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Comparative Study of Fluorescent Dyes for Thin Layer Chromatography Detection of Arson Accelerants: Identifying a Safer Alternative to Rhodamine B

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ABSTRACT

Thin Layer Chromatography (TLC) is a most widely used technique in arson investigations and Rhodamine B is the commonly used fluorescent dye in this technique due to its strong fluorescence but it have chemical hazard concerns. This study explores Eosin Yellow, Rose Bengal, Fluorescein Sodium, and Coumarin as potential substitutes, assessing their fluorescence, stability, and detection efficiency. The objective is to find a safer yet equally effective alternative for forensic applications.

Key words: Thin Layer Chromatography, Rhodamine B, Eosin Yellow, arson accelerants, fluorescent dyes.

1. INTRODUCTION

Thin Layer Chromatography (TLC) is a key technique in forensic science for detecting arson accelerants, with fluorescent dyes playing a key role in enhancing visibility. Rhodamine B is a commonly used dye due to its strong fluorescence, but it have chemical hazard concerns due to its potential carcinogenicity, genotoxicity and high environmental persistence. This study explores Eosin Yellow, Rose Bengal, Fluorescein Sodium, and Coumarin as possible alternatives, comparing their effectiveness in TLC detection by visualizing under a UV cabinet. By evaluating fluorescence intensity, stability, and detection efficiency, this research aims to identify a safer yet equally effective dye.

2. MATERIALS AND METHODS

This study adopts a structured methodology to evaluate the effectiveness of five fluorescent dyes in detecting accelerants through Thin Layer Chromatography (TLC). A standardized experimental procedure is followed, ensuring uniform sample preparation, dye application, and UV light examination. Silica-coated TLC plates function as the stationary phase, while a chosen solvent system aids in the movement and separation of accelerants. The performance of each dye is analyzed based on fluorescence intensity, clarity, and detection sensitivity using both qualitative and quantitative methods to identify the most effective and safest alternative for Rhodamine B.

3. RESULT ANALYSIS

The study confirmed that while Rhodamine B remains the most commonly used fluorescent dye in forensic TLC for detecting arson accelerants, safer and more effective alternatives exist as Eosin Yellow demonstrated superior fluorescence intensity and better accelerant compatibility. It emerged as the best alternative by offering high detection efficiency while being safer by overcoming the safety concerns of Rhodamine B. Its cost-effectiveness further strengthens its suitability for forensic applications, making it a viable replacement in arson investigations. Figure 1 illustrates the TLC plate treated with Rhodamine B, observed under low wave UV light, while Figure 2 displays the TLC plate treated with Eosin Yellow under the same conditions.

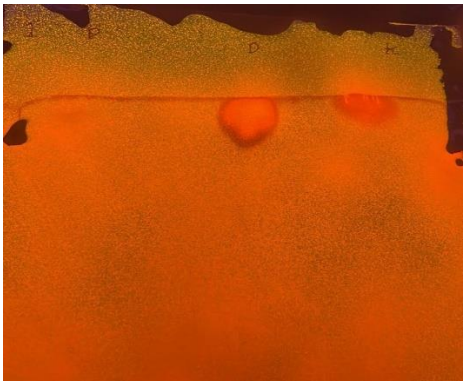

Fig 1

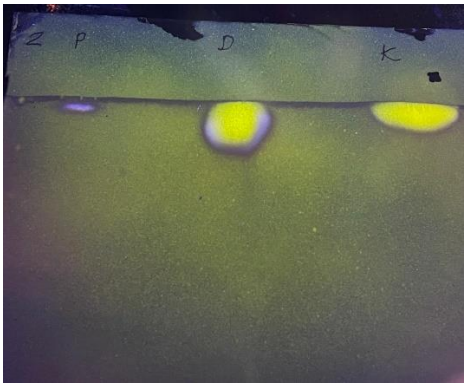

Fig 2

Table 1: Comparative analysis of fluorescent dyes

Fluorescent dye	Fluorescence intensity	Sensitivity	Cost-effectiveness	stability	Overall suitability
Rhodamine B	High	High	High	poor	Standard
Eosin yellow	Very high	Very high	High	Best	Best alternative
Fluorescein sodium	High	Moderate	low	Moderate	Good
Rose Bengal	Moderate	Moderate	high	Moderate	Average
Coumarin	Low	Low	low	Low	Below average

4. CONCLUSION

The comparative study of fluorescent dyes for tlc detection of arson accelerants demonstrated that eventhough rhodamine B is widely used, its chemical hazard concerns and less stability limits its stability. Among the alternatives I have taken Eosin Yellow demonstrated superior fluorescence and sensitivity, while remaining cost-effective and stable over time. These advantages make it a strong replacement for Rhodamine B in forensic investigations, offering a safer and more efficient alternative for detecting accelerants.

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