

Optimization of carotenoid extraction from *Citrus unshiu* peels using green solvents

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INTRODUCTION

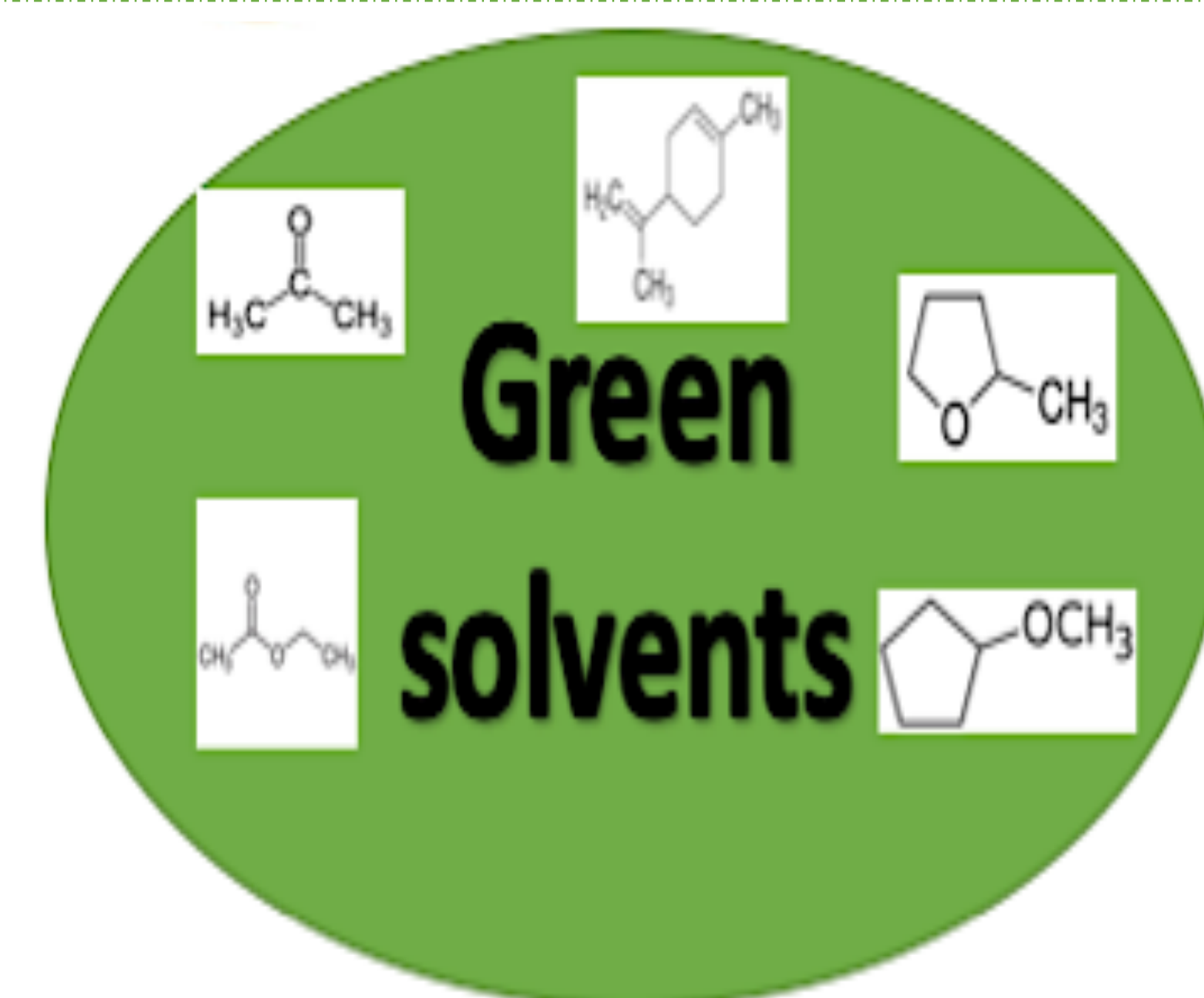
Sample treatment is one of the most contaminant steps in the analytical process, mainly due to the high consumption of energy and petrol-based organic solvents, which involve a high environmental impact. One of the most promising strategies to reduce the side effects of the analytical methodology consists of the substitution of organic solvents with a greener alternative. Carotenoids belong to a group of organic chemical compounds. They are naturally occurring pigments in citrus peel. Standard extraction methods of carotenoids from citrus peel use *n*-hexane.

