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Entomotoxicology: A review on its significance in Forensic Science

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Abstract

The human corpse is exploited by a variety of fauna ranging from microbes to vertebrate scavengers. Arthropods or insects usually constitute major proportion of invading fauna population. Many a times deaths are accounted after a long period of time and corpses are found in decomposed or skeletonised state. In such circumstances, there wouldn't be enough tissue for toxicological analysis. Entomotoxicology is that branch of forensic entomology which deals with utilizing the potential of insects in drug detection and identification of toxins in decomposing tissues. The importance of insects in the decomposition of human bodies was first documented in the early 19th century by biologist Carl von Linne. Conventional parameters like body temperature and rigor are only accurate for a couple of days and are eventually altered due to differences in ambient temperature. Accessible researches have demonstrated that insects aid crime scene investigation as alternative toxicological samples and determinants of post-mortem time interval. Immature larvae stages and adult vary in absorbing foreign chemicals from the cadaver. The ability to retain toxicological indications allow forensic entomological evidence to be a valuable source of information about the past behaviour and medical history of the deceased. Literature concerning entomotoxicology, their storage and their evidentiary value in forensic science has been extensively studied and reviewed with the intent to highlight existing work on entomotoxicology and shed light on the additional work that is needed.

Introduction

Entomotoxicology is the study of application of toxicological analysis to insects for evaluation of narcotics, drugs and toxins present in intoxicated biological tissues [1]. It deals with arthropods involvement in crimes like murder, suicide, rape but also other violations like physical abuse and contraband trafficking [2]. The entomological evidence that can be used as samples are: insects, larval skins or puparial skin present near the corpse. Maggots were first used by Beyers as qualitative assessment for the presence of drug in a suspected suicide case[3]. Entomotoxicology treats insects as xenobiotics in the decomposing tissue. It is of evidentiary value in the investigation [4]. Entomology has three categories: (i) Urban Entomology (ii) Stored-product Entomology (iii) Medico legal Entomology[2]. Entomotoxicology is studied under medico legal entomology. The two aspects of forensic entomotoxicology that demonstrate high value are: (i) Estimation of post-mortem interval and (ii) identification and quantification of drugs in the body [5]. Factors like maggot mass, ambient weather and temperature, quantity of drugs or toxins in the body and geographic region can affect the insect development [3]. Insects are usually analysed after homogenisation of the most representative specimens by common toxicological procedures such as gas chromatography-mass spectroscopy (GC-MS), thin layer chromatography (TLC), high pressure liquid chromatography (HPLC) and radio-immune analysis (RIA) [6].

Drug pharmacokinetics depends on the insect's metabolism and feeding mechanisms. Temperature and photoperiod are the two bioclimatic factors that affect the oviposition and development of most insects [7]. Humidity, temperature and UV radiation are few other factors that influence the stability and bioaccumulation of a drug in the tissues [8]. Post-mortem drug re-distribution (PMR) [9] are changes in toxic substance concentrations after death as a result of diffusion from ruptured cell membranes [10]. The possible implications of the processes used in obtaining entomotoxicological evidence affect the insect by (i) extraction and detection efficiencies in the analytical tools and techniques (ii) toxicant response in the body, and (iii) ante- and post- mortem changes [11].

Sarcophagidae (flesh flies) and Calliphoridae (bottle flies or blow flies) are the principal families that are of medico-criminal interest. Food substrates like beef or pork liver are used for sustenance of the entomological evidence, as it being transported from the crime scene to the laboratory [12].

Processing and analysis of the entomotoxicological evidence

The most common drugs and poisons involved with entomological evidence are: barbiturates, opiates, morphine, cocaine, heroin, hydrocortisone, methadone, methamphetamine, malathion and sodium methohexital [13]. Certain drugs like cocaine and heroin fasten the development of larvae while poisons like malthione delay the colonization of insects [14]. The presence of such drugs or toxic substances may alter the patterns of development in the colonizing insects that use such tissues as food, which subsequently alter the estimates of PMI [15].

