Innovation and Integrative Research Center Journal
ISSN: 2584-1491 | www.iircj.org
Volume-3 | Issue-5 | May-2025 | Page 87-94

FORENSIC CHARACTERIZATION OF POISONOUS PLANTS USING LCMS-MS

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ABSTRACT:
Due to the widespread use of poisonous plants as weapons of crime.The accidental ingestion or criminal use of these plant poisons is observed to be increasing day by day; The analysis of poisonous plants has become an important and challenging task. In present, The technique including liquid chromatography coupled with mass spectrometry (lcms), were found to be an important technique in the analysis of complex bioactive constituents. The present study was aimed at forensic characterization of poisonous plants from selected Indian plants viz, 1.Calotropis gigantea(cardenolides like calotropin, calactin, calotoxin, and uscharin), 2.Nerium oleander (cardiac glycosides), 3.Abrus Precatorius (abrin), 4.Datura(alkaloids such as hyoscine (scopolamine), hyoscyamine, and atropine), 5.Semecarpus anacardium (bhilawanols, phenolic compounds, biflavonoids, sterols, and glycosides) by LCMS - Liquid Chromatography Mass Spectrometry) analysis.

INTRODUCTION:
Since time immemorial, mankind has observed the twofold character of toxic plants, witnessing their capabilities both for deadly and medicinal uses. Such plants, stores of various chemical substances—such as alkaloids, glycosides, toxic proteins, and resins—constitute serious analytical problems in forensic science. Sophisticated methods such as GC-MS, HPLC, LC-MS, NMR, and immunological assays are used to detect these complicated drugs in body matrices, which are usually traceable and undergoing metabolic changes and postmortem redistribution. Toxicological results are to be linked by forensic experts with autopsy results, botanical examination, and circumstantial evidence in order to decide the cause and manner of death, establish intent (homicide, suicide, accidental), and reconstruct crime scenes. Knowledge of the pharmacokinetics and pharmacodynamics of such toxins, such as stability, solubility, and interaction with biological targets, is important. Proper botanical identification, at times requiring DNA analysis and microscopic analysis, is important for connecting suspects, victims, and crime scenes. Thorough databases of plant toxins, their chemical and physical parameters, detection techniques, and case studies are important tools. There is also a part for environmental forensics with examination of water, soil, and plant material samples. As some plant products are used as medicine in regulated doses with special care given to the structure-activity relationship as well as for potential toxicity, using them as in criminal ventures needs to undergo strenuous investigation and expert affidavit. Quality assurance and control principles must be stringent in forensic science laboratories to validate precise and repeatable results. Finally, the multi-disciplinary approach, combining forensic toxicology, botany, pathology, and chemistry, is essential to leverage plant-derived evidence successfully in both medicine and crime, and comprehend the complex dance of these powerful natural compounds and human health.

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BACKGROUND

The forensic importance of toxic plants stems from centuries of utilization as tools of harm, and the early civilizations having documented their use in assassination and war. As forensic toxicology became a more sophisticated field, the innovation of advanced analytical methods, such as chromatography and mass spectrometry, transformed plant toxin detection into an ability to identify trace residues. Plant biochemistry emphasizes the extensive range of bioactive secondary metabolites that are synthesized by plants, including alkaloids and glycosides, which are themselves highly toxic agents. The global botanical richness presents a challenge for forensic botany, demanding specialized knowledge of plant taxonomy and biogeography when plants are relocated from their homelands. It is important to understand the pharmacology and toxicology of plant substances, i.e., their uptake, distribution, and toxicity mechanisms, in order to interpret forensic data. Development of thorough databases on plant toxins, with chemical makeup and detection methods, will aid effective investigations. Legal and ethical implications on the employment of plant toxins for criminal purposes call for strict adherence to procedures and objective, unswerving expert opinions. Finally, forensic examination of toxic plants demands a multidisciplinary effort, combining historical insight, sophisticated scientific methods, and ethical awareness.