MATERIALS AND METHODS

optimization of solid-liquid extraction (0.1 g of peel powder in 5 mL solvent) of carotenoids from *Citrus unshiu* peels using **green solvents**:

- acetone
- ethyl acetate
- limonene
- 2-methyl tetrahydrofuran
- cyclopentyl methyl ether.

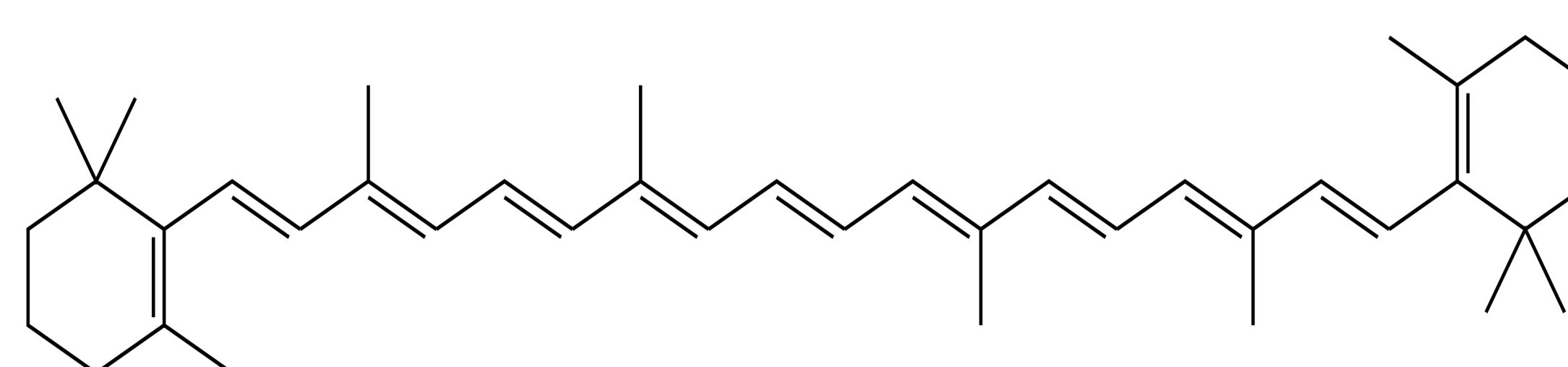
Response surface methodology (RSM) using the central composite designs (CCD) approach was used. Total carotenoids were determined spectrophotometrically



RESULTS

Table 1. Optimized conditions of time, temperature and type of solvents

Solvent	Temperature /°C	Time /MIN	Predicted value	Experimental value
			Beta caroten (mg/L)	Beta caroten (mg/L)
n-hexane	65.00	64.00	7.7465	7.6531
acetone	62.00	63.00	10.6568	10.4754
cyclopentilmethyl ether	65.00	65.00	10.4258	10.5068
2-methyl-tetrahydrofurane	65.00	47.00	10.4751	10.4747
ethyl acetate	47.00	95.00	9.8209	9.6128
limonene	25.00	57.00	10.1656	8.9287



Beta-carotene

CONCLUSIONS

Optimized conditions of time, temperature, and type of solvent were 65 min, 65 °C with cyclopentyl methyl ether giving carotenoid content of 10.51 mg/L. Compared with the conventional solvent hexane gave an increase of 37.29 %. Also, other green solvents gave significantly higher results compared to hexane. Using green solvents to extract carotenoids from mandarin peels could be recommended as an alternative to *n*-hexane.

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