Standardization and Fluorescence Analysis of Turmeric (Curcuma longa) Extract for Eco-Friendly Presumptive Detection of Blood

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***Abstract*—Blood detection plays a crucial role in forensic investigations, especially in cases involving latent or cleaned crime scenes. Conventional reagents such as luminol, although sensitive, present limitations including toxicity and false positive reactions. The present study proposes the standardization and fluorescence analysis of turmeric (Curcuma longa) extract as an eco-friendly presumptive reagent for blood detection. The extraction procedure, preparation of working solution, and fluorescence response under ultraviolet illumination are described. The study aims to evaluate the feasibility and practical applicability of turmeric-based detection in forensic screening.**

***Index Terms*—Blood Detection, Eco-friendly Reagent, Forensic Science, Presumptive Test Turmeric Extract.**

I. INTRODUCTION

Bloodstain detection plays a fundamental role in forensic science and crime scene reconstruction. Presumptive tests are commonly used to identify possible blood traces before confirmatory analysis. Turmeric (Curcuma longa) contains curcumin, a natural polyphenolic compound known for its strong pigmentation and fluorescence properties under ultraviolet light. These characteristics suggest potential applicability in forensic detection systems. The present study proposes the evaluation and standardization of turmeric extract as a potential eco-friendly alternative for preliminary blood detection.

II. AIM AND OBJECTIVES

Aim

To standardize and evaluate turmeric extract as an eco-friendly presumptive reagent for preliminary blood detection.

Objectives

To prepare turmeric extract using solvent extraction
- To standardize working solution
- To apply extract on blood-stained surfaces
- To observe color change and fluorescence under UV
- To assess practical feasibility

III. LITERATURE REVIEW

Luminol is one of the most widely used presumptive reagents in forensic science due to its ability to produce blue chemiluminescence when oxidized in the presence of iron from hemoglobin . However, several studies have reported limitations such as false positive reactions with oxidizing agents like bleach and certain metals, along with concerns related to toxicity and environmental impact (Barni et al., 2007).

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Curcumin, the principal bioactive compound of Curcuma longa, is a polyphenolic compound known for its strong fluorescence under ultraviolet light and its ability to undergo oxidative reactions (Yadav et al., 2022). Its conjugated structure allows absorption in the visible range and emission in the yellow-green region, making it a potential candidate for forensic detection systems.

Recent interest has shifted toward plant-based and eco-friendly reagents in forensic science due to sustainability concerns (Yadav et al., 2022). Although turmeric has been widely studied for medicinal and chemical properties, its systematic evaluation as a presumptive blood detection reagent remains limited. Some plant-based substitutes such as soybean-derived

artificial blood systems have been explored (Rani et al., 2017), but turmeric-based fluorescence detection is still underexplored.

IV. MATERIALS AND PROPOSED METHODOLOGY

4.1 Materials

- Turmeric powder (Curcuma longa)
- Ethanol (70%)
- Distilled water
- Hydrogen peroxide (3%)
- Sodium bicarbonate
- Whatman filter paper
- Beakers and conical flasks
- Magnetic stirrer / hot plate
- Measuring cylinder and pipettes
- Amber-colored storage bottle
- Ceramic tiles, glass slides, and cotton fabric pieces
- Fresh animal blood (obtained from authorized source)
- UV torch (365 nm wavelength)
- Spray bottles
- Digital camera for documentation

4.2 Preparation of Turmeric Extract

Ethanol Extraction Method

- 10 grams of commercially available turmeric powder was weighed using a digital balance.
- The powder was transferred into a 250 ml conical flask.
- 100 ml of 70% ethanol was added to the flask.
- The mixture was heated at approximately 50–60°C for 30 minutes with continuous stirring to facilitate extraction of curcumin.
- After heating, the solution was allowed to cool to room temperature.
- The extract was filtered using Whatman filter paper to remove solid residues.
- The filtered extract was stored in an amber-colored bottle to prevent light degradation and kept at room temperature until use.

4.3 Preparation of Working Reagent

- To enhance oxidative interaction, a working solution was prepared as follows:
- 10 ml of turmeric ethanol extract was taken in a clean beaker.
- 2 ml of 3% hydrogen peroxide was added slowly.
- A small quantity (approximately 0.5 g) of sodium bicarbonate was added to create mildly alkaline conditions.
- The solution was mixed gently and transferred into a spray bottle for application.
- The working reagent was freshly prepared before each experimental trial to ensure consistency.

