Hydrophobic and hydrophilic Deep Eutectic Solvents to obtain green extracts with biological activity

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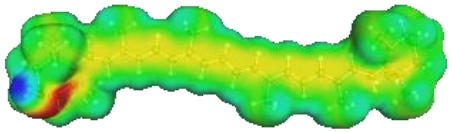
INTRODUCTION

Deep eutectic solvents (DES)

Fermentable sugars
Carbohydrate polymers
Flavonoids
Polyphenols
Vitamins
Essential oils

Carotenoids

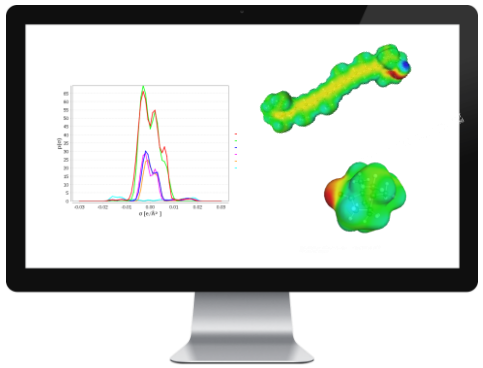


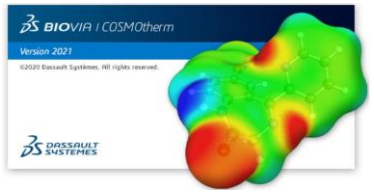
THE AIM of the present study was to select the most promising DES for carotenoid extraction from orange peel and obtain green extracts with biological activity following the principles of green chemistry.

DES → Green extraction → Hydrophobic and Hydrophilic → Based on nature compounds → Replace organic solvents

METHODOLOGY

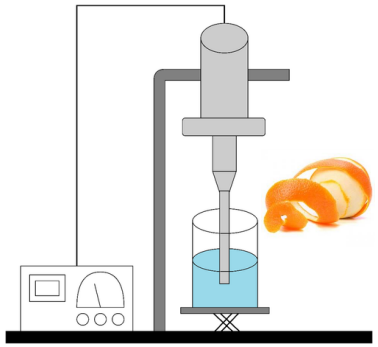
1. COSMOtherm screening





68 Hydrophobic and Hydrophilic DES

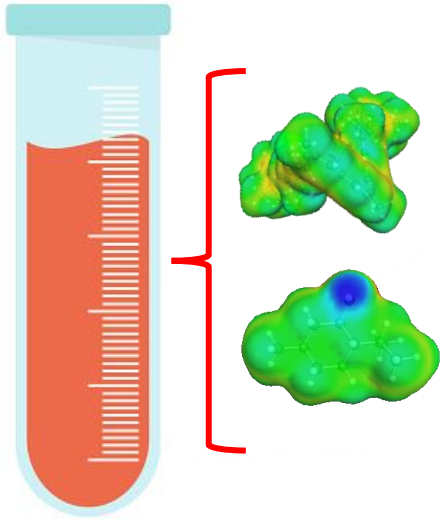
2. Experimental validation



Ultrasound-assisted extraction

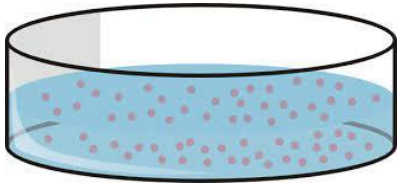
Total carotenoid content spectrophotometrically

3. Green extracts



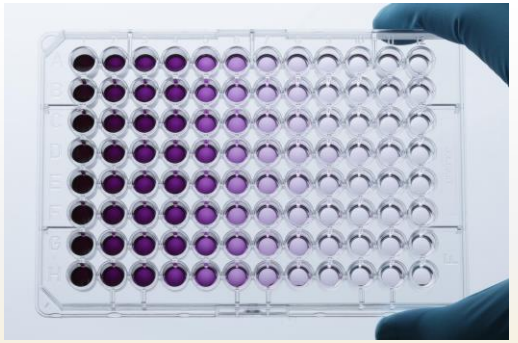
Menthol: Camphor (Me: Cam)
Menthol: Eucalyptol (Me: Eu)
Lauric Acid: Octanoic acid (C12:C8)
Proline: Malic acid (Pro: MA)
Choline chloride: Urea (ChChl: U)

4. Biological activity



In vitro antiproliferative assay HeLa cells

MTS assay



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RESULTS AND DISCUSSION

Predicted ln $\gamma_{solutes}$ for β-carotene and β-cryptoxanthin in DES using COSMO-RS.