All entomological findings do not serve as an evidence for forensic investigations. The three important families that can probably be found at the scene of crime are: *Calliphoridae*, *Sarcophagidae* and *Muscidae*. In a 2012 study, in a experiment on in-vivo rat brain model using blow flies, it was observed that LC-MS is a sensitive technique to detect drugs like MPH in an overdose situation. This technique can also help the forensic entomotoxicologists to find out whether the drug was co-ingested with other substances [16].

Immuno-histochemical technique is a potential alternative for the conventional assays used for drug detection in insects. Depending on the time intervals checked in analysis different fixatives were used. PP, CF, KS, ethanol in different concentrations and ethanol in combination with PP and CF are the few immune-histochemical fixatives (Souza et al., 2013). The larvae on the carrion can be macerated and examined using TLC, GC and/or MS(Isaac et al., 2011). Purified and PCR amplified human DNA can be extracted from the guts of these insects [18].

Future aspects

Forensic entomotoxicology is an emerging field and continues to progress as a discipline of science. It leads to greater understanding of insects and refinement of methods. Currently, there is insufficient research and data, which makes entomotoxicological evidence vulnerable to Type I and Type II statistical errors. The inclusion of DNA analysis and instrumentation improved the accuracy in the processing of entomotoxicological evidence. The development of forensic entomotoxicology has been a significant advancement in identification of toxins and drugs from bodies that have been decomposed or burned, where tissue and fluid are at a premium. Being a young discipline, there are many questions yet to be answered. Though, evidence existed since a long period of time, it was only recently when forensic scientists and medico legal experts made concrete effort to set up methods and guidelines for entomotoxicology as a stand-

alone discipline. Specified curriculum training program should be established, like other disciplines, to reinforce credibility in the court of law and protect the integrity of discipline.

Abbreviations

GC-MS – Gas chromatography and mass spectroscopy

TLC – Thin layer chromatography

HPLC – High pressure liquid chromatography

RIA – Radio-immune analysis

PMR – Post-mortem drug re-distribution

PMI – Post mortem interval

MPH - Methylphenidate

PP – Phosphate buffered paraformaldehyde

CF – Carnoy's fluid

KS – Kahle's solution

PCR – Polymerase chain reaction

DNA – Deoxyribo nucleic acid

References

[1] Sallawad, S. S., Sharma, A., Pandey, D., & Ahirwar, B. (2018). Entomotoxicology - A Juvenile Branch of Forensic Entomological Studies. *Research Journal of Pharmacy and Technology*. https://doi.org/https://doi.org/10.5958/0974-360X.2018.00013.6

[2] Catts, E. P., & Goff, M. L. (1992). Forensic entomology in criminal investigations. *Annual Review of Entomology*, *37*(1), 253–272. https://doi.org/10.1146/annurev.en.37.010192.001345

[3] Sankhla, M. S., Sharma, K., & Kumar, R. (2017). Future Trends in Forensic Entamotoxicology Future

Trends in Forensic Entamotoxicology. *International Journal of Innovative Research in Science, Engineering and Technology*, *6*(4), 5584–5590. https://doi.org/10.15680/IJIRSET.2017.0604113

[4] Hodecek, J. (2020). Revisiting the concept of entomotoxicology. *Forensic Science International: Synergy*, *2*, 282–286. https://doi.org/10.1016/j.fsisyn.2020.09.003

[5] Wallace, D. R., & Se1, P. (2017). Evolution of Forensic Entomotoxicology. *Toxicology and Forensic Medicine – Open Journal*, *SE*(1), Se1–Se4. https://doi.org/10.17140/TFMOJ-SE-1-e001

[6] Introna, F., Campobasso, C. Pietro, & Goff, M. L. (2001). Entomotoxicology. *Forensic Science International*, *120*(1–2), 42–47. https://doi.org/10.1016/S0379-0738(01)00418-2