4.4 Preparation of Blood-Stained Samples

- Measured drops of fresh animal blood were placed on selected surfaces including ceramic tile, glass slide, and cotton cloth.
- The samples were allowed to air-dry at room temperature for 24 hours.

Cleaning Simulation

- To simulate real-life crime scene conditions:
- Some samples were washed with tap water.
- Some were cleaned using detergent solution.
- Some were treated with diluted bleach solution.
- All cleaned samples were allowed to dry completely before reagent application.

4.5 Application of Reagent

- The prepared turmeric working solution was sprayed uniformly over the test surfaces from a fixed distance of approximately 15–20 cm.
- Observations were recorded under normal room lighting for any visible color change.
- The samples were then examined in a dark room using a 365 nm UV torch.
- Fluorescence response, intensity, and duration were noted.

4.6 Control Samples

- To ensure reliability:
- Positive control: Known untreated blood-stained surface.
- Negative control: Clean surface without blood.
- Both controls were tested under identical conditions for comparison.

4.7 Comparative Evaluation with Luminol

- For qualitative comparison, standard luminol reagent was applied to similar blood-stained surfaces in a dark environment. Chemiluminescence intensity and visibility were

visually compared with turmeric fluorescence response.

4.8 Documentation and Observation Recording

- Observations were documented photographically.
- Fluorescence intensity was categorized as:
- No fluorescence
- Low intensity
- Moderate intensity
- High intensity
- Time taken for visible reaction and duration of fluorescence were also recorded.

4.9 Flowchart: Preparation of Turmeric Extract

Turmeric Powder (10 g)
↓
Add 70% Ethanol (100 ml)
↓
Heat (50–60°C, 30 min)
↓
Cool to Room Temperature
↓
Filter (Whatman Paper)
↓
Collect Extract
↓
Store in Amber Bottle

4.10 Flowchart: Preparation of Working Solution

Turmeric Extract (10 ml)
↓
Add H_2O_2 (2 ml, 3%)
↓
Add $NaHCO_3$ (~0.5 g)
↓
Mix Gently
↓
Transfer to Spray Bottle
↓
Use Fresh for Testing

V. RESULTS AND OBSERVATIONS

Bloodstains treated with turmeric working solution showed high-intensity yellow-green fluorescence under UV light (365 nm), which aligns with the fluorescence behavior of curcumin reported in previous studies (Yadav et al., 2022).

The ability of the reagent to detect blood on multiple surfaces such as glass, tile, and fabric demonstrates its substrate versatility, which is an important factor in forensic applications (Barni et al., 2007).

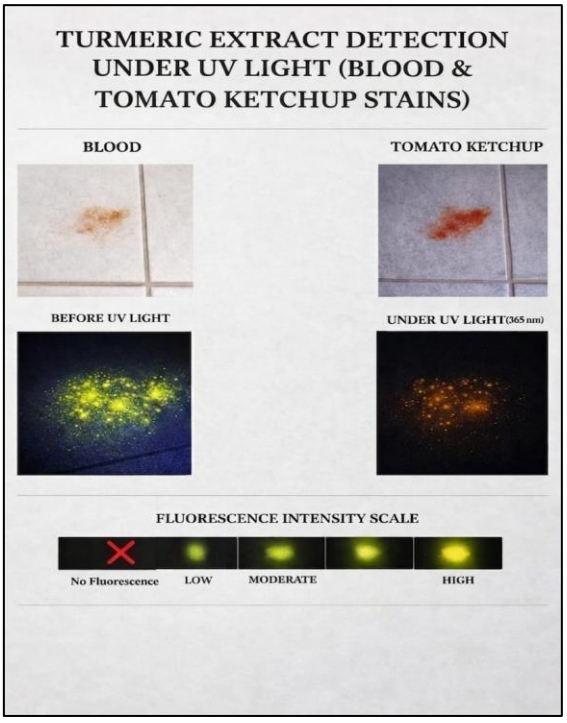
Interestingly, the reagent maintained detectable fluorescence even after cleaning treatments, including bleach exposure. This contrasts with luminol, which is known to produce false positives in the presence of bleach due to oxidation reactions (Barni et al., 2007).

5.1 Fluorescence Intensity and Visual Detection

Blood Stains: Upon application of the turmeric working solution, bloodstains exhibited high-intensity yellow-green fluorescence when illuminated with a 365 nm UV torch.

Surface Versatility: The reagent proved effective across various substrates, including ceramic tiles, glass slides, and cotton fabric, with the intensity remaining high across all tested materials.

