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Green next generation biomaterials from virtuous recovery of grape processing waste bentonite

Giulia Di Prima¹, Elena Belfiore², Giuseppe Angellotti^{1,x}, Viviana De Caro¹

¹Dipartimento STEBICEF, UNIPA, Via Archirafi 32, 90123, Palermo, Italia

²Dipartimento DICHIRONS, UNIPA, Via L. Giuffrè 5, 90127, Palermo, Italia

^xPresent affiliation: ISMN-CNR, Via U. La Malfa 153, 90146, Palermo, Italia

INTRODUCTION & AIM



According to the **UN Agenda 2030**, several actions could be taken to act synergistically towards various areas of critical importance for both the humanity and the planet. Among them, the application of a **circular economy model** based on the **valorisation of the waste** could be a virtuous attitude. Even more, the recycle of waste from the **local manufacturing** could maximize the impact of the circular economy idea by enhancing the territorial resources and creating new products free from additional raw materials consumption.

In this view, this work proposes a **dual green approach** to produce **novel functional biomaterials** by recovering the waste **black bentonite (BB)** from the fining of **Sicilian organic white grape must**. Indeed, this virtuous recovery idea is enhanced by the choice of both **eco-friendly extraction method and unconventional solvents**. This choice perfectly fit with an **industrial, easily scalable and waste-to-market approach** as well as with the **SDGs 12, 8 and 3** of the UN agenda 2030.



