

## ABSTRACT

*Myristica fragrans* Houtt. produces two economically important spices, but its fleshy outer pericarp is often discarded, leading to environmental pollution, despite its potential as a rich source of bioactive compounds. These compounds contribute to the antioxidant, antimicrobial, and many therapeutic properties. Diversifying pericarp by extracting its compounds as essential oil and oleoresin could enhance its economic value. Conventional extraction methods result in lower extraction efficiency and quality. To circumvent these issues, eco-innovative technologies such as Microwave Assisted Hydro-distillation (MAHD) for volatile essential oil and Ultrasound Assisted Extraction (UAE) for non-volatile oleoresin which offers sustainable results were exploited in this study to efficiently extract the phytochemicals in pericarp and to optimise the process parameters thus increasing its utilisation potential. For MAHD process, Box-Behnken design was framed with the selected process variables of solid to water ratio (1:4 to 1:8 g/ml), exposure time (1 to 2 h) and microwave power (320 to 640 W) and the responses were essential oil yield, specific gravity, and energy consumption. For extracting the oleoresin from the MAHD extracted samples UAE was employed, for which a Central Composite experimental design was framed. The process variables such as solid to solvent ratio (1:4 to 1:6 g/ml), sonication time (10 to 30 min) and types of solvent (ethanol and ethyl acetate) were selected for optimising the response variables of oleoresin yield, total phenolic content (TPC) and total flavonoid content (TFC). The optimised conditions for essential oil yield were determined as 1:8 g/ml, 1.5 h with 320 W power for obtaining a maximum yield of 0.4% with minimum energy consumption of 0.6 kWh and a specific gravity of 0.917. Maximum oleoresin yield, TPC and TFC of 5.524%, 66.449 mg GAE/g and 4.284 mg QE/g respectively were observed for the process variables of 1:5.42 g/ml, 30 min in ethanol as the optimized condition for oleoresin. The optimised extracts exhibited improved physicochemical and microstructural properties compared to conventional extraction process. These findings suggests that the extraction of bioactive compounds from nutmeg pericarp employing MAHD and UAE holds a significant economic potential with high extraction efficiency and quality.