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Comparative Pollen Morphological Characterization of Five Selected Poisonous Plants for Forensic Purposes

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Abstract
When pollen samples are degraded or processed, it can be difficult to identify poisonous plant material in a forensic investigation it may say that pollen morphology plays an important role in investigation of crime. Five poisonous plants were selected for the study. After collection of flower anther pollen grain were extracted by using acetolysis process. Extracted pollen grain were placed under light microscope at 45x-100x for examination and identification. In examination and identification it was found that the size, shape, aperture, exine ornamentation of pollen grain it was observed that the Cannabis pollen was smallest (18-25 µm) with porate apertures. Dhatura had the highest grains size (50-65 µm). Calotropis (45-55 µm) had longitudinal apertures, Argemone (35-45 µm) had spinulose-reticulate ornamentation and Nerium (38-46 µm) had prolate-spheroidal shape.

Keywords: *Forensic palynology, Pollen morphology, Cannabis indica, Dhatura, Argemone, Nerium, Calotropis, Crime Scene Investigation.*

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I. Introduction

The illegal cultivation of narcotic and poisonous plants has significant public health and national security implications and the NDPS Act, 1985 is the main legislation to fight against the menace in India **(Mildenhall *et al*., 2006)**. One of the major problems of forensic studies is the f00inding of seized plant material in powdered, degraded or processed form, and thus unable to be identified by traditional morphology **(Hirapure *et al*., 2014)**. Chemical analysis is not sufficient to provide geographic origin, cultivation links, or associative evidence between suspects and crime scenes. Pollen grains are a powerful tool which can solve this obvious problem of evidence **(Erdtman, 1960; Faegri & Iversen, 1989)**. Pollen grains have distinctive features suitable for forensic purposes species-specific features such as size, shape, aperture type and exine ornamentation are exceptional they are extremely resistant due to the presence of sporopollenin they occur universally in the environment and are recoverable from processed drugs and from surfaces that have been contaminated **(Ahmad *et al*., 2022; Rakshanda & Reddy, 2022; Singh *et a*l., 2023)**. This study covers five forensically important plants present in India namely Calotropis (cardenolides), Dhatura (tropane alkaloids), Nerium (cardiac glycosides), Argemone (sanguinarine alkaloids) and Cannabis indica (psychoactive cannabinoids under NDPS regulation). The morphology of each species is unique, with pollen that can be identified and distinguished by precise morphology. Locard's Exchange Principle links suspects, contraband and locations together as the pollen is exchanged during cultivation, harvesting, processing and transportation. Pollen can confirm possible presence at crime scene, invalidate alibis, track drug supply chains and support cultivation when plants have been destroyed.

II. Methodology

Five poisonous plant flower were collected from Prayagraj, Uttar Pradesh, India (March-June 2026) for the study of their pollen grain morphology. For this study pollen grain were extracted by use of acetolysis process in which pollen grain anther were crushed in glacial acetic acid at 100°C for 3-4 minutes, then centrifuged (2000 rpm, 5 min), washed, dehydrated through ethanol series, and mounted in glycerine jelly. Further for examination of pollen grain slides were prepared and placed under trinocular compound microscope (Magnus MLX) at 10×, 40× and 100× magnifications. Pollen grain characterization were based on their size, shape, type of aperture and ornamentation of the exine for each species.

III. Results

The pollen grain morphology of Five poisonous plant species. Calotropis (45-55 µm) Reticulate ornamentation with well defined lumina, characteristic longitudinal aperture. Pollen of Dhatura (50-65 µm) is largest in size, colpate aperture with distinct pores and reticulate ornamentation with irregular lumina. Nerium (38-46 µm) prolate-spheroidal in shape clearly with a reticulate ornamentation with parallel ridges porate aperture. Argemone (35-45 µm) special ornamentation with spinulose-reticulate (small spines on reticulate base) colpate aperture. Pollen of smallest size, porate aperture, reticulate exine, diagnostically significant size, cannabis indica (18-25 µm).

3.2 Morphological Characterization

Five poisonous plant pollen grain characteristics after examination and identification are mention in Table 1.1

Table 1.1: Comparative Pollen Morphological Characteristics

Species	Size (P × E) µm	Shape	P/E Ratio	Aperture	Exine Ornamentation
Calotropis	45-55 × 40-48	Subspheroidal	1.08-1.18	Longitudinal	Reticulate
Dhatura	50-65 × 48-60	Spheroidal	1.02-1.12	Colpate	Reticulate
Nerium	38-46 × 35-42	Prolate-spheroidal	1.12-1.25	Porate	Reticulate
Argemone	35-45 × 30-40	Subspheroidal	1.08-1.15	Colpate	Reticulate-spinulose
Cannabis	18-25 × 15-22	Subspheroidal	1.02-1.15	Porate	Reticulate

IV. Discussion

In this study detailed pollen morphological profile of five forensically important plants, Calotropis, Dhatura, Nerium, Argemone and Cannabis indica, by the standard acetolysis and light microscopy, characterized and documented pollen morphological features. It was found that each species has its own set of diagnostic characters, with the characteristics of Cannabis being smallest (18–25 µm), with porate apertures. Dhatura, largest (50–65 µm), with colpate apertures. Argemone, unique spinulose-reticulate exine ornamentation. Calotropis, characteristic longitudinal apertures and Nerium, prolate-spheroidal shape with porate apertures. The results are similar to previous palynological investigations by **Kumari and Srivastava (2018)** on the Uttar Pradesh weed flora, **Molina *et al.* (2019)** on the pollen of Cannabis, and **Ahmad *et al.* (2022**) on the weed flora of Pakistan, who also reported species-specific size ranges and exine patterns. But our findings showed some variation in the upper and lower limit of the size of the different species which may be due to geographical and environmental differences as also mentioned by **Singh *et al.* (2023)** in their study on intraspecific variation in Cannabis sativa pollen.

V. Conclusion

The present study successfully identified and described the pollen morphological characters of five forensically important plants, such as Calotropis, Dhatura, Nerium, Argemone and Cannabis indica by conventional acetolysis followed by light microscopy technique and obtained a comprehensive reference pollen profile for each species. We found that the diagnostic characters for species differentiation are size and exine ornamentation, spinulose or reticulately ornamented, and a distinct characteristic size, showed that every pollen grain have unique morphological feature whivhcan be very significant for forensic purposes in relation to linkage between culprit to victim, victim to crime scene and site of transportation of the drug and locality etc.

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