Recovery and storage of the waste BB

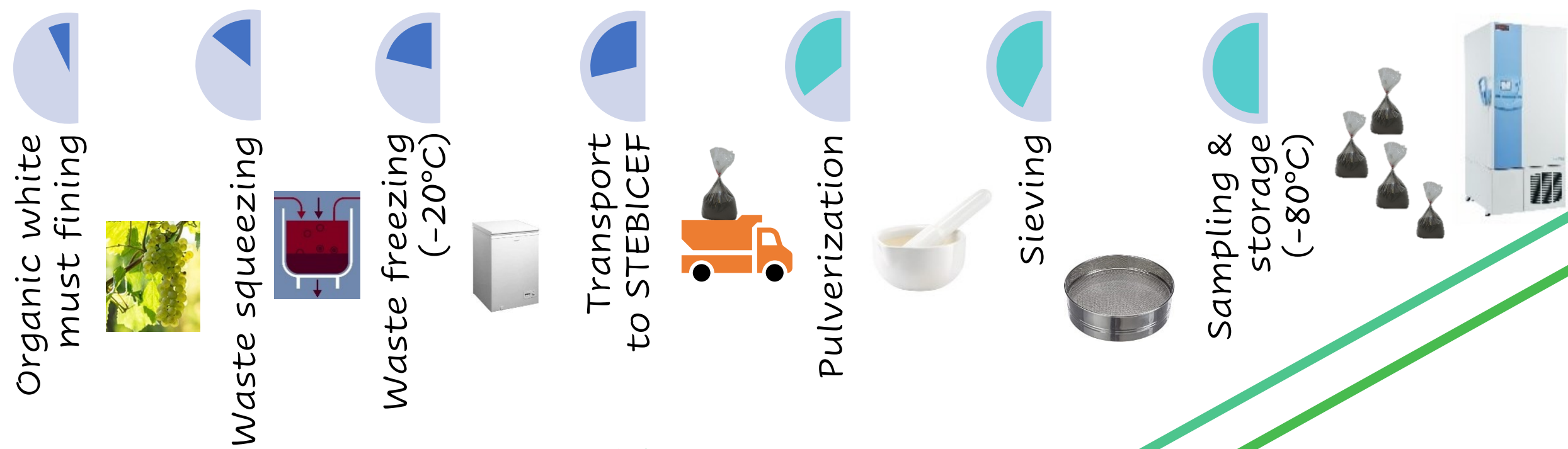
Pre-treatments

Extraction procedure

Extracts characterizations

Biological evaluations

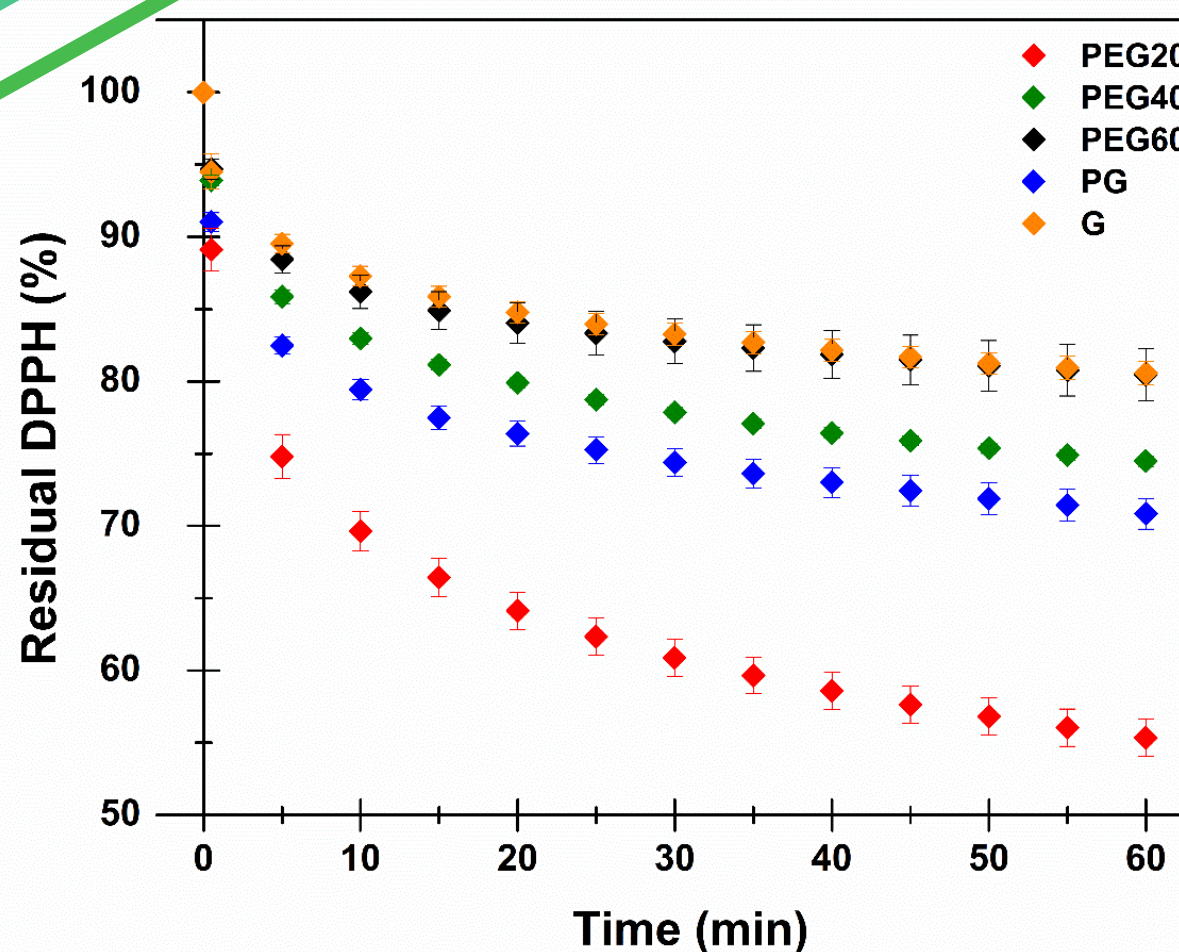
RECOVERY & PRE-TREATMENTS



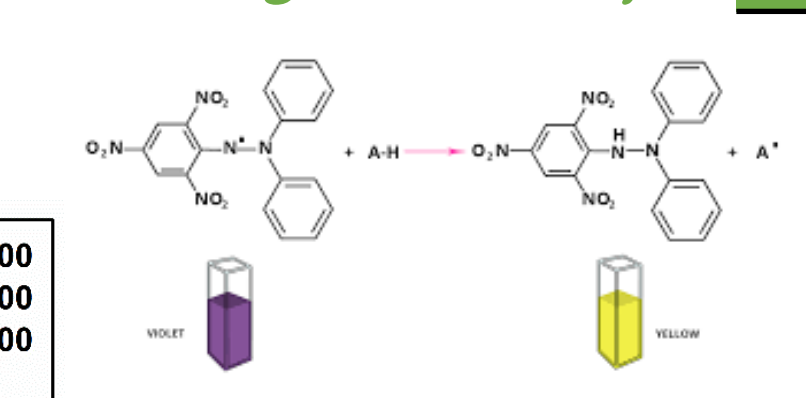
EXTRACTION

1. Maceration with **PEGs (200, 400, 600), Propylene Glycol and Glycerine** for 1 h in the dark (25±1°C)
2. Centrifugation
3. Filtration

AP: **Antioxidant Power at 60 min** Determined by the **DPPH assay** Expressed as **mg GA equivalent per gram of extract**



Antioxidant & Scavenger activity



Sample	AP at 60 min
PEG200	1.304 ± 0.047
PEG400	0.602 ± 0.014
PEG600	0.378 ± 0.068
PG	0.732 ± 0.036
G	0.369 ± 0.030

