



Original Article

Forensic Botany: The Growing Discipline Revolutionizing Plant Science and Criminal Investigations

Md. Kafil Uddin¹, Sabiha Yasmin Moni², Md. Shamsul Islam³, Md. Mizanur Rahman⁴, Nasima Sultana⁵, Md. Rakibul Islam⁶

¹Associate Professor, Department of Forensic Medicine & Toxicology, Rajshahi Medical College, Rajshahi, Bangladesh. ²Professor, Department of Pharmacology & Therapeutics, Rajshahi Medical College, Rajshahi, Bangladesh. ³Associate Professor, Department of Forensic Medicine & Toxicology, Sylhet MAG Osmani Medical College, Sylhet, Bangladesh. ⁴Associate Professor, Department of Forensic Medicine & Toxicology, Shaheed Ziaur Rahman Medical College, Bogura, Bangladesh. ⁵Lecturer, Department of Forensic Medicine & Toxicology, North Bengal Medical College, Sirajganj, Bangladesh. ⁶Lecturer, Department of Forensic Medicine & Toxicology, Barind Medical College, Rajshahi, Bangladesh.

Abstract

Introduction: Forensic botany is the study of plants in legal cases. It's a fast-growing field. Changing criminal investigations and plant research. Forensic botanists analyze plant parts. These include seeds, pollen, leaves, and wood. They give vital evidence. It can establish timelines, connect suspects to murder scenes, and locate secret graves. This field is multidisciplinary. It offers new tools for crime investigation. It fuses botanical knowledge with modern forensic procedures. Forensic botany's advancement has a big impact. It affects our understanding of nature and the law.

Aim and objectives: This study aimed to observe the forensic botany growing discipline revolutionizing plant science and criminal investigations.

Materials: This Observational Study outline offers a thorough method for forensic botany, facilitating accurate identification of plants and making a major contribution to criminal investigations. The all-encompassing method highlights the interdisciplinary nature of this developing discipline by fusing cutting-edge molecular and chemical investigations with conventional botanical procedures.

Results: This page provides details on a number of fields. subfields within forensic botany. The several fields of forensic botany. The right order for forensic evidence the identification of evidence at the criminal scene must come first. The second, and no less crucial, need is that the evidence be thoroughly recorded. In order to retain the integrity of the evidence, collecting and preservation must be maintained. As with any sort of evidence, investigators are attempting to create links or linkages between the suspect, victim, scene, and particular things. The study's overall findings support the usefulness of forensic botany as a tool in criminal investigations. It provides a scientific basis for linking suspects to crime scenes, reconstructing events, and uncovering vital evidence.

Conclusion: The study's results highlight a potential link. It's between forensic botany and criminal investigations. The use of plant evidence to support forensic death investigations is known as forensic botany. Plants can give useful information. By analyzing plant evidence, forensic investigators can find key information. It can help solve cases and catch criminals.

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Address for Correspondence:

Dr. Md. Kafil Uddin, Associate Professor, Department of Forensic Medicine & Toxicology, Rajshahi Medical College, Rajshahi, Bangladesh.

E-mail: mdkafiluddin1982rnc@gmail.com

Introduction

The law of circumstances states that “Facts do not lie, but man can do.” This law proves that every piece of evidence is important and useful while investigating a sequence of events. It also shows that although spoken evidence is subject to influence or modification, the outcome of applying the skills, methods, and research of plant science to legal issues¹. The importance of forensic botany lies in its ability to provide unique evidence that can corroborate or refute other findings in a criminal investigation. For instance, the specific identification of plant species at a crime scene can link a suspect to the location or track the movement of objects and bodies. Techniques such as palynology (the study of pollen) can reveal whether a body has been moved or how long it has been in a particular location. Moreover, the discipline extends to various subfields, including dendrochronology (the study of tree rings), which can determine the age of wooden objects and trace their geographic origin². One of the most compelling aspects of forensic botany is its application in historical and high-profile criminal cases. For example, botanical evidence has played a crucial role in solving cases such as the Lindbergh kidnapping in the 1930s, where wood analysis helped trace the ladder used by the kidnapper. More recently, forensic botany has been instrumental in uncovering clandestine graves in war-torn regions and in tracking illegal logging activities, demonstrating its broad relevance and impact³. There are several uses for botanical trace evidence, including linking suspects, victims, crime sites, and goods. By contrasting the botanical evidence recovered from the crime site with the botanical pieces of evidence taken from the suspects, this connection was made⁴. However, because so few forensic scientists receive