Classification of poisonous plants on the basis of Chemical constituents

Plants containing alkaloids and glucosides are used as medicines. There are more than 20 groups of chemical constituents (alkaloids, Glycosides, saponins, resinoids and mineral compounds) accumulated From the soil, which make a plant or its part to be poisonous. According.To their chemical constituents, plant poisons are broadly classified in

Four groups:

- Alkaloids
- Glycosides
- Toxic proteins and
- Resins

Which are further sub-divided on the basis of their chemical Structure and pharmacological actions.

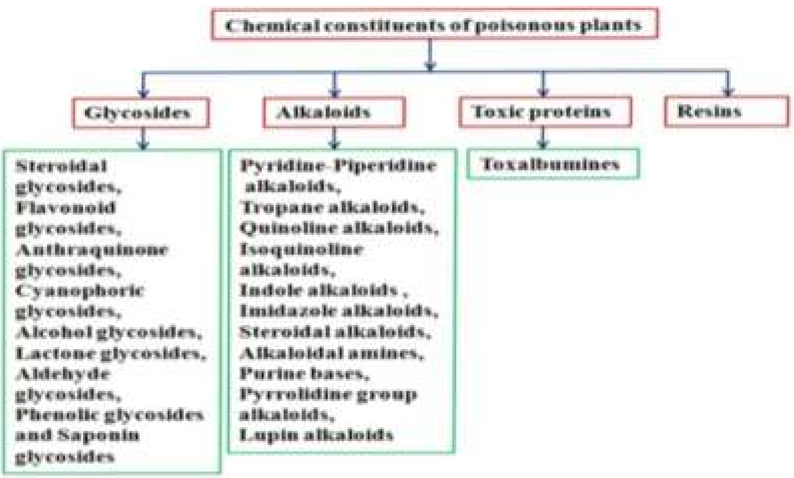

Figure 1: Classification of poisonous plants on the basis of chemical constituents

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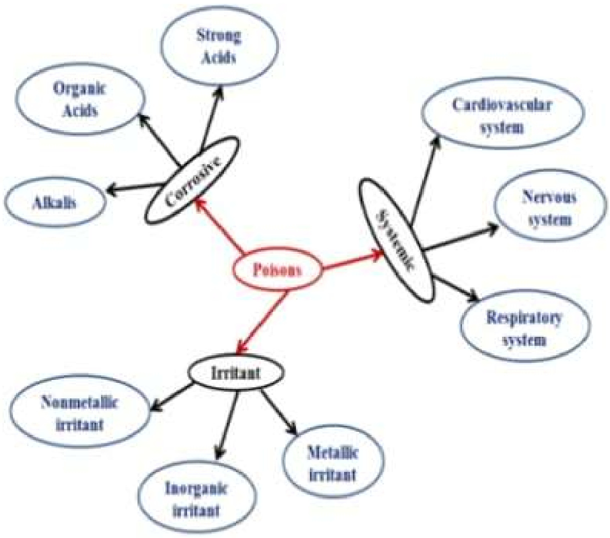

Figure 2: Types of poisons according to nature of poisoning.

Table 1 List of plants having toxic constituent's

Name of plant	Common name	Family	Toxic parts
calotropisprocera	Calotropissps, and madar, akdo	Apocynaceae	Latex
Nerium oleander	White oleander and kaner	Apocynaceae	All parts
Semecarpusanacardium	Marking nut and bhilawa	Anacardiaceae	Juice
Prunusamygdalus	Almond, baadam	Rosacea	Almod
Nicotianatabaccum	Tobacco and tambaku	Solonaceae	All parts except ripe seeds
Dhaturafastuosa	Thorn apple and dhatura	Solonaceae	All parts especially seeds and fruit
Papaver somniferum	Opium poppy and afim	Papavaraceae	Petals,stems,and ripe dried capsules
Stychnosnux vomica	Poison nut and kuchila	Loganiaceae	All parts especially seeds of ripe fruits
Abrusprecatorius	Jequirity,Indian liquorice, guchi or rati	Leguminosae	Seeds (mainly), roots and stem leaves
Cannabis sativa or cannabis indica	Indian hemp, hashish	Cannabinaceae	Dried leaves and fruit (Bhang), flowers top of female plant(Ganja) resin of leaves and stems (charas)

Methods for Characterization of poisonous plants :

Botanical Characterization:

1. **Macroscopic Analysis:**

Macroscopic/Microscopic Analysis: Gross and microscopic study describes plant organization, facilitating morphological and cell-based species determination.The identification of possibly

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toxic plants begins with intensive macroscopic inspection, recording the exterior morphological details—phyllotaxy, inflorescence, and fruit form—for preliminary discrimination between species. Microscopic scrutiny then reveals cell anatomy, types of vascular bundle arrangement, and special tissue composition, refining the taxonomic value. Employing published botanical keys and herbarium collections, taxonomic analysis delivers codified nomenclature. Molecular methods, such as DNA sequencing and polymerase chain reaction (PCR), complement these examinations, clarifying taxonomic uncertainties and detecting degraded samples. This combined, hierarchical methodology, working from gross morphological inspection to molecular genetic examination, guarantees precise determination of the species, a requirement for ensuing phytochemical studies, bioassays, and toxicological evaluation.

2.chromatography technique:

research undertakes a complete phytochemical profiling of toxic plants, using sophisticated chromatographic methods. Liquid Chromatography-Mass Spectrometry (This LC-MS) is the central analytical technique, allowing the separation and identification of non-volatile and thermally labile phytotoxins by accurate mass-to-charge ratio detection. High-Performance Liquid Chromatography (HPLC) is used for preparatory sample fractionation, augmenting LC-MS analysis. Thin-Layer Chromatography (TLC) is used for fast, qualitative screening of plant extracts. The study is focused on the improvement and optimization of LC-MS methodologies targeting sensitive and selective detection of analytes in complex matrices. This involves the design of analytical protocols for known and new phytotoxin identification, quantitation, and metabolite identification. LC-MS/MS methods are utilized for compound confirmation and quantitation. The research seeks to build detailed phytochemical profiles, supporting forensic toxicology investigations, pharmacological studies, and risk assessment, by explaining the intricate chemical structures of these plants.

3.Chemical Methods:

Extraction/Chromatographic Techniques: Chromatography and solvents separate and identify toxins by employing GC-MS, HPLC, and LC-MS to detect and separate compounds.

Phytotoxin characterization requires a set of chemical techniques. First, target compounds are extracted from plant matrices using extraction methods, with solvents of different polarity or supercritical fluids. Follow-up chromatographic separation, mainly through Liquid Chromatography-Mass Spectrometry (LC-MS), in addition to GC-MS and HPLC, allows for the identification and quantification of individual constituents according to their physicochemical properties. Spectroscopic studies, such as NMR, IR, and UV-Vis, determine the structural features of these compounds. Lastly, toxicological tests, including immunoassays and bioassays, determine the biological activity and possible toxicity of the purified compounds. This chemical strategy, with emphasis placed on LC-MS analysis, offers a complete phytochemical characterization, which is necessary for forensic toxicology, pharmacology, and risk evaluation.

4.Biological method:

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In this study clarify the physiological actions of plant toxins, supplementing chemical measurements. In vitro bioassays measure cytotoxicity and pharmacological properties, determining toxin activity on cell viability and enzyme processes. Receptor binding assays determine target biomolecular interactions. Preliminary pharmacological testing determines toxin effects on biological systems. Toxicity screening determines relative levels of toxicity. This convergence of biological approaches, specifically in vitro assays, aligns LC-MS-derived chemical profiles with biological activities, defining mechanisms of action, determining human health effects including metabolites, and investigating neurological and cardiovascular effects, offering a holistic toxicological insight.

Conclusion:

Toxic plants, medicinally and criminally employed, pose challenging forensics because they have varied chemical makeup. Sophisticated methods such as LC-MS reveal toxins within biological material to assist in cause of death determination as well as intent. Proper identification of plants and knowledge about the behavior of toxins are vital. Multidisciplinary specialist teams and intense analysis guarantee quality proof within both clinical and legal settings. This work utilizes LC-MS, supported by HPLC and TLC, to comprehensively analyze poisonous plant phytotoxins. It aims at the creation of optimized LC-MS procedures for sensitive detection, quantification, and metabolite identification in complex plant matrices. LC-MS/MS improves compound confirmation. The objective is to construct detailed phytochemical profiles for forensic, pharmacological, and risk assessment applications.

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