Specificity vs. Other Stains: When compared to other organic stains, blood produced a significantly brighter and more distinct reaction. Tomato ketchup exhibited an orange hue with minimal-to-no fluorescence, allowing for clear visual differentiation.



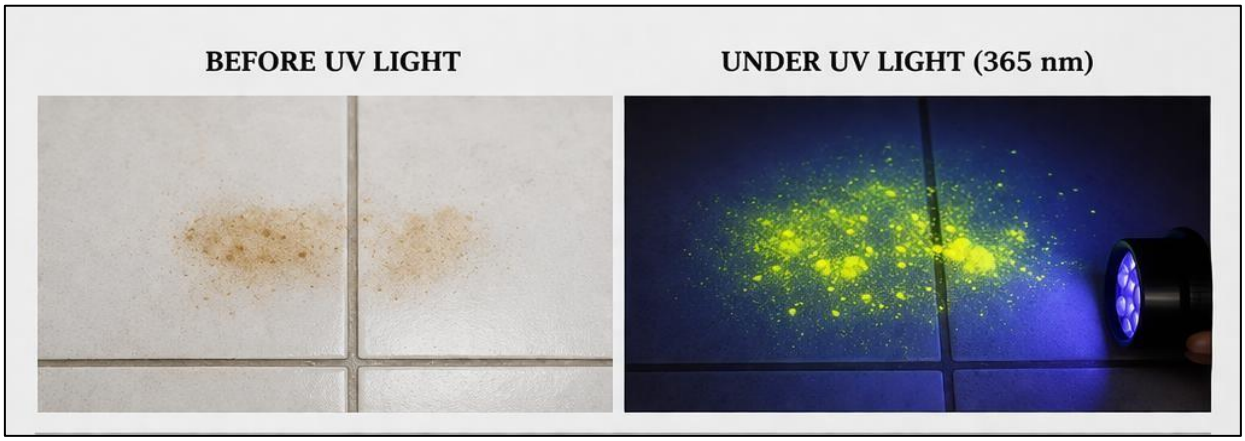
5.2 Effect of Cleaning Agents

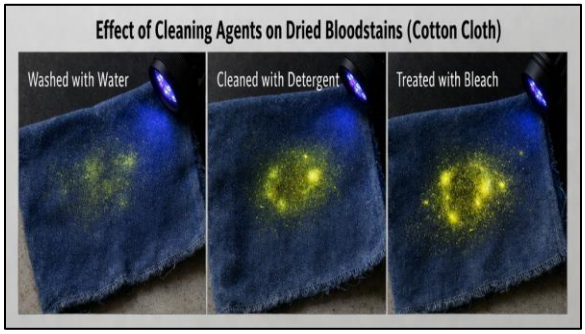
A critical finding of the study was the reagent's ability to detect blood traces after attempted cleaning:

Water-Washed Samples: Maintained moderate-to-high intensity fluorescence.

Detergent-Cleaned Samples: Exhibited moderate intensity, proving the extract can detect latent traces even after chemical scrubbing.

Bleach-Treated Samples: Remained detectable with moderate-to-high intensity, a significant result given that bleach often interferes with traditional reagents.





VI. DISCUSSION

The present proposed study explores the potential application of turmeric (Curcuma longa) extract as an eco-friendly presumptive reagent for blood detection. Turmeric contains curcumin, a naturally occurring polyphenolic compound known for its strong pigmentation and fluorescence under ultraviolet light. These chemical properties suggest possible interaction with blood components, which may support its use in preliminary forensic screening.

Compared to conventional chemical reagents, turmeric extract offers advantages such as low toxicity, easy availability, cost-effectiveness, and reduced environmental impact. These factors make it a promising candidate for sustainable forensic applications, particularly in resource-limited settings. However, factors such as sensitivity, specificity, and potential interference from cleaning agents must be carefully evaluated through experimental validation. Further optimization and systematic testing will be necessary to determine its reliability and reproducibility before practical forensic implementation.

VII. CONCLUSION

This study proposes the standardization and preliminary evaluation of Curcuma longa extract as an eco-friendly presumptive reagent for blood detection. The findings indicate that turmeric extract exhibits promising fluorescence-based detection even on cleaned surfaces.

Future research should focus on quantitative sensitivity analysis, validation under real crime scene conditions, and comparison with standard forensic reagents at a larger scale. Additionally, the development of portable turmeric-based detection kits could enhance field applicability. Integration with forensic imaging technologies may further improve detection accuracy and documentation.

The use of plant-based reagents like turmeric represents a step toward sustainable and safer forensic practices.

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