[7] Gosselin, M., Wille, S. M. R., Fernandez, M. del M. R., Di Fazio, V., Samyn, N., De Boeck, G., & Bourel, B. (2011). Entomotoxicology, experimental set-up and interpretation for forensic toxicologists. *Forensic Science International*, *208*(1–3), 1–9. https://doi.org/10.1016/j.forsciint.2010.12.015

[8] A, T., C, K.-T., P, K., & B, L. (2004). Entomotoxicology for the forensic toxicologist: much ado about nothing? *Internation Journal of Legal Medicine*. https://doi.org/https://doi.org/10.1007/s00414-004-0442-7

[9] Gerostamoulos, D., Beyer, J., Staikos, V., Tayler, P., Woodford, N., & Drummer, O. H. (2012). The effect of the postmortem interval on the redistribution of drugs: a comparison of mortuary admission and autopsy blood specimens. *Forensic Science, Medicine, and Pathology*. https://doi.org/https://doi.org/10.1007/s12024-012-9341-2

[10] Drummer, O. H., & Gerostamoulos, J. (2002). Postmortem drug analysis: Analytical and toxicological aspects. *Therapeutic Drug Monitoring*, *24*(2), 199–209. https://doi.org/10.1097/00007691-200204000-00002

[11] Mbatha, E. I. T. D. S. (2017). *The evaluation of potential dietary media , measurement parameters and storage techniques for use in forensic entomotoxicology*. *December*.

[12] Robert, H. D. (2001). *Forensic Entomology - The Utility of Arthropods in Legal Investigations* (B. H. Jason & C. L. James (eds.)). CRC Press. https://books.google.co.in/books?hl=en&lr=&id=iAtRGA2IfcwC&oi=fnd&pg=PA331&dq=%22tool+for+experiments%22+forensic+entomotoxicology&ots=kejwB8El04&sig=UUZIVJyMXIYjuaTdR2qTsYwbl6w&redir_esc=y#v=onepage&q&f=false

[13] Reject Paul MP, K. V. (2013). Assessment of Post Mortem Interval, (PMI) from Forensic Entomotoxicological Studies of Larvae and Flies. *Entomology, Ornithology & Herpetology: Current Research*, *02*(01). https://doi.org/10.4172/2161-0983.1000104

[14] Isaac, J., Mathew, D. G., Pradeesh, S., & Geetha, V. (2011). The use of insects in forensic investigations: An overview on the scope of forensic entomology. *Journal of Forensic Dental Sciences*. https://doi.org/https://dx.doi.org/10.4103%2F0975-1475.92154

[15] Goff, M. L., & Lord, W. . (1994). Entomotoxicology. A new area for forensic investigation. *The American Journal of Forensic Medicine and Pathology*, 51–57. https://europepmc.org/article/med/8166117

[16] Bushby, S. K., Thomas, N., Priemel, P. A., Coulter, C. V., Rades, T., & Kieser, J. A. (2012). Determination of methylphenidate in Calliphorid larvae by liquid-liquid extraction and liquid chromatography mass spectrometry - Forensic entomotoxicology using an in vivo rat brain model. *Journal of Pharmaceutical and Biomedical Analysis*, *70*, 456–461. https://doi.org/10.1016/j.jpba.2012.06.024

[17] Souza, C. M., Lima, C. G. P., Alves-Jr, M. J., Arrais-Silva, W. W., Giorgio, S., Linhares, A. X., & Thyssen, P. J. (2013). Standardization of histological procedures for the detection of toxic substances by immunohistochemistry in dipteran larvae of forensic importance. *Journal of Forensic Sciences*, *58*(4), 1015–1021. https://doi.org/10.1111/1556-4029.12140

[18] Sharma, D. M. (n.d.). *e-Pathshala*. http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/S000016FS/P000701/M015723/ET/1464337622FSC_P14_M8_e-text.pdf