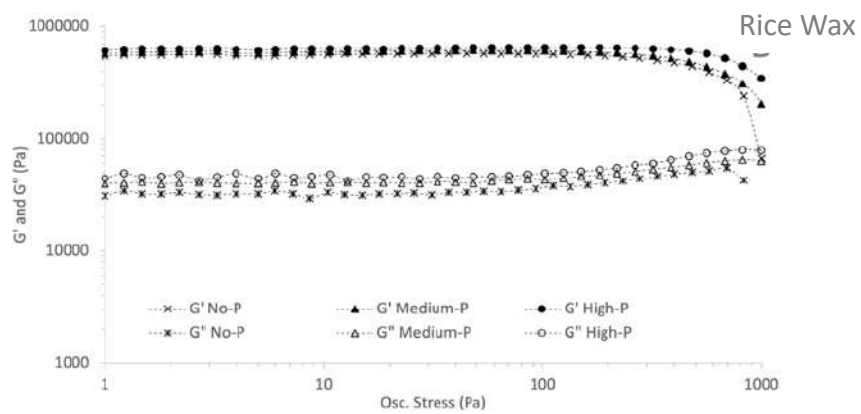
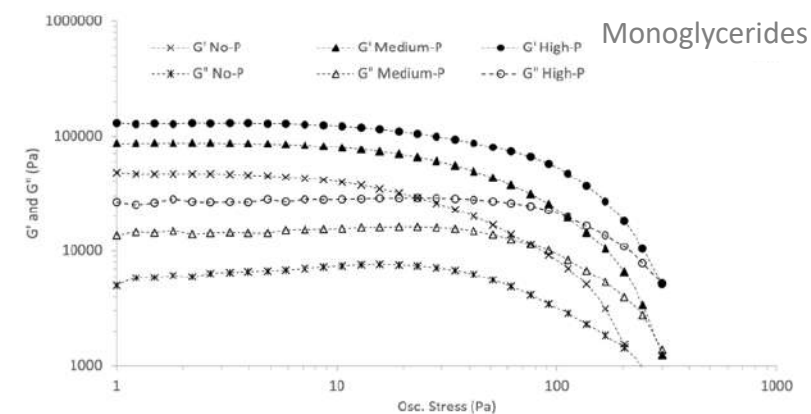
No-P



