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HIGH VOLTAGE ELECTRIC DISCHARGE EXTRACTION OF CHLOROGENIC ACID FROM TOBACCO INDUSTRIAL WASTE

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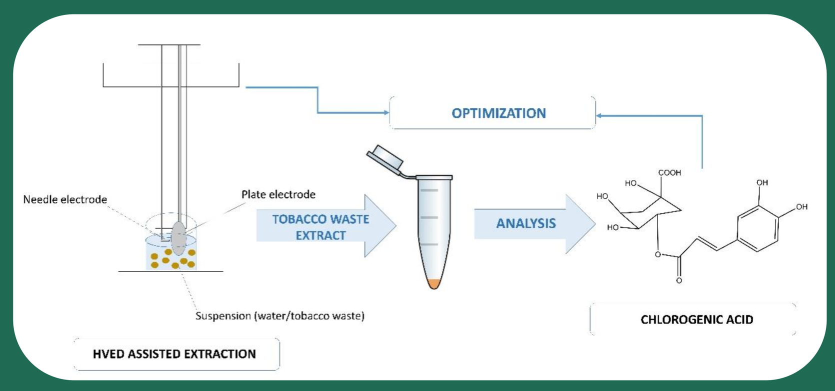
ABSTRACT

Three fractions of tobacco waste (scrap, dust and midrib) were subjected to a high voltage electric discharge (HVED) extraction procedure under different experimental conditions: Solvent:solid ratio (300, 500, 700 mL/g), frequency (40, 70, 100 Hz) and treatment time (15, 30, 45 min), according to Box-Behnken design in order to study the influence of these conditions on the content of chlorogenic acid. The content of chlorogenic acid ranged from 1.54 to 3.66 mg/100 g for scrap, from 1.90 to 2.97 mg/100 g for dust, and from 2.30 to 3.38 mg/100 g for midrib extract, showing a strong dependence on the applied process parameters.



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INTRODUCTION

The chlorogenic acid (3-O-Caffeoylquinic acid) is a member of a group of caffeoylquinic acids, commercially delivered from *Lonicera japonica* Thunb and *Eucommia ulmoides* Oliver plants. It can be naturally found in green coffee beans, tea leaves and tobacco. Recently, the chlorogenic acid and its isomers have received increasing attention due to its multiple pharmacological effects and biological activities such as antioxidant, antibacterial, antiobesity, anti-inflammatory, antitumor, antihypertensive, and gastrointestinal tract-protective effects. This study aimed to evaluate the potential of high voltage electrical discharge in the extraction of chlorogenic acid from tobacco industrial waste, as an alternative source of this important compound.

METHODS

Extraction was conducted using high voltage electric discharge procedure under various process conditions: solvent/solid ratio (from 300 to 700 mL/g), treatment time (from 15 to 45 min) and frequency (from 40 to 100 Hz), to study the effect of these conditions on the concentration of chlorogenic acid. Extraction was performed using custom-built equipment constructed by Ingeniare CPTS1 at the Faculty of Food Technology Osijek. Separation, identification and quantification of chlorogenic acid (CA) in extracts from tobacco waste were performed using an HPLC instrument equipped with a variable wavelength detector. Statistical analysis and experimental design were performed using Design Expert® commercial software (Ver. 9, Stat-Ease Inc., Minneapolis, MN, USA).