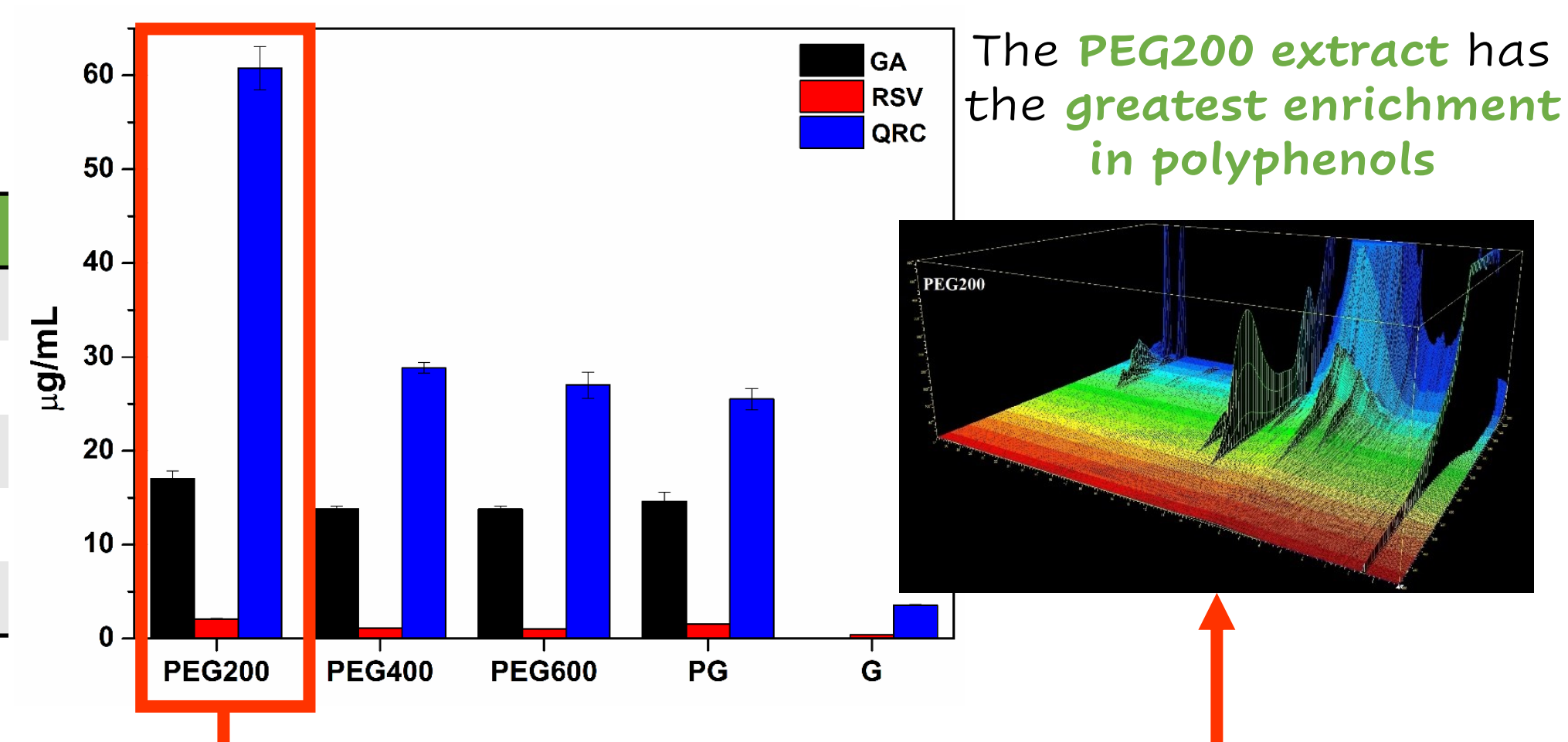
EXTRACTS CHARACTERIZATIONS

Five coloured and viscous liquid extracts were obtained, studied & compared

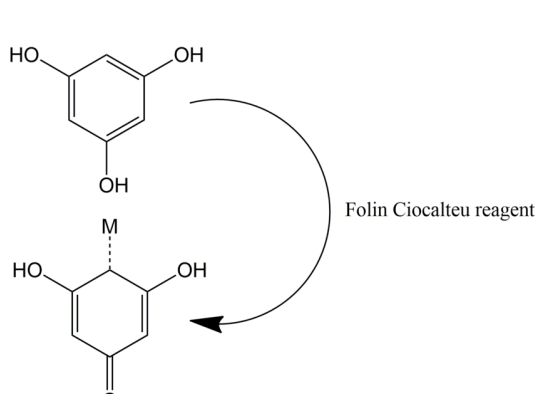


Sample	Yield%	Density (g/mL)	pH after water dilution
PEG200	65.7 ± 2.4	1.140 ± 0.005	4.47 ± 0.14
PEG400	63.3 ± 2.0	1.122 ± 0.005	3.54 ± 0.06
PEG600	49.0 ± 10.0	1.111 ± 0.009	3.57 ± 0.02
PG	71.8 ± 1.9	1.039 ± 0.004	4.30 ± 0.21
G	35.3 ± 6.0	1.226 ± 0.005	3.45 ± 0.01