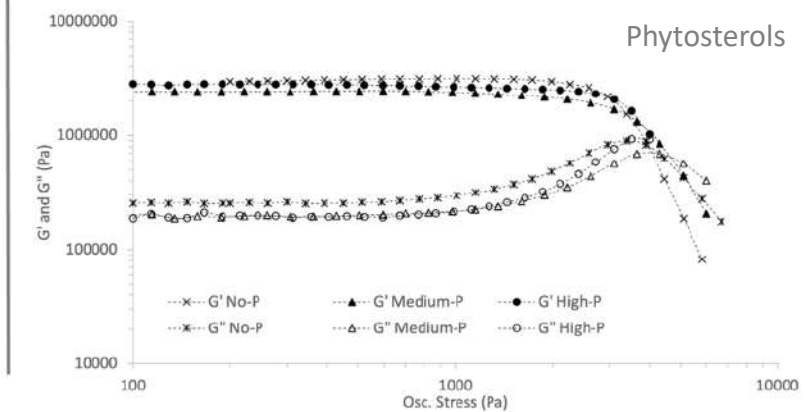
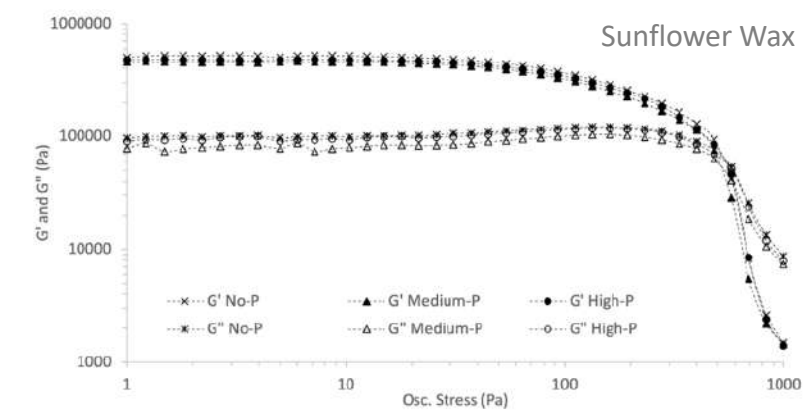
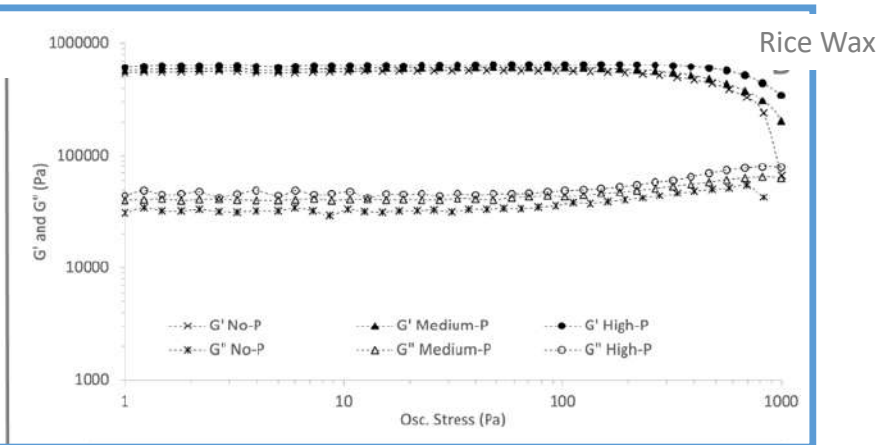
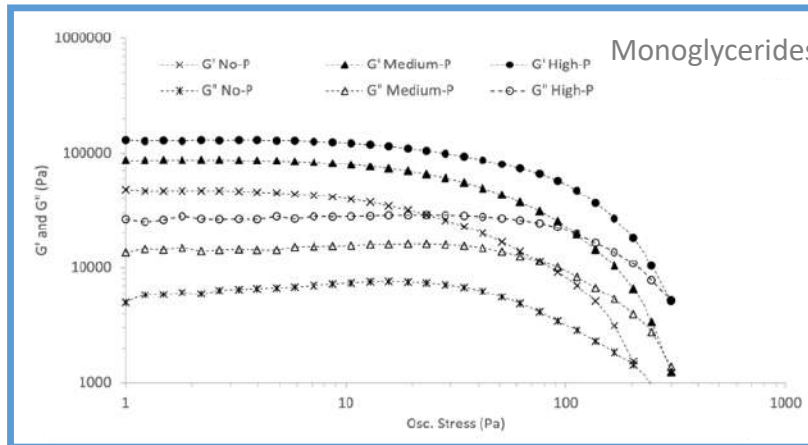
Oil Retention
under
Centrifugation
> 99.9%