their training in this discipline from academic institutions, the application of forensic botany in criminal or civil proceedings is restricted⁵. Notably, whereas the majority of forensic scientists are conversant with techniques for evaluating human identity, little is known about the evidence derived from flora, fauna, and insects. This scarcity in knowledge is due to the lack of awareness by evidence collection teams, who are unaware of the value of collecting botanical trace evidence⁶. The scope of forensic botany extends beyond criminal cases. Environmental forensics, a related branch, uses similar techniques to investigate ecological crimes such as illegal logging, habitat destruction, and pollution. This overlap underscores the versatility of botanical evidence in addressing a wide array of legal and environmental issues. For example, the analysis of tree rings and growth patterns can not only help determine the timeline of a crime but also monitor environmental changes and compliance with conservation laws³. As the field advances, it continues to integrate cutting-edge technologies such as DNA barcoding and geographic information systems (GIS), enhancing the precision and scope of botanical evidence. DNA barcoding allows for the identification of plant species from minute samples, increasing the reliability of botanical evidence. GIS technology helps in mapping and analyzing spatial data, which can be crucial in cases involving the movement of objects or bodies over large areas⁷. This integration not only improves the reliability of forensic investigations but also underscores the interdisciplinary nature of forensic botany, which draws on expertise from ecology, biology, and environmental science. The area of forensic botany is expanding, and a sizable corpus of research is fostering this

growth. Research like the ones by⁸⁻⁹ has improved our knowledge of the methods that can be used to gather and examine plant evidence in a variety of forensic settings. Additionally, works by¹⁰ have provided foundational methodologies for the analysis of pollen in forensic investigations, while research by¹¹ has highlighted the role of plant DNA in linking suspects to crime scenes. In conclusion, forensic botany is a dynamic and evolving discipline that is revolutionizing both plant science and criminal investigations. Its ability to provide unique and critical evidence underscores the profound connection between the natural world and human activities. As forensic botanists continue to refine their techniques and expand their applications, the field promises to play an increasingly vital role in the pursuit of justice and the advancement of scientific knowledge^{2,3}.

Objectives

General objective:

- To observe the forensic botany growing discipline revolutionizing plant science and criminal investigations.

Specific Objectives:

- To know the role of forensic botany in crime scene investigation and its current trends.
- Using plant evidence to support forensic death investigations.

Materials and Methods

This Observational Study outline offers a thorough method for forensic botany, facilitating accurate identification of plants and making a major contribution to criminal

investigations. The all-encompassing method highlights the interdisciplinary nature of this developing discipline by fusing cutting-edge molecular and chemical investigations with conventional botanical procedures. This study was conducted at Rajshahi Medical College's Department of Forensic Medicine & Toxicology in Rajshahi, Bangladesh. It took place from January 1st, 2024, until May 31st, 2024. The authors' attempt to cover several forensic botany subdisciplines with appropriate illustrations is presented in this study.

Results

Disciplines of Forensic Botany: There are several subdisciplines that fall under the umbrella of forensic botany. Plant anatomy, which studies leaves, dendrochronology, which studies the growth rings of tree stems, wood, and roots, bryology, which studies bryophytes, plant ecology, which studies the growth patterns of vegetations, limnology, which studies freshwater plants, and plant systematics, which studies the evolutionary relationships between plant species and taxonomy for the analysis of plant species, are among them¹². The information provided is relevant to forensics¹³. Additionally, this article provides information on a number of fields. subfields within forensic botany as well as other forensic botany fields.

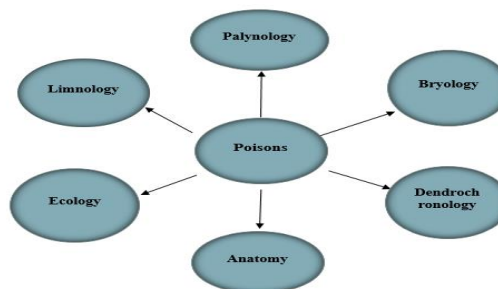


Figure-1: Disciplines of Forensic Botany

The right order for forensic evidence: The evidence needs to be identified at the crime scene first and foremost. The second, and no less crucial, need is that the evidence be thoroughly documented. In order to retain the integrity of the evidence, collecting and preservation must be maintained.

