REVIEW ARTICLE

Forensic Mycology: Fungal Evidences in Forensic Analysis: A Review

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ABSTRACT

This is an overview of forensic fungi. It depends on what was mentioned in the references, provides principles information about fungi, and a detailing of the value of fungi in this field, and may achieve effective use of fungi in the forensic analysis. These involved: Provide a tracking guide; post-mortem estimation; Finding the give rise to death, hallucination, or poisoning; determine the place of buried bodies. Previous work was evaluated by taking into consideration the important points that these works contained and their value to display in the tribunal. Situations in which mycology might assist in the investigation were identified in a concise form and presented issues related to the development of the topic**.**

Keywords: Forensic mycology, Forensic science, Forensic investigation, Forensic analysis.

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INTRODUCTION

The use of fungi as evidence from forensic evidence, and its presentation as effective evidence by investigators, is known as "forensic mycology." It is a new science that describes the deals between the species of fungi found in corpses. It could have a forensic implementation, especially identifying fungal populations to help determine the time of death.[1] Fungi can provide a variety of proofs useful for forensic analysis, involving determining post-mortem period by fungus growth on carcasses, toxicity caused by toxic substances, and tracking evidence by connecting people and things to places. Fungal parts such as spores and their remnants perhaps attached by any things touching them thus can be used as trace evidence in solving many crimes .[(2)]. Fruiting structures of some fungi, particularly post-rot fungi, have been repeatedly recorded with decaying mammalian carcasses in many places.[1,2] This review presented information on the use of fungi as forensic evidence and to identify cases in which fungal evidence could be useful.

Tracking Guide (Traced Evidence)

Tracked evidence is any material left at or taken from the site of a crime; Lockard's principle says that a criminal will bring something to the crime scene and take something from it, and both can be used as forensic evidence. Lockard's principle of forensic science says: "Every contact leaves a sign."

Spores and any parts of Fungal can be carried by whatever it comes into contact with as other palynomorphs and are subject to similar considerations.[1] Even part of a mushroom's body can get stuck in objects and are useful in forensic science analysis (Figure 1). Thus their spores may supply proof in cases

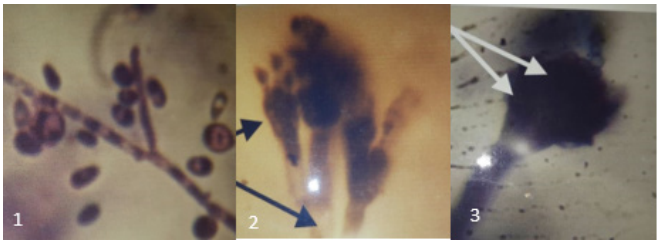

Figure 1: Example of fungi parts have value in forensic analysis:1-Aspergillus niger 2-Penicillium griseofulvum 3-Geotrichum candidum

Wherever other forms are rare or missing, parts of mold things can separate and get stuck in items involved in a criminal investigation. A realization into the killing of a young woman lying in a bed of Urtica dioica can upholding at more species of fungi, of which only seventeen are renowned of this plant.[3] Fungus spores are spread in case of dead stinging nettle (such as *Periconia sp., Torula herbarum*) was found in palynological preparations from the crime place and as well in the suspect's car. This environmental and palynological upholding is proof of a connection between the suspect and the site where the corpse had been deposited.[4]

For the first time, evidence related to fungi was used to identify the perpetrator in the reported rape of a young woman: A young woman alleged that she was raped at night on a piece of wooded ground 120 meters from her house. The suspect disproved her allegations and told her they had consensual sexual relations in a short area in a local park, 130 meters from the claimed crime site. Comparative specimens were obtained from each site, and clothes and shoes from each

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part for evaluated and tested. All sites believed relevant to the case were visited, and recorded of plant species were compiled. Results appear that the features of palynological and mycological profiles produced by shoes and clothes for both sides are very comparable to those in the wooded ground but different from those in the garden. The profile of the wooded site closely reflects its vegetation. When the fungal evidence was proven in court, the suspect confessed to the crime.[5]

Currently, it may be thought that the DNA characteristics of the samples containing the fungi have value for tracking evidence. The truth is that the procedures are not powerful enough to be accepted in court. We have not traced the work endeavor at setting the reproducibility of molecular features obtained from a single site due to the multitude and broad range of fungal types expected in one sample.

Post-mortem Estimation

The fungi that are important in post-mortem estimation are not medicinal, or fungi specialized in decomposition, but rather are fungi that have the ability to colonize carcass and body parts after death, as in Figures 2, 3.[2,6]

Van de Voorde & Van Dyck[7] were the first investigators to report that the growth of fungi on carcass had a role in determining the time of death. They were isolated from fungal growth on the eyelid and on the skin of a victim in Belgium. They grew fungal isolates at the temperature (12°C) at which the body was found and noted colony extent every day. They evaluated that the woman died at a minimum of 18 days before her corpse was found, and this is fully consistent with the admission made by the killer. They behold that the growth of fungi could aid in limiting the time of death, and the fungi included in this event were named: *Geotrichum candidum, Cladosporium sp., Fusarium sp., Mortierella sp, Hormodendron sp.,* and *Penicillium chysogenum* . White growth was observed on the face of a male carcass found in Japan.[8] The temperature was at 12–13°C; molds were grown in media, dead 10 days ago, despite not growing. Colony measurements were made, and the fungal results were comparable with the time of death in general. The fungi grow in 3 to 7 days. Thus fungi can provide a useful method for post-mortem estimation. Fu *et, al* (2019)[9] mentioned that the diversity of fungal communities discovered through a metabolic approach allows distinguishing between the sites of decomposition of the corpse, meaning that mycoflora after decomposition can be useful in determining the site where the corpse was placed or the original site from which the corpse was removed. An example of a fungal species of particular value in estimating the post-mortem interval is shown in Table 1.