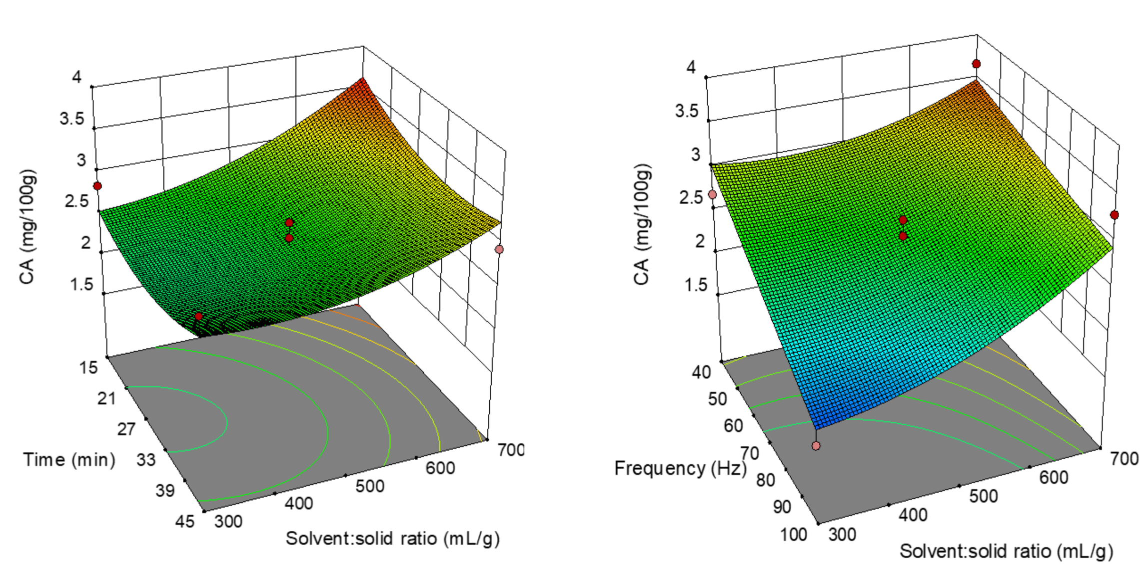

Figure 1. 3D plot showing the combined effects of HVED assisted extraction process on chlorogenic acid content of scrap

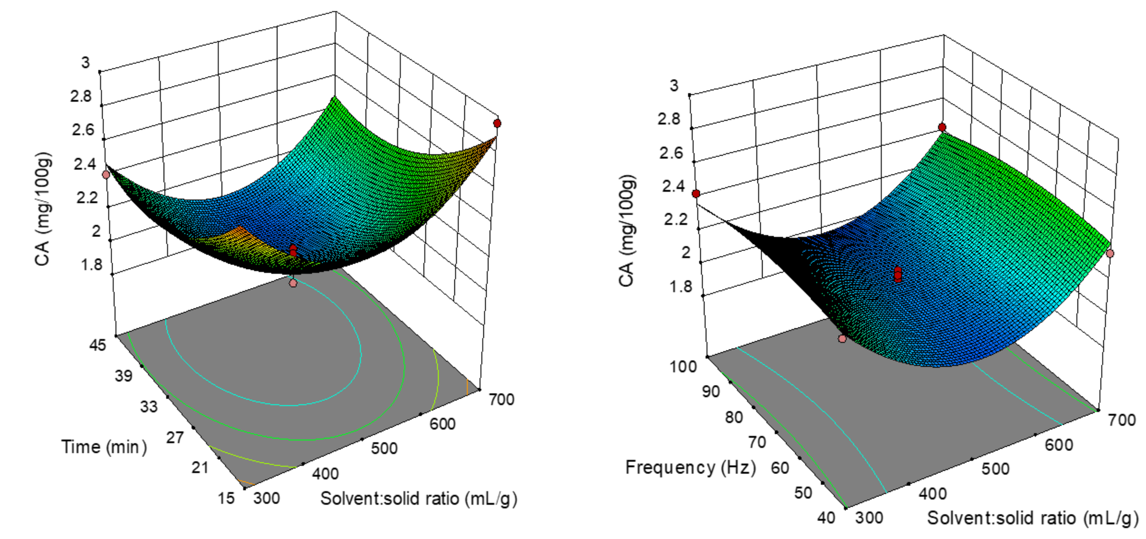

Figure 2. 3D plot showing the combined effects of HVED assisted extraction process on chloro-genic acid content of dust

