CHAPTER V
CONCLUSIONS

This research successfully developed a fluorometric method for detecting carbaryl residues in agricultural products, utilizing MCM-41-CTAB as a solid base reagent. The study demonstrated that MCM-41-CTAB provides a viable alternative to conventional strong alkaline hydrolysis, enabling the transformation of carbaryl into 1-naphthol, which exhibits strong fluorescence at 485 nm when excited at 335 nm. This method allows for sensitive, selective, and efficient carbaryl detection without harsh chemical reagents.

The synthesis and characterization of MCM-41-CTAB confirmed its highly ordered mesoporous structure. The basicity of MCM-41-CTAB, derived from its siloxy anion (SiO^-) groups, played a crucial role in the hydrolysis reaction. The optimal reaction conditions were identified as 100 mg of MCM-41-CTAB reacting with carbaryl in 50% ethanol solution for 60 min, yielding a linear calibration curve for carbaryl concentrations ranging from 0.12 to 10 μM, with a detection limit of 0.11 μM.

The method was successfully applied to real sample analysis, specifically for quantifying carbaryl residues in chili and Thai eggplant. The results obtained from the fluorometric method were validated against ultra-high-performance liquid chromatography, demonstrating strong agreement between the two techniques. Additionally, an interference study confirmed that the method remained highly selective, as the presence of common metal ions (Mg^{2+}, Ca^{2+}, Zn^{2+}) and another pesticide (methomyl) had negligible effects on the fluorescence signal of 1-naphthol.

The reusability study revealed that MCM-41-CTAB could be reused, but its efficiency gradually declined due to CTAB leaching after multiple reaction cycles. Thermal analysis showed a significant decrease in the CTAB content, while XRD and FTIR analyses indicated structural shrinkage and a reduction in functional groups after repeated use, explaining the observed decrease in the material activity.

Overall, this study provides a simple and environmentally friendly method for detecting carbaryl residues in agricultural products. By eliminating the need for strong alkaline hydrolysis and complex sample preparation, this method offers a practical alternative to conventional chromatographic techniques. Future research could further improve the reusability of MCM-41-CTAB and extend its application to other pesticide residues to enhance food safety monitoring and environmental protection.