Oleogel Characterization

Rheological Parameters



Rheological Parameters

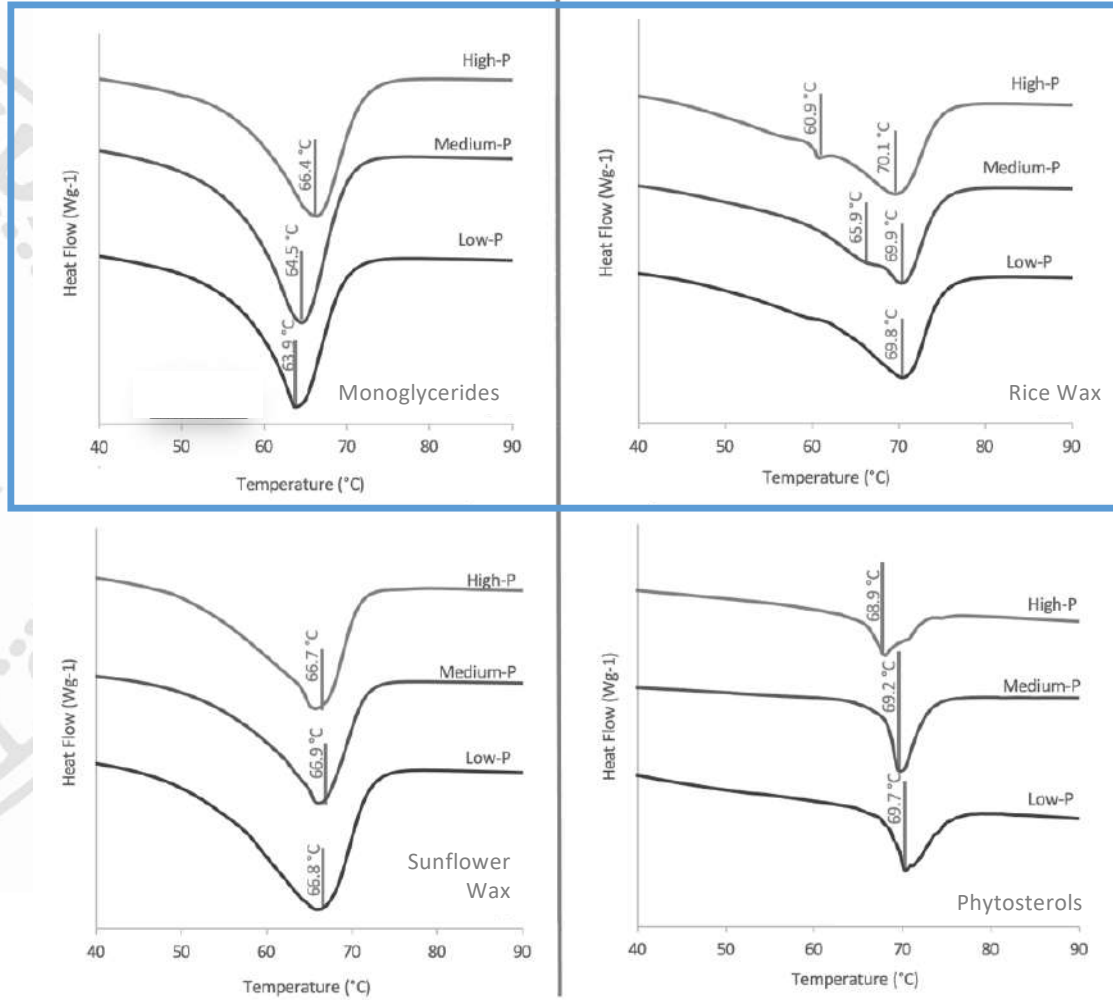


Rheological Parameters

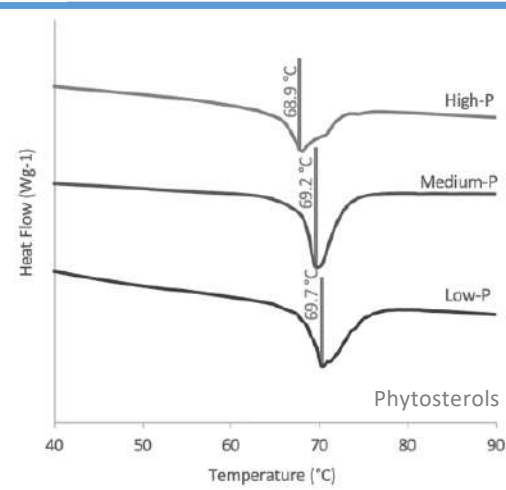
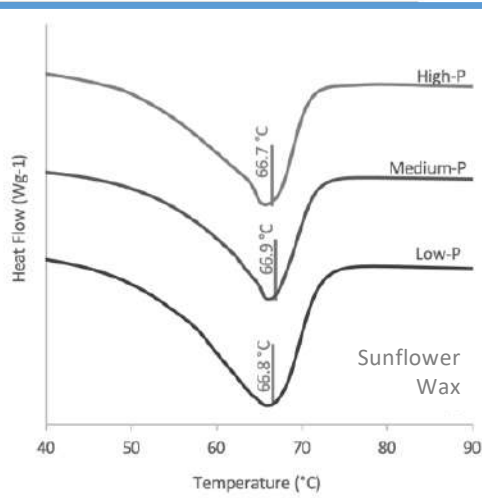
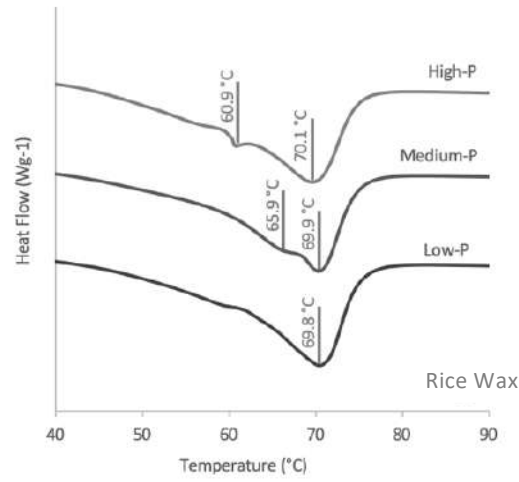
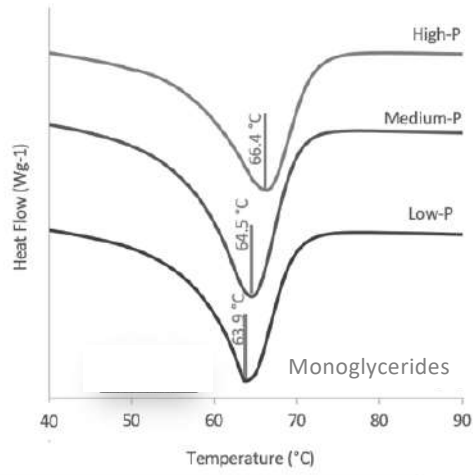
Oleogelator	Sample	$G' \times 10^4$ (Pa)	Critical stress (Pa)
Monoglycerides	High-P (control)	9.3 ± 1.0^a	12.32 ± 1.16^a
	Medium-P	8.2 ± 1.7^a	12.29 ± 2.95^a
	No-P	6.2 ± 0.7^b	7.61 ± 1.37^b
Rice Wax	High-P	68.1 ± 4.3^a	464.95 ± 7.06^a
	Medium-P	68.1 ± 6.7^a	317.56 ± 3.52^b
	No-P	68.7 ± 9.9^a	287.10 ± 17.60^c



