ABSTRACT

Aromatherapy research has demonstrated relaxation potential through modulation of brain waves, notably increasing alpha activity associated with relaxation and decreasing beta activity linked to stress. However, objective neurological evaluation of aromatherapy effects remains impeded by the complexity of EEG signal processing and dependence on specialized software that is difficult for non-technical researchers to access. The main problem addressed in this study is the absence of a user-friendly application for processing and analyzing EEG data before and after aromatherapy by novice users.

To overcome these challenges, a Python-based desktop application with an intuitive graphical user interface was developed, eliminating the need for any coding. Key features include loading EEG data in CSV format, cleaning NaN/Inf values, a 1–40 Hz bandpass filter, Fast Fourier Transform and power spectrum estimation, spectrogram visualization, as well as advanced analyses using Independent Component Analysis (ICA) and frequency-band ratio calculations.

System validation was conducted through two testing phases: Quality Assurance (QA) by 15 system technicians and User Acceptance Testing (UAT) using the Black-Box method with three psychology students. QA results indicated that all core features functioned correctly and without errors. In addition, EEG data analysis before and after the aromatherapy intervention showed changes in brainwave activity, particularly an increase in theta/beta and alpha/beta ratios in several channels, suggesting a shift toward a more relaxed state. Target users also gave positive feedback regarding the application's usability. These findings demonstrate that the application is capable of generating objective quantitative data and can be used to support neurocognitive research and the scientific validation of aromatherapy as a relaxation method.

Keywords**:** aromatherapy, EEG, FFT, ICA, power spectrum