HPLC-DAD analyses



The **PEG200 extract** has the **greatest enrichment in polyphenols**



TPC: **Total Phenolic Content** Determined by the **Folin-Ciocalteu assay**

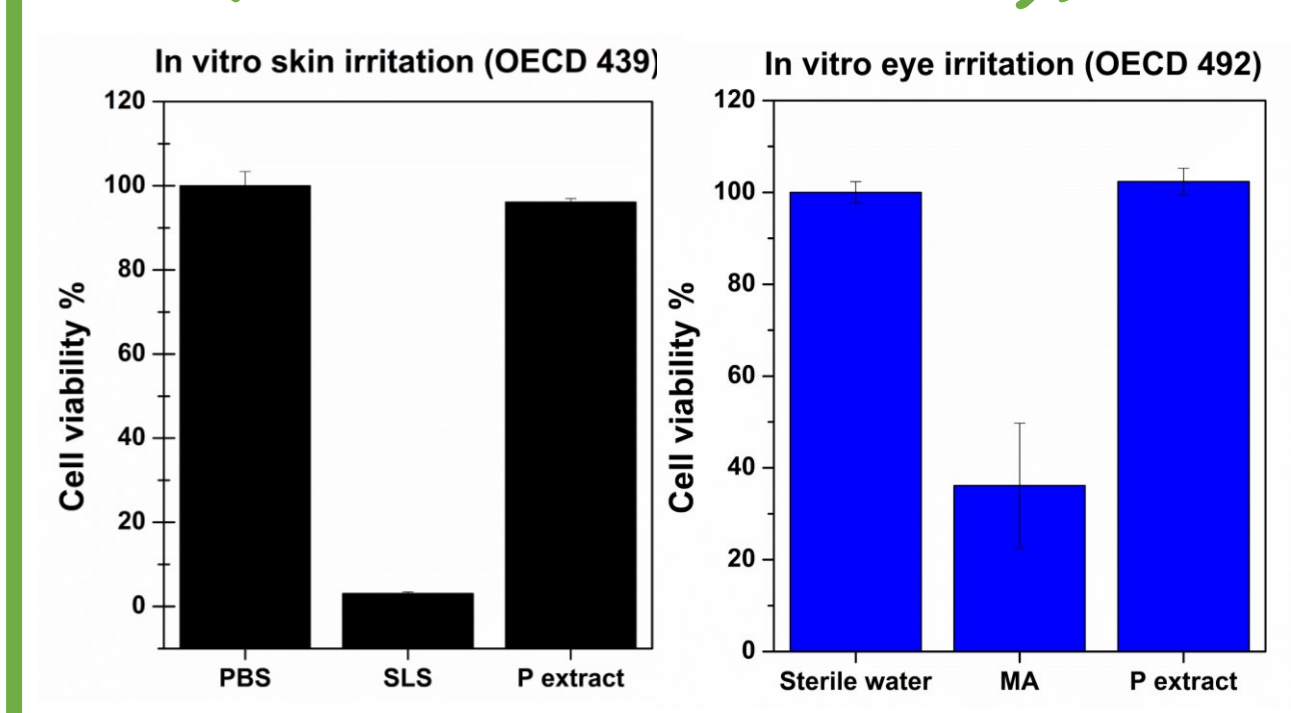
Expressed as **mg GA equivalent per gram of extract**

Sample	TPC (mg/g)	TPtC (mg/g)
PEG200	3.123 ± 0.106	0.250 ± 0.016
PEG400	2.090 ± 0.122	0.186 ± 0.002
PEG600	1.713 ± 0.187	0.175 ± 0.007
PG	1.827 ± 0.071	0.156 ± 0.013
G	1.618 ± 0.067	0.211 ± 0.007

