# Kinetic Study on Chlorophyll and Antioxidant Activity from Polyscias fruticosa (L.) Harms Leaves via Microwave- Assisted Extraction

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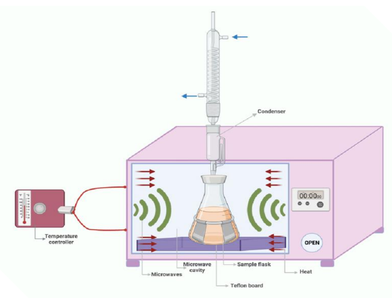
## ABSTRACT:

Polyscias fruticosa (L.) leaves contain significant bioactive compounds with high antioxidant activity such as chlorophylls, total polyphenols, etc. but these have still been underutilized. In this study, the kinetics of chlorophyll and antioxidant activity extraction from P. fruticosa leaves by microwave-assisted extraction (MAE) were investigated. Microwave power was 300, 450, or 600 (W); the ratio of material/solvent varied from 1:40 to 1:80 (g/mL). In this study, the second-order kinetic model successfully predicted the change of chlorophyll and antioxidant activity during MAE. The increase of microwave power or/and the solvent amount increased saturated extraction efficiency and the extraction rate constant. However, the saturated concentration of chlorophyll and antioxidant activity increased with the increment of microwave power and the decrease in solvent amount. [4]

## INTRODUCTION

- Polyscias fruticosa (L.) Harms lea [1]
  - Significant medicinal and nutritional potential
  - Contribute to various health benefits
- Microwave-assisted extraction [2]
  - Shorter extraction time
  - Reduce solvent usage and energy consumption
  - Improve extraction efficiency and yield




## METHODS AND MATERIALS

Dry by hot air at 50 °C

Grind

Sieve (16 mesh)

Extract with 80% acetone

- MW power (300, 450, and 600 W)
- Ratio of materials to solvent (1:40, and 1:80 g/mL)

Filter

- Physics
  - Moisture
- Chemical
  - Chlorophyll
  - DPPH
- Extraction kinetics
  - First-order
  - Second-order
  - Power-law models
  - Elovich's equation

## RESULTS AND DISCUSSION

### *Mathematical Models for MAE of P. fruticosa Leaves*

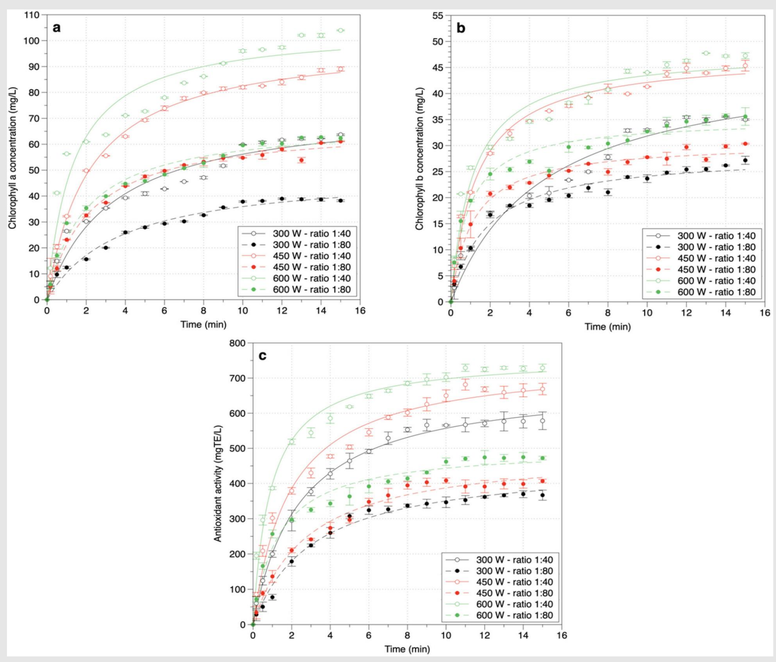



Figure 1. Changes in the concentration of chlorophyll a (a), chlorophyll b (b), antioxidant activity (c) during MAE of *P. fruticosa* leaves at different microwave power and material/solvent ratios. [4]