From the above mentioned, the fungi can be considered to have great potential for post mortem estimation, especially in the case of highly decomposing bodies. Mold growth on cooked food residues (Figure 4) ability also gives a signal of time. In an apartment accident in London in 2013,[10] fungi growth on leftovers of stewed food contributed to a mother's conviction, causing the death of a child due to omission. It was determined the period that the children were left alone in a closed apartment. Fungal isolates were identified, and the results compare to the growing size of the same fungi on the culture at apartment temperatures. The growth rate of *Aspergillus niger* and *Geotrichum candidum* indicates that the food was left for a period of ten to fourteen days, and the period was not during the weekend as the mother alleged.

Table 1: Types of fungal species that have important in respect of post-mortem time

Geotrichum candidum
Mucor hiemalis
Mucor plumbeus
Penicillium brevicompactum
Penicillium citrinum
Pseudogymnoascus pannorum

Figure 2: *Penicillium griseofulvum* developed directly on a human corpse

Figure 3: Penicillium sp. on abdominal the skin of a cadaver

Figure 4: Mold growths on cooked food residues

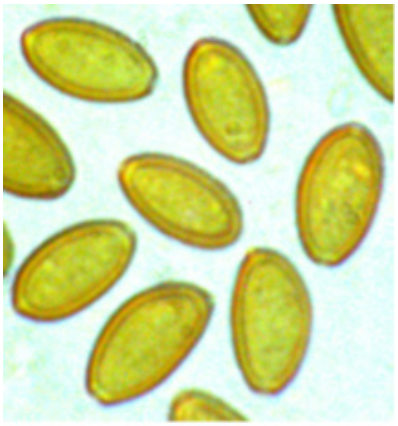

Figure5: *Psilocybe semilanceata*

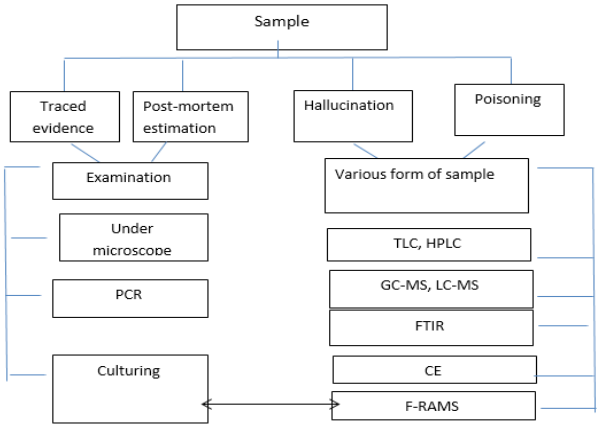

Figure 6: Flow chart showing steps for analyzing the mushroom sample

Cause of Death (Hallucinations or Poisoning):

Poison is a substance that causes a harmful effect when taken by a living organism. Toxins include gases, drugs, minerals, pesticides, and various substances that include mycotoxins. Mycotoxins are secondary metabolic products released by fungi during their growth. In recent years, forensic mycology is used mainly in cases involving poisonous and psychotropic substances.[2] The common toxic fungal species under to genus, Clitocybe m Amanita and Inocybe, Gyromitra. Cortinarius, and Psilocybe.[11,12]

If dimethyltryptamine (DMT) was found in a specimen of a man who died four days after the presence of a party. Police were informed that the deceased used magic mushrooms. The mushrooms were diagnosed as *Psilocybe semilanceata*. Like many psychotropic molds, and to ensure that the dead ate mushrooms, the contents of his stomach and colon were tested microscopically. found the colon was contained numerous spores from the fungi (Figure 5), and microscopic examination showed a vial found in the dead man's house was covered with Psilocybe spores.[12]

Fungi are used as hallucinogens or psychoactive substances in all countries that have agreed to the 1971 United Nations Convention, for example, in the United Kingdom Medicines law 2005, psilocybin and their derivatives of psilocin are considered first-category drugs, which are produced from "magic mushrooms.", unlawful. However, at least thirty "magic mushrooms" grow in the United Kingdom, and *Psilocybe semilanceata* is the rolling. *Psilocybe cubensis, P mexicana* and P. *semilanceat*a are among the most commonly used species, and there are at least 216 species known to have neurotrophic effects;[13,14]. Molecular analysis is suitable for analyzing evidentiary materials (dried hallucinogenic fungi) in forensic genetic laboratories as well as for supplementing classical methods of analyzing clinical material[15-17].

When we used forensic mycology?

From the information as mentioned above, the situations in which forensic mycology is used can be summarized as follows (Figure 6):

1-In the case where the time of death is uncertain, and colonies appear on human remains, clothes, or related objects, inside or outside, the fungus can be deemed as an independent line of the guide

2-If trace evidence is searched, and mold spores are found in palynological preparations.

3-When fungi are found on the suspect's property, in food and drink linked with death or nervous behavior.

4-If the molds were grown in the mass culture.

CONCLUSION

Forensic mycology provides exciting forensic evidence, but it is less used, especially in developing countries, due to a lack of awareness in linking crime investigators with toxicologists. Investigators should collaborate with mycologists to gain experience, and there should be an awareness of the probative value of fungi and not overlook their presence. Fungi can be used in solving cases of poisoning and illegal trade as a tracing guide by linking the actor to the crime scene and estimating the time period since the death. Therefore, there is a need to disseminate this culture among the investigators and establish identification manuals to accurately identify the different types of fungi. With all that forensic mycology offers, we need to do more research to develop this science as part of mycology, which allows the reliable use of its results in forensic analysis, as it is in entomology.

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