Investigation of the extraction of peppermint (*Menthae piperitae folium*) active ingredients using microwave-assisted extraction

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Introduction

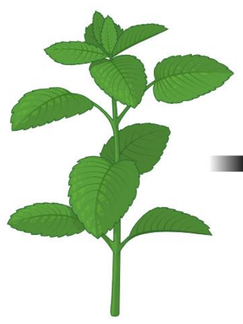
Nowadays, herbals are enjoying a renaissance. Peppermint (Menthae piperitae folium) is one of the most popular and widely consumed herbs in Hungary. At present, the production of filter tea generates a large amount of by-products and waste, which can account for up to 10-40% of the starting material. For all of the above reasons, it is therefore worthwhile to ensure that the peppermint is processed in the most efficient manner possible.

The aim of the research was to extract as much as possible of the active ingredients from peppermint raw material by microwave-assisted extraction.

Materials

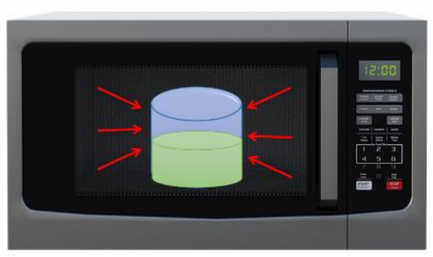
The dried chopped peppermint (*Menthae piperitae folium*) used in the research was purchased from Gyógyfű Gyógynövény Forgalmazó Kft. The solvent used in the experiment was a mixture of ethanol and water, and the solvent-to-mint ratio was set at 30 ml/g.

Methods



Peppermint

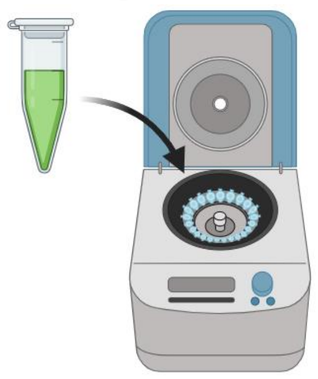
Microwave-assisted Extraction



Central composite RSM design with 6 measurements in the center point

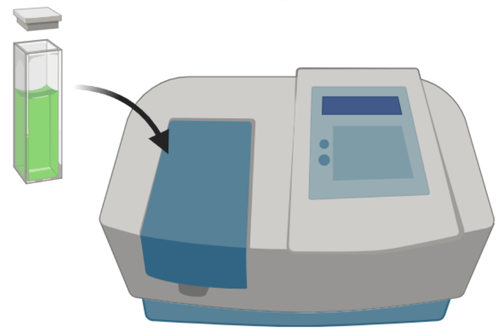
	Time (min)	MW Power (W)	Solvent Concentration (V/V%)
Min	2	100	10
Center	7	450	35
Max	12	800	60

Cenrifugation of extracts



6000 rpm
20 min

Analysis



Antioxidant Capacity (FRAP)
Antioxidant Capacity (DPPH)
Total Phenol Content (TPC)
Total Flavonoid Content (TFC)

Numerical optimization
to maximize the concentration of the valuable components using Design Expert trial version.