NADES	Abb	Ratio	β-carotene ln $\gamma_{solutes}$	β-cryptoxantin ln $\gamma_{solutes}$
Hexane	Hex	1	-0.27	2.06
L-Menthol: D.L- Camphor	Me: Cam	1:1	0.56	-0.59
L-Menthol: Eucalyptol	Me: EU	1:1	0.65	-0.37
L-Menthol: Thymol	Me: Ty	3:2	1.28	0.07
L-Menthol: Linoleic acid	Me: C18:2	1:1	1.48	0.19
L-Menthol: Decanoic acid	Me: C10	1:1	1.81	0.41
L-Menthol: Octanoic acid	Me: C8	1:1	1.94	0.03
Thymol: Coumarin	Ty: Cou	3:2	2.01	0.20
L-Menthol: Peryllic acid	Me: PA	1:1	2.07	0.40
Thymol: Octanoic acid	Ty: C8	1:3	2.12	-0.20
Lauric acid: Decanoic acid	C12: C10	1:3	2.55	0.31
Lauric acid: Octanoic acid	C12: C8	1:3	2.72	0.42
Proline: Malic acid	Pro: Ma	1:1	16.80	13.59
Betaine: Ethylene glycol	B: EG	1:2	17.74	14.84
Choline Chloride: Lactic acid	ChChl: LA	1:3	17.87	14.86
Sorbose: Ethylene glycol	Sor: EG	1:2	17.90	17.59
Betaine: Lysine	B: Lys	1:1	18.25	15.37
Betaine: Malic acid: Proline	B: Ma: Pro	1:1:1	18.53	15.60
Fructose: Ethylene glicol	Fru: EG	1:2	19.20	18.90
Choline: Chloride: Ethylene glycol	ChChl: EG	1:2	19.28	16.40
Betaine: Sucrose	B: Suc	4:1	19.55	16.57
Water		1	36.6	33.554

