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Optimization of Ultrasound-Assisted Extraction Conditions for Phenolic Content and Antioxidant activities of *Quercus Ilex* Using Response Surface Methodology

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ABSTRACT

The valorization of medicinal plants has gained significant attention due to their therapeutic properties. In this study, the optimization of the extraction of secondary metabolites and antioxidant activity from medicinal plant Quercus Ilex using ultrasound technique and applying the Response Surface Methodology (RSM) based on a CCD Centered Composite Design were carried out. This approach demonstrated promising results in extracting bioactive compounds from medicinal plants and provide a sustainable and efficient means of producing pharmaceuticals while preserving natural resources.

Keywords: Quercus Ilex, phenolic compounds, antioxidant activity, RSM

1. Introduction

Medicinal plants, have garnered increased interest in recent years due to their potential in treating chronic diseases such as cancer. These health benefits have been attributed to plant-derived compounds known as bioactive compounds [1]. The main challenge while extracting these bioactive compounds is to choose the appropriate extraction technique. Environmentally-friendly extraction methods, including ultrasound-assisted extraction (UAE), has emerged as non-conventional approache. This method utilize advanced equipment, enabling efficient extraction within shorter timeframes and flexible operating conditions of pressure and temperature. Various design of experiments DOE) methodologies, including central composite design (CCD), and Box-Behnken design (BBD), have been widely employed to screen and optimize the UAE of secondary metabolites from medicinal plants [2].

2. Experimental

Quercus Ilex leaves were collected from medea region (in February 2021). The phenolic extract of Quercus Ilex leaves was extracted using a sonication water bath under the designed conditions. The working ultrasound's frequency and power were fixed at 40 kHz and 100 W respectively. The extractions were performed when the temperature changed (40–60 °C) and solvent to solid ratio (20–40 g /mL), and sonication time varied (20–40 min). At the end of an extraction cycle, the obtained ethanolic extracts with different volumes were filtrated from the residual plant material, and then the liquid extracts were equilibrated to the final volume and stored at 4 °C until use for optimization.

3. Results and Discussion

The main results concerning the optimization of parameters influencing the extraction of phenolic compounds and their antioxidant capacities, as well as their antibacterial activity, from the leaves of the Quercus Ilex plant, are presented in the figures 1, 2, and 3.

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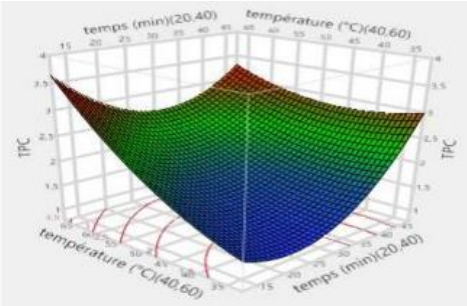

Figure 1: Response surface diagram showing the ef extraction temperature and extraction time on TPC

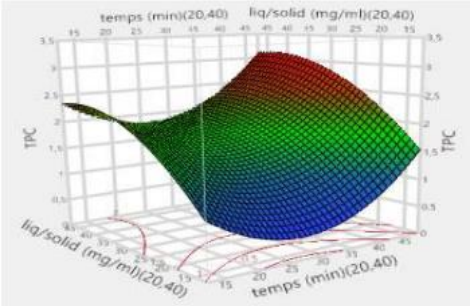

Figure 2: Surface diagram showing the effect of solid/liquid Ratio and extraction time on TPC

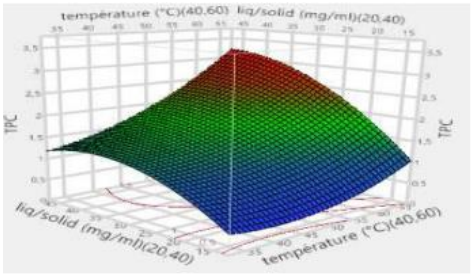

Figure 3: Surface diagram showing the effect of extraction temperature and solid/liquid ratio on TPC

According to Fig 1 and 2, it is observed that high yields of TPC were recorded at high temperature ranges, and these yields increased proportionally with the temperature increase. This is because the extraction efficiency improves due to the increase in the number of formed cavitation bubbles. Additionally, temperature influences the mass transfer process by enhancing the solvent penetration into plant cells due to the reduction in viscosity [3].

However, prolonging the extraction time did not contribute to improved recoveries. According to Fig 2 and 3, the solid/liquid ratio had a positive influence on increasing the yield of TPC. This can be explained by the fact that an increase in this factor improves the mass concentration difference between the inside and outside of cells, leading to an increase in the driving force for mass transfer and diffusion rate.

4. Conclusions

The vast diversity of secondary metabolites found in medicinal plants has turned them into a reservoir of bioactive substances; continually providing effective alternatives to widely used synthetic products in pharmacy. The phytochemical study of the obtained extracts has revealed a significant content of phenolic compounds, endowing them with a strong antioxidant potential.

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