Figures have been created in https://BioRender.com

Results

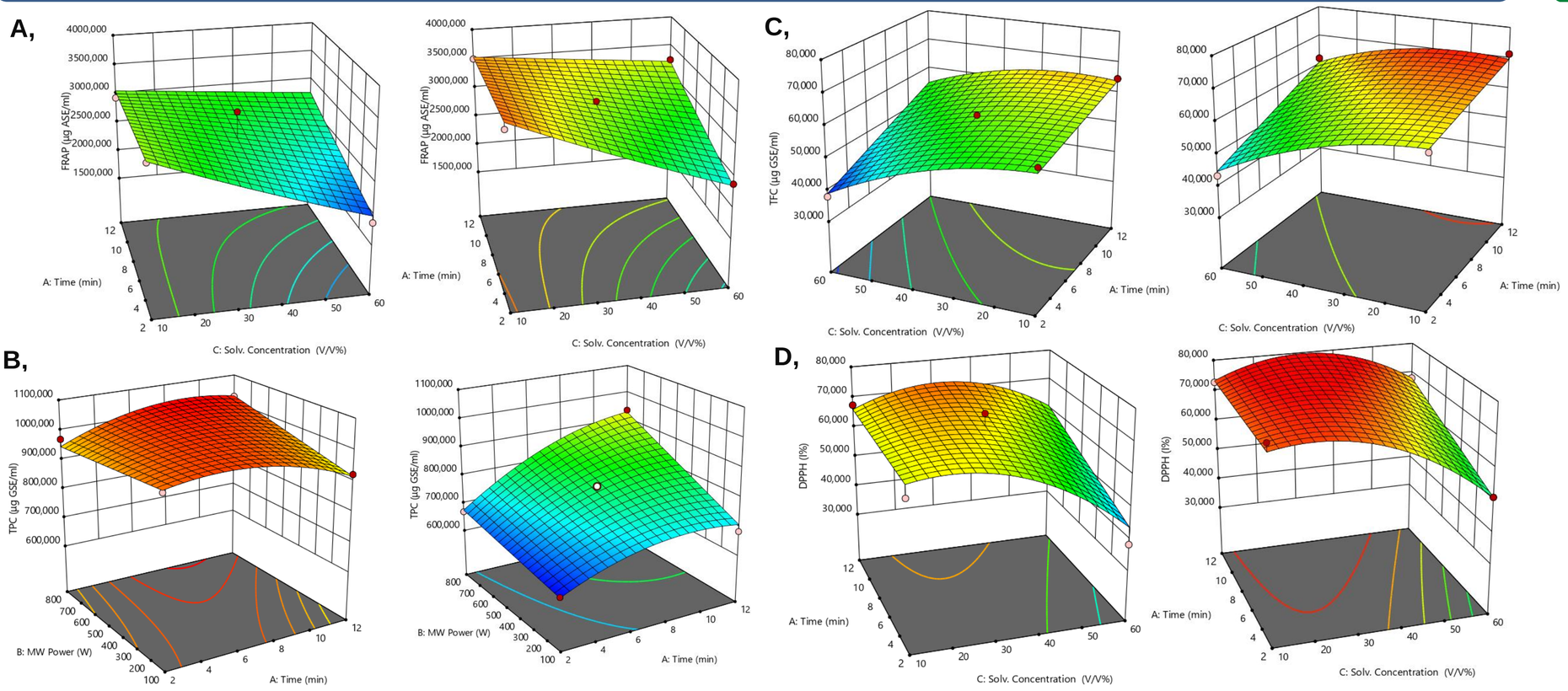


Figure 1. Effect of operating parameters on (A) Antioxidant Capacity test with FRAP method (B) Total Phenol Content test, (C) Total Flavonoid Content test and (D) Antioxidant Capacity test with DPPH method [The graphs on the left show data from the lowest solvent concentration, and the graphs on the right show data from the highest]

The optimal parameters for individual components:

	Max Concentration	Time, A (min)	MW Power, B (W)	Solv. Concentration, C (V/V%)
FRAP	3830.70 mg/l	2.51	594.52	10.16
TPC	1056.09 mg/l	10.35	764.46	20.31
TFC	71.23 mg/l	12.00	631.80	21.39
DPPH	76.41 I %	7.69	566.70	28.60

$$\mathrm{Sqrt(FRAP)} = 56.227 - 0.271 * A + 0.031 * B - 0.271 * C + 0.018 * \mathrm{AC} - 0{,}000028 \cdot B^2$$

$$\mathrm{TPC} = 985.275 + 14.429 * A - 0.142 * B - 0.363 * C + 0.022 * \mathrm{AB} + 0.342 * \mathrm{AC} + 0.003 * \mathrm{BC} - 1{,}967 * A^2 - 0.118 * \mathrm{C}^2$$

$$\mathrm{TFC} = 51.953 + 0.599 * A + 0.029 * B + 0.074 * C + 0.017 * \mathrm{AC} - 0{,}000023 * B^2 - 0.006 \cdot \mathrm{C}^2$$

$$DPPH = 60.595 - 0.252 * A + 0.01 * B - 0.487 * C + 0.033 * \mathrm{AC} - 0.014 \cdot \mathrm{C}^2$$

Conclusion

We found that extraction time, microwave power, and solvent concentration significantly affected the measured responses (TPC, TFC, DPPH, and FRAP). Additionally, the interaction between time and solvent concentration was significant. Several quadratic terms, such as time², power², and concentration², were also significant, indicating the nonlinear nature of the extraction process.

To simultaneously achieve the maximum yield of the tested compounds (TPC, AC, TFC, and DPPH), the optimal parameters are as follows: A 12 minute treatment time, 663.35 W of microwave power, and a 19.55 V/V% solvent concentration.

Acknowledgement

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