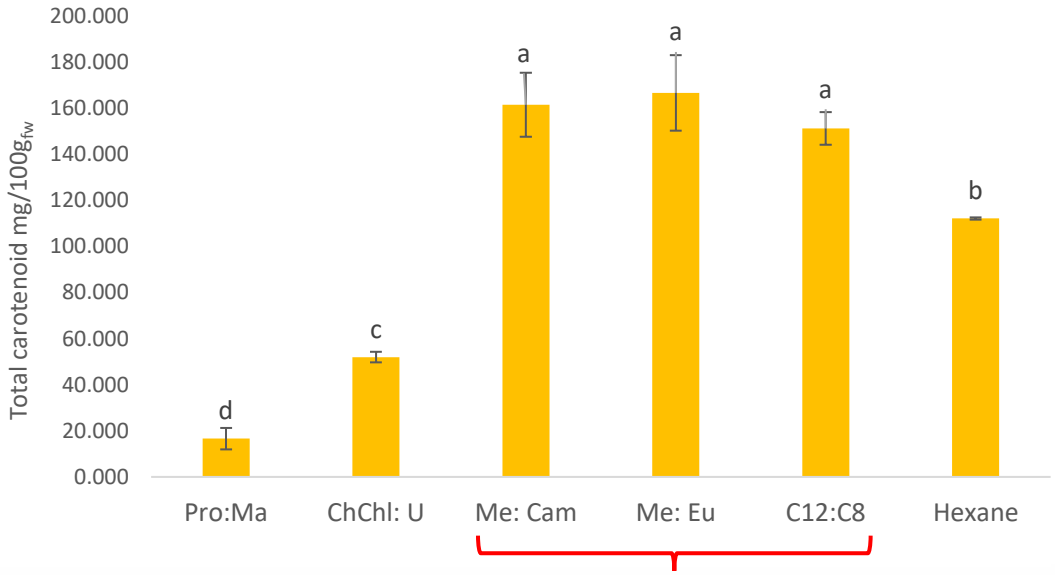
HYDROPHOBIC DES

HYDROPHILLIC DES

	High
	Medium
	Low

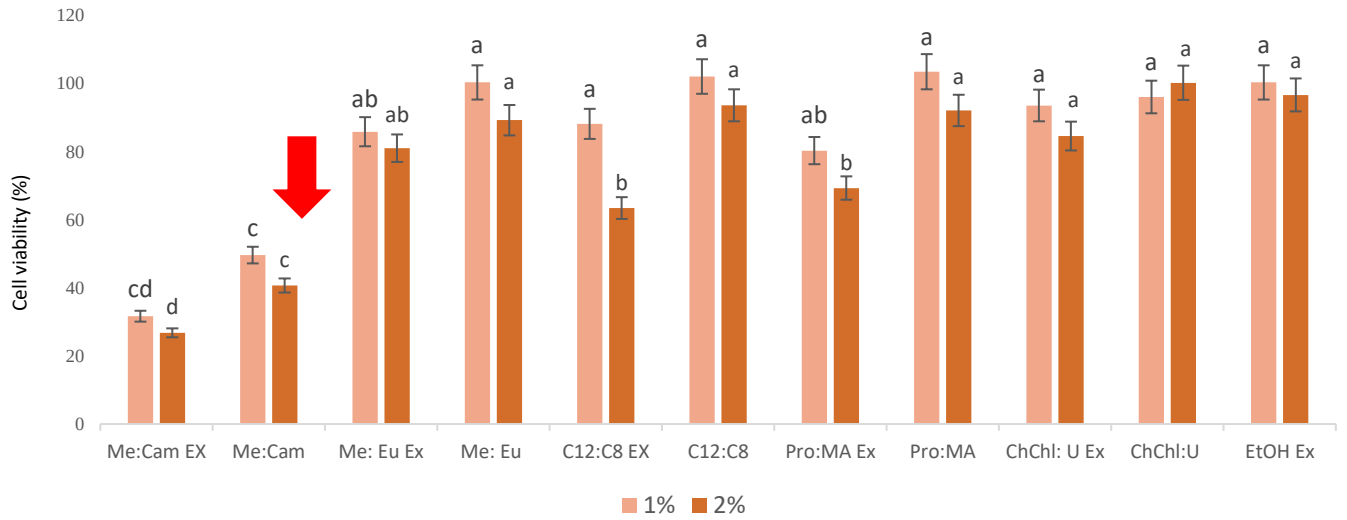
RESULTS AND DISCUSSION

Total carotenoid content (mg/100g_{fw}) in hydrophilic and hydrophobic DES selected for model validation.



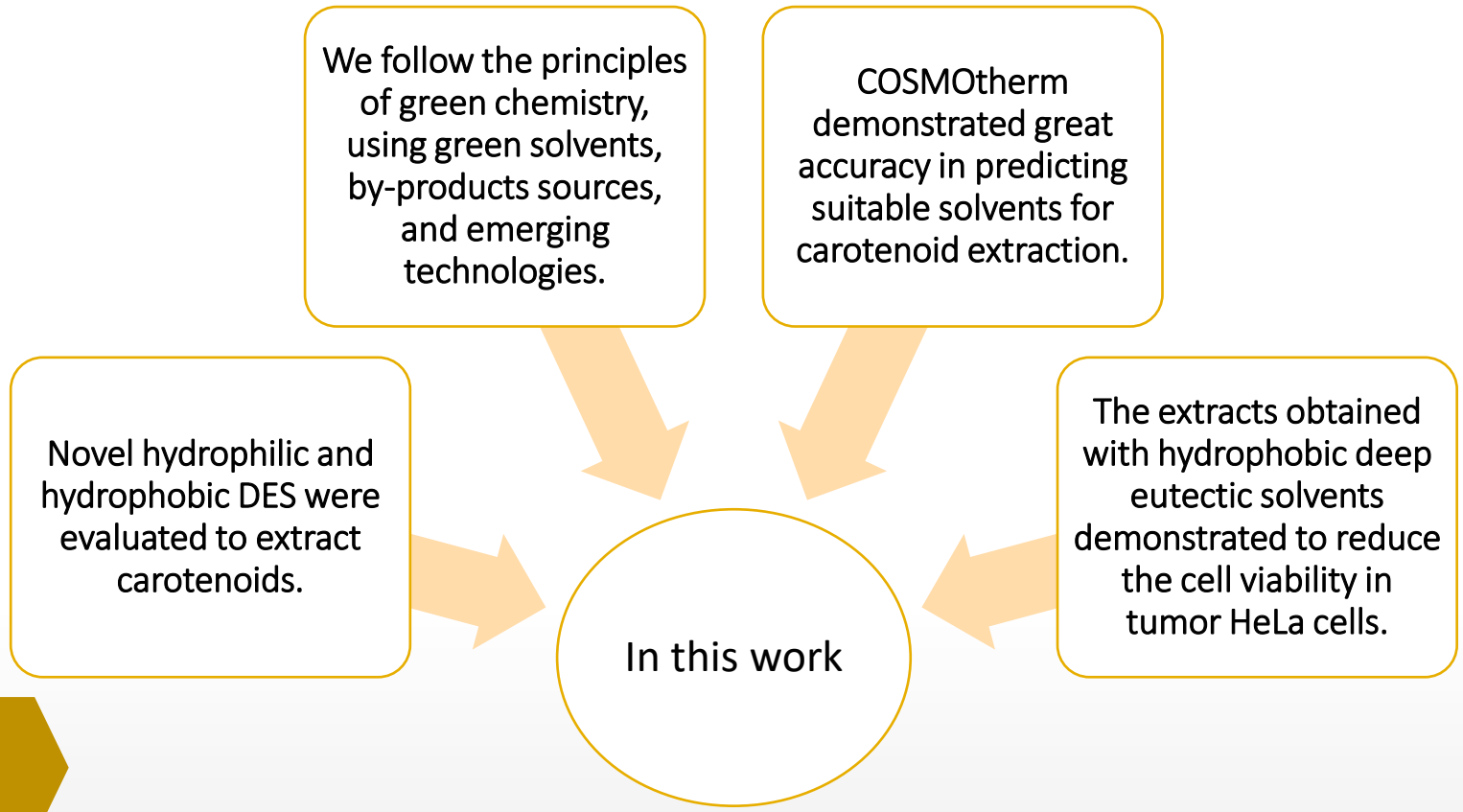
Good prediction of COSMOtherm

Effect of DES extracts on HeLa cell viability determined by the MTS assay, it was assessed in volume ratio 1% - 2% (v/v).



HeLa cells showed a 26.70% of cell viability in Menthol: Camphor extract

Conclusion and future trends



The fundamental benefit of the obtained extract is that the whole formulation (DES and bioactive compound) can be included in the final products.

DES are expected to replace other conventional solvents in the short future; however, more research should be directed to the study of their application in food formulations.

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