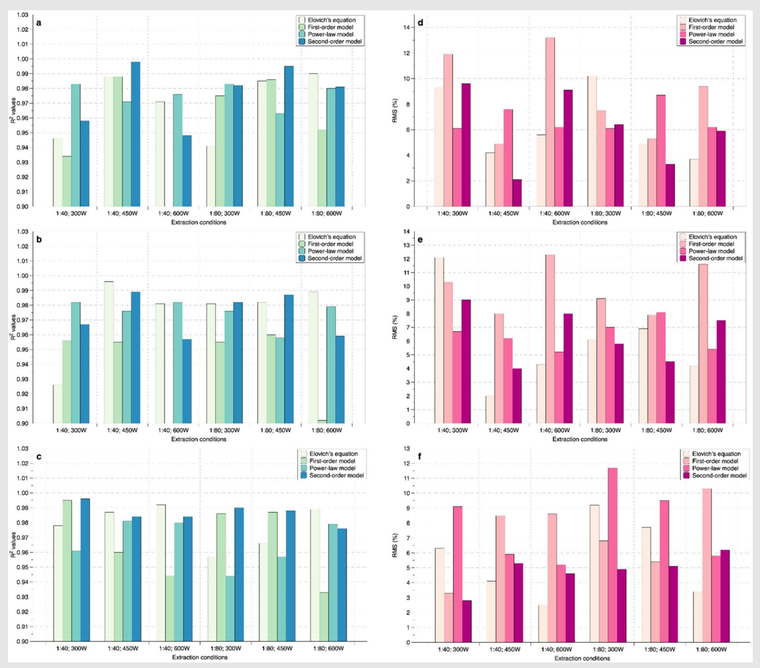



Figure 2. Comparison of model statistical parameters for MAE of *P. fruticosa* leaves: R2 value (chlorophyll a (a); chlorophyll b (b), antioxidant activity (c)); RMSE ((chlorophyll a (d); chlorophyll b (e), antioxidant activity (f)). [4]

### *Kinetics of Chlorophyll Content from P. fruticosa Leaves via MAE*

Table 1. Nonlinear regression analysis of mathematical models in both chlorophyll a and b extraction kinetics by MAE technique [4]

| Material/Solvent Ratio (g/mL) | Microwave power (W) | $C_s$ (mg/mL) | K (mL/mg/min) | $Y_s$ (mg/g) |
|---|---|---|---|---|
| **1:40** | 300 | 74.71 | 4.06 x 10-3 | 2.99 |
| | 450 | 100.44 | 4.58 x 10-3 | 4.02 |
| | 600 | 105.06 | 7.12 x 10-3 | 4.20 |
| **1:80** | 300 | 49.43 | 5.39 x 10-3 | 3.95 |
| | 450 | 67.53 | 6.85 x 10-3 | 5.40 |
| | 600 | 68.53 | 7.64 x 10-3 | 5.48 |
| **1:40** | 300 | 47.05 | 4.44 x 10-3 | 1.88 |
| | 450 | 47.53 | 1.64 x 10-2 | 1.90 |
| | 600 | 48.25 | 1.88 x 10-2 | 1.93 |
| **1:80** | 300 | 28.41 | 1.97 x 10-2 | 2.27 |
| | 450 | 30.64 | 2.95 x 10-2 | 2.45 |
| | 600 | 35.15 | 3.26 x 10-2 | 2.81 |

Table 2. Nonlinear regression analysis of mathematical models in antioxidant activity extraction kinetics by MAE technique. [4]

| Material/Solvent Ratio (g/mL) | Microwave power (W) | $C_s$ (mg/mL) | K (mL/mg/min) | $Y_s$ (mg/g) |
|---|---|---|---|---|
| **1:40** | 300 | 692.23 | 5.95 x 10-4 | 27.69 |
| | 450 | 751.78 | 7.02 x 10-4 | 30.07 |
| | 600 | 761.03 | 1.45 x 10-3 | 30.44 |
| **1:80** | 300 | 459.11 | 7.03 x 10-4 | 36.73 |
| | 450 | 493.67 | 7.39 x 10-4 | 39.49 |
| | 600 | 501.64 | 1.52 x 10-3 | 40.13 |

## CONCLUSIONS

The kinetics study of chlorophyll content and the antioxidant activity from P. fruticosa leaves using the MAE technique was performed and evaluated. The experimental data in the extraction of chlorophyll and antioxidant activity from P. fruticosa leaves via MAE was best fit to the second-order model in comparison with the first-order, power-law model Elovich's equation. Based on the second-order model, kinetics parameters were estimated. In this study, two investigated factors, including the MW power, and the material/solvent ratio, showed significant impacts on the MAE of P. fruticosa leaves. Responses including saturated concentration, saturated extraction efficiency, and the extraction rate constant were correlated to MW power and the material/solvent ratio using linear regression of data. The larger the microwave power, the higher the values of saturated concentration, saturated extraction efficiency, and the extraction rate constant for both chlorophyll and antioxidant activity. In addition, the increase of solvent amount (ranging from 1:40 to 1:80 g/mL) would increase the saturated extraction efficiency and extraction rate constant but decrease the saturated concentration. In this study, the extraction process with a large amount of solvent could improve the extraction efficiency of chlorophyll and antioxidant activity from P. fruticosa leaves using the MAE technique. However, it is necessary to consider some drawbacks in removing the solvent to collect products. This study provided critical empirical data in the MAE of alternative plant resources and the rule of effects of extraction conditions on kinetics parameters. This information could be applied to design and scale up the process by solving a multi-objective optimization problem with economic consideration [4]

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