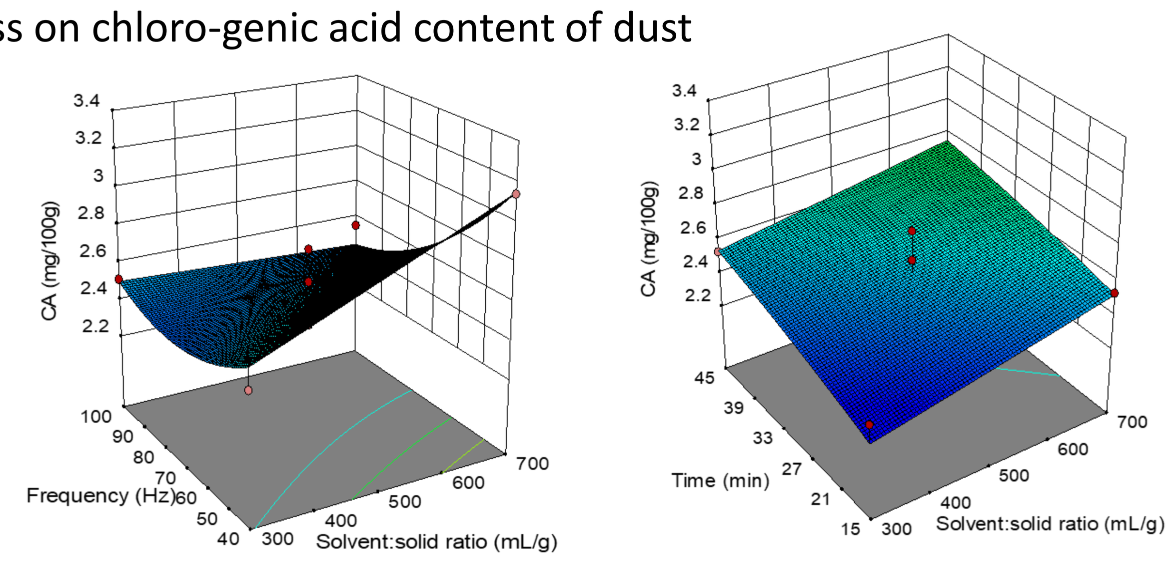

Figure 3. 3D plot showing the combined effects of HVED assisted extraction process on chlorogenic acid content of midrib

RESULTS

Table 1 Content of CA in tobacco waste extracts obtained with HVED assisted extraction

RUN	TOBACCO WASTE		
	Scrap	Dust	Midrib
	CA (mg/100 g)	CA (mg/100 g)	CA (mg/100 g)
1	3.66	2.36	3.14
2	2.69	2.38	2.48
3	1.54	2.43	2.51
4	3.33	2.14	3.38
5	2.93	2.45	2.65
6	2.23	1.97	2.30
7	2.81	2.10	2.77
8	2.28	2.31	2.48
9	2.63	2.06	2.53
10	2.32	2.08	2.37
11	3.38	2.38	2.44
12	2.54	2.11	2.39
13	3.28	2.43	2.55
14	2.88	2.41	2.53
15	2.45	1.90	2.60
16	3.41	2.96	2.53
17	2.84	2.90	2.35

The best-fitted models for obtained values were quadratic models without response transformation:

$$Y_{SCRAP} = 2.55 + 0.416X_1 - 0.466X_2 - 0.067X_3 + 0.23X_1^2 + 0.016X_2^2 + 0.24X_3^2 + 0.19\,X_1X_2 - 0.13\,X_1X_3 - 5.61\text{x}10^{-17}\,X_2X_3$$

$$Y_{DUST} = 2.05 + 0.01X_1 - 0.015X_2 - 0.20X_3 + 0.41X_1^2 - 0.06\,X_2^2 + 0.22X_3^2 + 5\text{x}10^{-3}X_1X_2 - 5\text{x}10^{-3}X_1X_3 - 0.025X_2X_3$$

$$Y_{MIDRIB} = 2.53 + 0.13X_1 - 0.20X_2 + 0.13X_3 + 1.5\text{x}10^{-3}X_1^2 + 0.014X_2^2 + 0.018X_3^2 - 0.16X_1X_2 - 0.15X_1X_3 - 0.28X_2X_3$$

Table 2 Optimal HVED assisted parameters for tobacco waste obtained by RSM

Optimal parameters and results	Tobacco waste		
	Scrap	Dust	Midrib
Solvent:solid ratio (mL/g)	695.24	700.00	700.00
Frequency (Hz)	47.16	58.5	40.01
Time (min)	15.06	15.0	15.00
Predicted CA content (mg/mL)	3.82	2.88	2.73
Obtained CA content (mg/mL)	3.91	2.79	2.68
Predicted temperature changes (°C)	5.97	1.99	6.21
Obtained temperature changes (°C)	6.02	2.01	2.05

CONCLUSION

The obtained results showed the potential of HVED assisted extraction recovery improvement of CA from tobacco waste (scrap, dust and midrib). Based on findings from present study, it can be concluded that HVED is reliable non-thermal technology for recovery CA from tobacco waste. However, the feasibility of the application of HVED assisted extraction of CA from tobacco waste at pilot or industrial scales is still unknown. Nevertheless, tobacco wastes represent a great source of CA that could be recovered and used for many purposes as nutraceutical or food additive.