

Thesis Title Optimization of Microwave-assisted Extraction of Bioactive Compounds from Different Varieties of Coffee Pulp

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ABSTRACT

Coffee, one of the most widely consumed beverages globally, generates large amounts of coffee pulp waste during processing. This Pulp, rich in bioactive compounds such as polyphenols, flavonoids, and sugars, presents an opportunity for valorization. This study aimed to optimize Microwave-Assisted Extraction (MAE) conditions for bioactive compounds from Geisha and Bourbon coffee pulp varieties using Response Surface Methodology (RSM). Microwave power (500–900 Watt), extraction time (45–80 min), and sample-to-solvent ratios (1:1 to 1:10 g/mL) were varied to evaluate their effects on extraction yield, total phenolic content (TPC), antioxidant activity (DPPH assay), and sugar content (fructose and galactose). The optimized conditions for microwave-assisted extraction (MAE) were 708.7 W for 72.3 min for the Geisha variety and 699.3 W for 71.05 min for the Bourbon variety, both utilizing a solvent-to-sample ratio of 10:1 (mL/g). Under these conditions, Geisha yielded 12.66%, with a total phenolic content (TPC) of 25.36 mg GAE/g, DPPH radical scavenging activity of 6.43 mg TE/g, fructose content of 6.65%, and galactose content of 1.46%. Bourbon yielded 10.74%, with a TPC of 23.57 mg GAE/g, DPPH activity of 6.18 mg TE/g, fructose content of 7.02%, and galactose content of 1.69%. These optimized MAE conditions for each variety were applied prior to comprehensive chemical characterization. Antioxidant activities, including ABTS and FRAP assays, as well as TPC and DPPH values, were subsequently evaluated and compared to results obtained using conventional hot water extraction methods. MAE significantly enhanced antioxidant compound recovery from coffee pulp compared to conventional extraction. TPC increased from 21.3 mg GAE/g to

25.36 mg GAE/g in Geisha and from 22.5 mg GAE/g to 24.50 mg GAE/g in Bourbon. DPPH rose from 3.16 mg TE/g to 7.51 mg TE/g in Geisha and from 3.61 mg TE/g to 7.56 mg TE/g in Bourbon. ABTS values improved from 21.25 mg TE/g to 33.78 mg TE/g in Geisha and from 20.89 mg TE/g to 32.43 mg TE/g in Bourbon. FRAP values increased from 2.44 mg TE/g to 4.56 mg TE/g in Geisha and from 2.32 mg TE/g to 4.12 mg TE/g in Bourbon. Mass spectrometry revealed a richer phenolic profile in MAE extracts, including flavonoids such as hibiscetin and alkaloids such as caffeine and trigonelline. Enzyme inhibition assays showed strong α -amylase (90%) and α -glucosidase ($IC_{50} = 2.8$ mg/mL) inhibition in Geisha MAE extracts. Overall, MAE proved to be a rapid, eco-friendly method for extracting valuable bioactive from coffee pulp, with promising applications in functional foods, nutraceuticals, and sustainable waste utilization.

Keywords: Coffee Pulp, Microwave-Assisted Extraction, Bioactive Compounds, Antioxidant Activity, Functional Foods