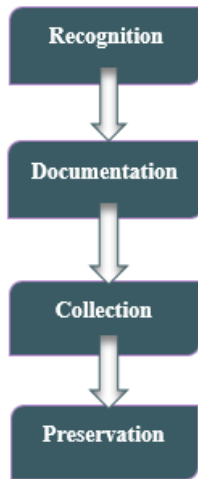


Figure-2: A schematic diagram of the proper sequence for forensic evidence.

Which plant evidence, when appropriately applied, is attributable to the overall crime scene investigation methodology? As with any type of evidence, investigators are attempting to create connections or relationships between the suspect, victim, scene, and specific items (Fig.2)(Fig.3).

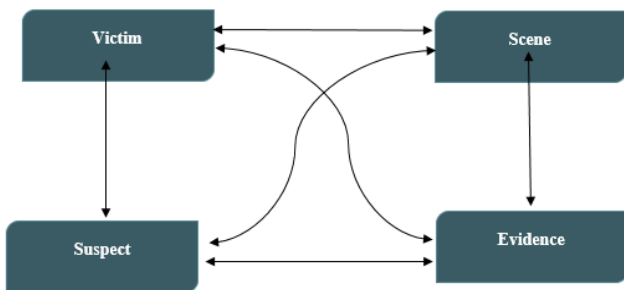


Figure-3: Botanical evidence may be used to link suspects, victims, and crime scenes using four-way linkage theory.

Botanical evidences are crucial in understanding the natural

world and the relationships between different plant species. These evidences can include plant morphology, anatomical features, biochemistry, and molecular genetics. For example, the shape and structure of a plant's leaves, flowers, and seeds can provide clues about its evolutionary history and ecological niche¹⁴.

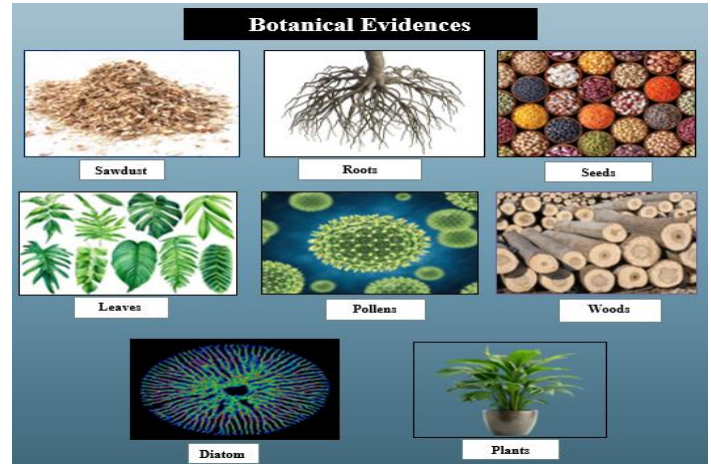


Figure-4: Utilizing plant samples in forensic botanical Evidence. Plants naturally produce plant poisons, which are chemical substances of an organic nature, through the actions of individual cells and the assistance of enzymes. Plant-based toxins can be roughly categorized into three major classes depending on their effects on the body: systemic, corrosive, and irritant. They are further separated based on their location of action and chemical makeup²⁴⁻²⁶, which are summed up in Figure 2.

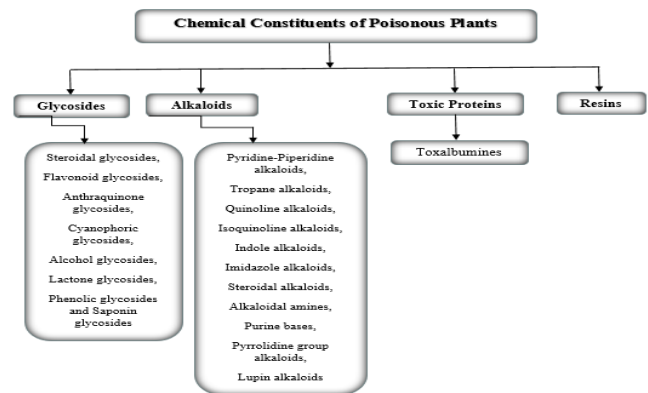


Figure-5: Classification of poisonous plants on the basis of chemical constituents.