Thermal Properties



Thermal Properties



Polarized Light Microscopy

MG
Monoglycerides

RW
Rice Wax

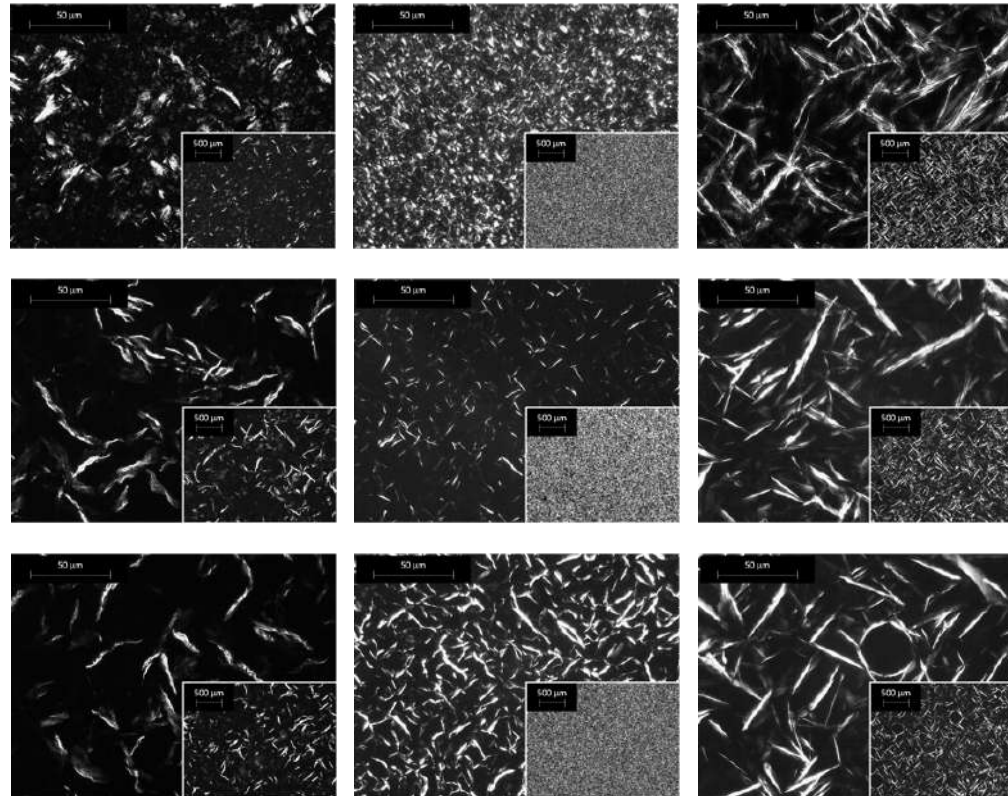
SW
Sunflower Wax

PS
Phytosterols



High-P
Control

Medium-P

No-P



Oleogel Characterization



EVOO can be structured in oleogel using as a gelators MG, RW, SW
and PS

Conclusions



EVOO can be structured in oleogel using as a gelators MG, RW, SW and PS

Polyphenols could differently impact the structure of oleogels. MG and RW were the most affected samples probably due to the participation of polyphenols to the structure.

Conclusions



Thanks for your
Attention