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Selecting the most promising Natural Deep Eutectic Solvent for greener extractions of carotenoids from orange peels

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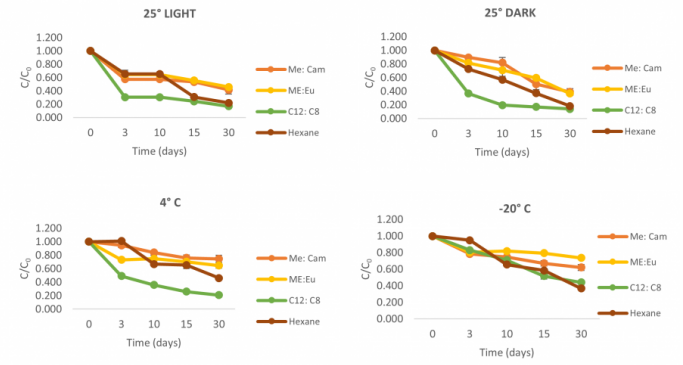
PURPOSE OF THE ABSTRACT

Introduction: Carotenoids are a group of pigments recognized for its preventive effects in developing cardiovascular diseases, cancer, macular degeneration, and cataract formation. Additionally, Pro-vitamin A carotenoids play an important role in human health for their antioxidant properties and immune system activity [1,2]. Extraction and quantification of carotenoid is an important step for food industry in order to concentrate them for their inclusion in food products in proper doses for human consume. Traditional extraction of carotenoids is usually performed using organic solvents with toxicological effects in environment and human health [3]. Development of greener solvents and techniques for the extraction of high value compounds is one of the principles of green chemistry and a concern for food industry. Natural Deep Eutectic Solvents (NADES) are a new generation of solvents that comply with the requirements of green extractions and can successfully replace other organic solvents [4]. Objective: The aim os this study was select the most promising NADES for carotenoid extraction from orange peels considering parameters as efficiency, stability, price, and antioxidant activity. Methods: Orange peels (OP) were obtained from orange fruits (Citrus sinensis, Navel cultivar) donated by a local agricultural cooperative (Carlet, Spain). The NADES were prepared in corresponding molar ratios and addition of water (Table1). Extractions were performed with 1 g of milled OP using different NADES (1:10) for 30 min and 150 rpm shaking speed at room temperature. A conventional extraction was also performed with hexane as a control. Total carotenoid content (TC) of OP was determined at 450 nm using a UV-Vis spectrophotometer and was expressed as mg ?-carotene/100g of fw. The effect of storage, light exposure, and temperature (25°, 4° and -20°C) on TC in extracts was monitored for 30 days and results are expressed as degradation rate (C/C0). The antioxidant capacity of extracts and solvents was evaluated using Oxygen Radical Absorbance Capacity Assay (ORAC) and the results were expressed as relative ORAC values (µmolTE/g of fw). All the experiments were performed in triplicate and results are expressed as the means and DS followed by Tukey test. Results and discussion: TC content was higher in the extracts using hydrophobic NADES. No significative difference ($p < 0.05$) was found between Menthol: Camphor (Me:Cam) (161.52 ± 13.9 mg/100gfw), Menthol: Eucalyptol (Me:Eu) (166.67 ± 16.41 mg/100gfw) and Lauric Acid: Octanoic acid (C12:C8) (151.24 ± 7.04 mg/100gfw) and in all the cases were higher compared with hexane (112.14 ± 0.044 mg/100gfw). In hydrophilic NADES, the higher value of TC was obtained with La:Glu (64.56 ±12.27 mg/100gfw). ORAC values of the extracts with hydrophobic NADES were also higher, 2650.94 ± 25.15 µmolTE/gfw in C12:C8 extract and no significative difference between Me:Eu (1650.82 ± 18.61 µmolTE/gfw) and Me:Cam (1442.97 ± 12.4 µmolTE/gfw) extracts. Also, NADES before the extraction were evaluated and C12:C8 was higher with 1265.33 ± 6.70 µmolTE/ml. The stability results showed that TC are more stable in Me:Cam and Me:Eu at 4°C and -20°C after 30 days, where the reduction of TC was 30% compared with C12:C8 with more than 60% (Figure1). The efficiency of extraction is an important parameter in selection of optimal solvent but also the stability of target compounds during storage is a relevant aspect for food industry. Me:Cam was selected as the most promising solvent for carotenoid extraction, due to the high

yields of carotenoids extracted, stability during storage, showed higher values of antioxidant activity and price is accessible [5,6]. Conclusion: The selection of the most promising NADES for a greener carotenoid extraction from orange peels was performed analyzing different parameter as extraction efficiency, antioxidant activity, stability, and prices. The selected optimal NADES was Me:Cam in 1:1 ratio.

FIGURES



NADES	Abbreviation	Molar ratio	Water content % (v/v)	Price (€/kg)
Lactic Acid: Glucose	LA: Glu	5:1	30	129.67
Betaine: Ethylene glycol	B: ET	1:2	30	118.65
Choline Chloride: Citric Acid	ChChl: CA	2:1	30	84.79
Choline Chloride: Glycerol	ChChl: Gly	1:2	30	183.18
Choline Chloride: Urea	ChChl: U	1:2	30	85.90
Proline: Malic acid	Pro: MA	1:1	30	605.54
L-Menthol: D, L-Camphor	Me: Cam	1:1	0	140.00
L-Menthol: Eucalyptol	Me: Eu	1:1	0	184.00
Lauric acid: Octanoid acid	C12: C8	1:3	0	58.00

FIGURE 1

Figure 1: Stability of carotenoids in hydrophobic NADES during storage for 30 days in different conditions (25?C in light and 25 ?C, 4?C and -20?C in dark)

Stability of carotenoids in hydrophobic NADES during storage for 30 days in different conditions (25ºC in light and 25 ºC, 4ºC and -20ºC in dark)

FIGURE 2

Table 1. Natural deep eutectic solvents used in this research

Natural deep eutectic solvents used in this research

KEYWORDS

Green extraction | Deep eutectic solvents | Carotenoids | Orange peels

BIBLIOGRAPHY