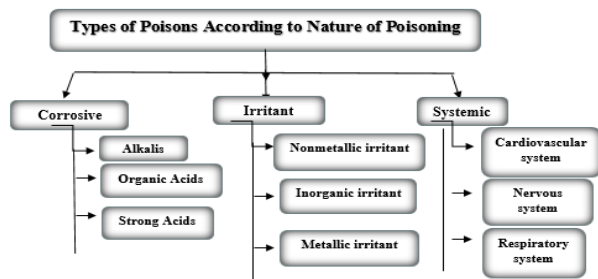


Figure-6: Types of poisons according to nature of poisoning.

Discussion

An effective tool for investigating crime scenes is forensic botany. Botanical materials have the potential to link a suspect to a crime scene or identify the cause of death, be it homicide, suicide, or accident¹⁵. A tiny fragment of plant could provide crucial information to the court. Pollen samples, for instance, can be helpful in differentiating one year from another¹⁶. Additionally, the growth rate of certain moss species can be a reliable indicator of the lowest PMI¹⁶. However, no search for that evidence will take place until an investigator is aware that it might exist. It is important to note that botanical evidence can be found at the microscopic level at crime scenes (e.g., pollen grains)¹⁵ and that meticulous gathering, recording, and storage of botanical evidence is essential to the assessment of plant evidence. Sadly, inexperienced workers have frequently collected samples¹⁷. Regulations should specify that the collection of plant materials must include control samples. Simple microscopy or more advanced plant DNA testing can be used to study plant material¹⁸. In forensic botany, the plant species must first be recognized using morphological traits, microscopy, or molecular biology^{19,20}. Once the species has been determined, an effort is made to individualize the

sample. Source attribution may not be difficult if a plant is scarce in the sampling area; nonetheless, the effectiveness of source attribution will rely on how rare the species is in the geographic area²¹. Every criminal case should take into account forensic botany, particularly (though not just when the crime occurs in an open space)²². The botanical evidence is circumstantial and weak on its own, but when combined with the other discoveries, it can give the courts sufficient direct and circumstantial evidence²³. Even while it is now obvious that forensic botany can play a significant part in many forensic investigations, it is still not widely acknowledged in many countries¹⁵. There are several kinds of botanical evidence at the crime site. For instance, a poison is described as a material that has the potential to negatively impact human health. If a tiny amount of the plant's stem, leaves, seeds, fruits, or roots is consumed, toxic plants have been used for assassinations, suicides, murders, and executions since ancient times^{24,25}. The intent behind the administration of a substance determines whether it is a poison or a medicine. It is a medicine if the goal is to save lives; if it is administered with the goal to injure, it is a poison²⁵. According to Paracelsus (1493-1541), the father of toxicology said "Everything is poison, there is poison in everything, only the dose makes a thing not a poison"²⁶. Now a days, mostly poisons are used for robbery and suicidal purposes. Suicide is very common as poison can be easily obtained and many poisonous plants grow wild e.g., datura, oleanders, aconite etc. Numerous studies have been published on the toxicology of plants; however, in the current study, the majority of plant chemical constituents have been reviewed in the perspective of forensics.

Conclusion

The study's results highlight a potential link. It's between forensic botany and criminal investigations. Forensic

botany is the use of plant evidence to aid in forensic death investigation. Plants can give useful information. They are helpful in cases about missing persons, homicides, accidental deaths, and other crimes. Plant evidence can help establish the time and location of death, link suspects to crime scenes, and even determine cause of death. There are several ways in which plant evidence can be used in forensic investigations. In addition to plant evidence, botanists can use growth patterns and seasonal changes. They use these to find the time of death in a forensic investigation. For example, if plant roots grow through a victim's clothing, it can show that the body has been at the crime scene for a long time. Similarly, some plants only bloom during specific seasons. They can help show when a crime took place. Forensic botany is a valuable tool in criminal investigations. It provides important insights into the circumstances of a death. By analyzing plant evidence, forensic investigators can find key information. It can help solve cases and catch criminals.

Limitation of the study

This study was carried out in the uncommon situation where more data were not accessible, and it was finished rather quickly. As a result, the outcomes might not fairly depict the overall scenario.

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Conflict of interest: The authors declare that there is no conflict of interest.

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a significant advancement in forensic botany by integrating state-of-the-art molecular and chemical techniques with traditional botanical methods. Our appreciation extends to all contributors whose efforts helped illustrate and cover various subdisciplines within forensic botany, enhancing its role in criminal investigations

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