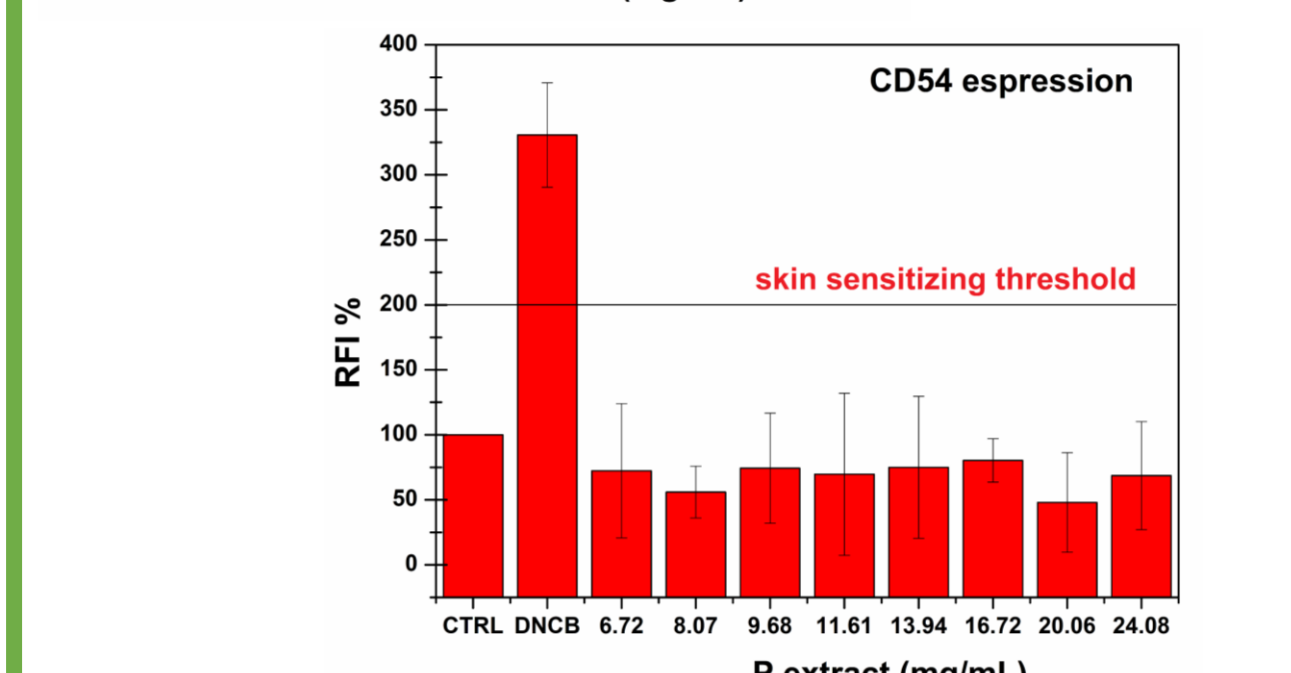
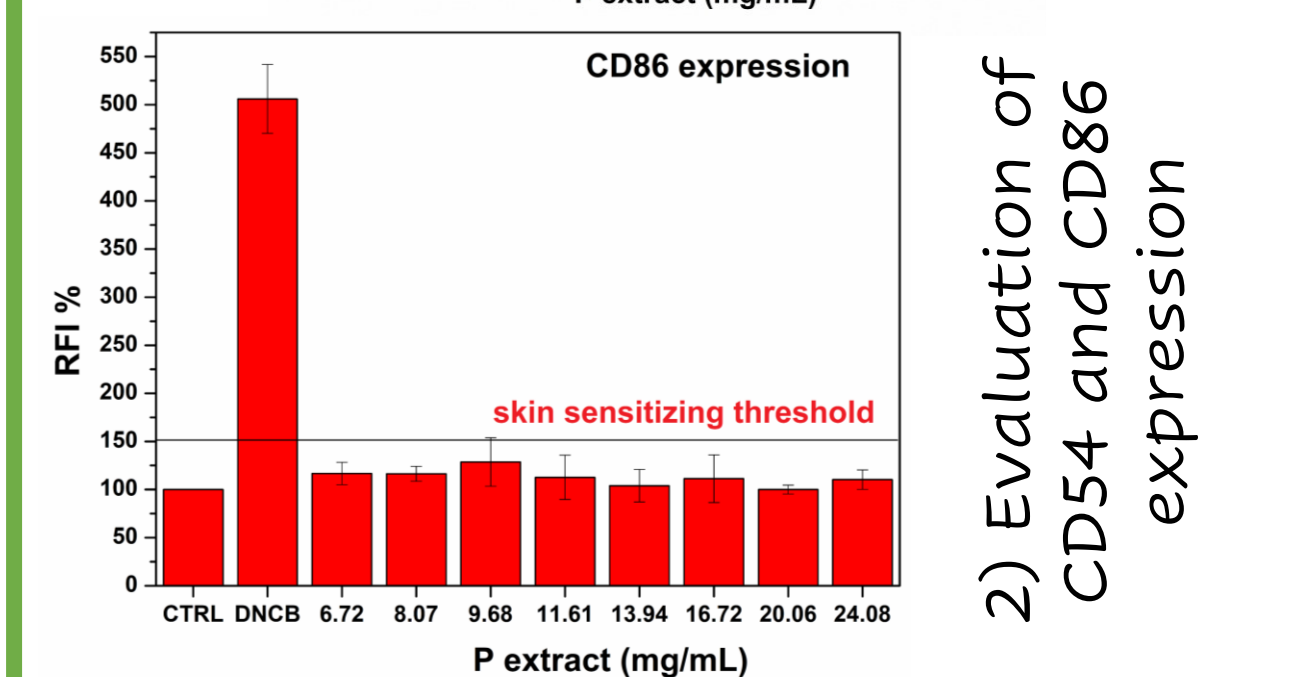
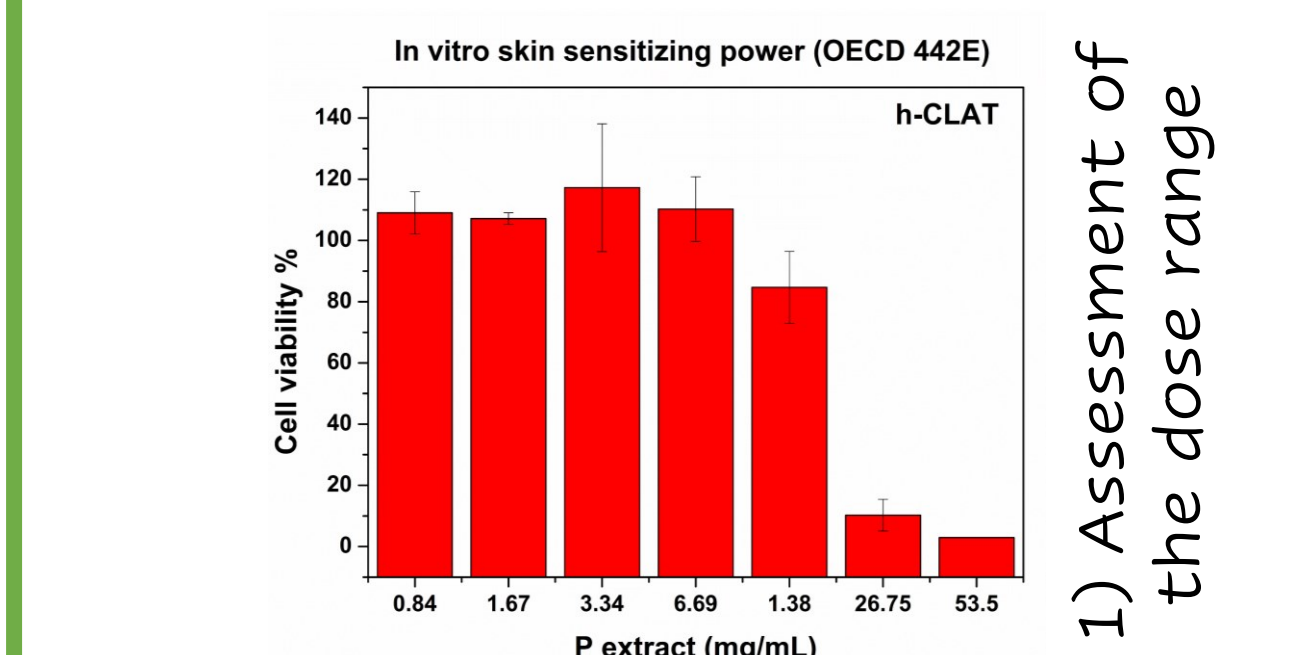
TPtC: **Total Protein Content** Determined by the **Bradford assay**

Expressed as **mg BSA equivalent per gram of extract**

BIOLOGICAL EVALUATIONS (PEG200 extract only)



The **PEG200 extract** is **cytocompatible** against **3D in vitro reconstructed epidermis and cornea**



The **PEG200 extract** does **not** determine skin sensitizing effects against **THP-1 cell line**

CONCLUSIONS

Here for the first time the **waste BB** from white organic grape must fining has been proven as a **valuable source of precious polyphenols** useful to obtain **novel biomaterials as functional ingredients** for both cosmetics and pharmaceuticals. Particularly, **PEG200** emerged as the most effective extraction solvent, leading to a **coloured extract** enriched in polyphenols and characterized by relevant **scavenger properties**. Additionally, it did not give nor ocular neither skin irritation and sensitizing effects, thus suggesting its **safety** for in human application.

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