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Forensic Identification of Methcathinone (MCAT) Using Analytical Techniques, Including ATR-FTIR Spectroscopy: A Case Study from Chhattisgarh, India

Authors: Shashank Dwivedi[1], Pankaj Tamrakar[2], Ankit Kumar Garg[3]

[1,2] Senior Scientific Officer, Regional Forensic Science Laboratory, Durg, Chhattisgarh, India
[3]Director, State Forensic Science Laboratory, Raipur, Chhattisgarh, India
Email- s.dwivedi@cg.gov.in
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ABSTRACT

This case study focuses on the forensic identification of methcathinone, also known as "MCAT," using various analytical techniques, specifically emphasizing Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy for its non-destructive, rapid, and "green" analytical capabilities[1]. Methcathinone, a Schedule-I controlled substance under the NDPS Act, poses significant challenges due to its structural similarities to methamphetamine and cathinone as well as its instability, distinguishing methcathinone from its structural isomers[2]. The current study details a specific case from Chhattisgarh, India, demonstrating the practical application of these methods in forensic investigations to accurately identify this controlled substance.

Keywords- ATR-FTIR, TLC, Methcathinone, MCAT, NDPS, FSL

1. INTRODUCTION

Drug (substance) abuse has become a global problem. Drug addiction affects everyone, everywhere. Drug misuse has developed as a severe worry, negatively impacting the country's physical and socioeconomic well-being. It has a significant impact on public health in numerous sectors of society. Drug usage among the younger generation has reached frightening proportions in India[3]. Methcathinone (also known as "mcat," "jeff," or "ephedrone") is a powerful psychoactive stimulant and restricted substance with structural similarities to methamphetamine and cathinone. It is a recreational drug with euphoric effects that is frequently synthesised from ephedrine or pseudoephedrine. Its use is highly addictive, neurotoxic, and can result in lasting brain damage[4,5].

Drug (substance) abuse cases in India's Chhattisgarh state are mostly concerned with the unlawful trafficking, possession, and transit of contraband, with a high volume of instances including Ganja (cannabis), opium and its derivatives, and pharmaceuticals such as tablets and injections[6]. However, Chhattisgarh's drug trade has changed significantly in recent years, shifting from conventional drugs like ganja (cannabis) to new, extremely addictive synthetic "designer" drugs, especially in major cities like Raipur, Durg, and Bilaspur. The expertise of the Forensic Science Laboratory (FSL) to detect and identify unknown compounds is extremely significant as new, non-controlled designer drugs enter the market at an increasing rate. Designer drugs have similar chemical structures and physiological effects to illicit drugs. Unfortunately, customers are unaware of the long-term toxicity or rapid physiological effects connected with these new designer drugs, which are not always related with the original unlawful drug that was duplicated. The truth is that societies have devised ways to take these substances for their hallucinatory effects[7].

This paper presents a case study of new designer drugs on the market. After analysing the unknown exhibit material in the laboratory using the presumptive colour test, thin layer chromatography, and ATR-FTIR, the sample was identified as methcathinone.

2. MATERIALS AND METHODS

2.1. Case study

On 02.07.2025, at 09:30 a.m., an informant at the City Kotwali Police Station in Durg, Chhattisgarh, reported that a person wearing a black lower and a grey T-shirt was selling narcotics-like substances to people near Sheetla Nagar Kham Talab, Durg. When the police team searched the suspect's clothing in front of witnesses, they recovered something that looked like drugs inside clear plastic packages. Judicial Magistrate First Class, Durg, Chhattisgarh, conducted an inventory in accordance with sub-section 2 of section 52A of the NDPS. The seized narcotics-like substance was sealed and retained for FSL's chemical testing.

The case exhibit along with test memo submitted in Regional Forensic Science Laboratory, Durg, through the Superintendent of Police, Durg for the chemical testing of the case exhibit. The case exhibit contained duly sealed and signed one yellow coloured paper envelope containing transparent plastic packet in which white, powdery substance found with a characteristic odour. **Fig.1**

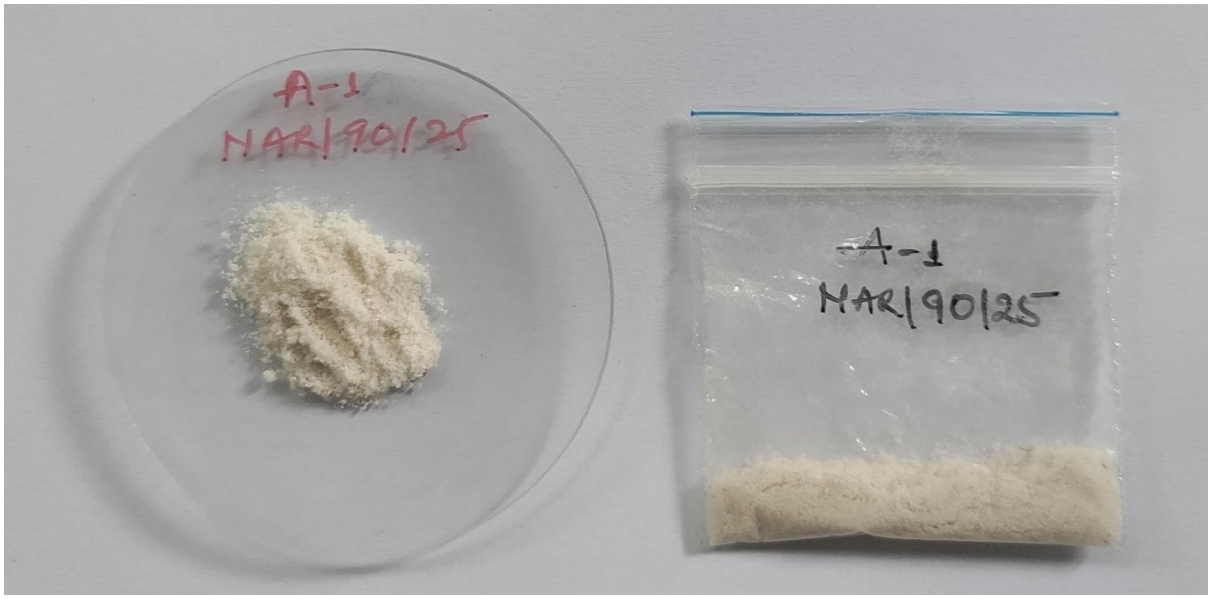

Fig.1 Case exhibit received in Forensic Science Laboratory.

2.2 Chemicals

Ammonia, chloroform, ethyl acetate, glacial acetic acid and potassium iodide were supplied by LOBA CHEMIE. Bismuth subnitrate was supplied by SRL. Methanol, silica gel G, and sodium nitrite were from CDH; formaldehyde was from Thermo Scientific chemicals. Sulphuric acid was supplied by Qualigens SQ, and double-distilled water was used.

2.3 Methodology

2.3.1 Preliminary color tests

The following color tests were performed in clean white porcelain spot plate and any color change immediately observed and recorded.

a) Liebermann's Test

Preparation of Liebermann's Reagent*:* Add 5 grams of Sodium nitrite to 50 ml of sulphuric acid with cooling and swirling to absorb the brown fumes[8].
An appropriate amount of the suspected material was placed on a spot plate and 2 drops of Liebermann's reagent was added.

b) Marquis Test

Preparation of Marquis Reagent*:* 8-10 drops of 40% formaldehyde solution is added to 10 ml of Con. Sulphuric acid[8].
A small amount of suspected sample was taken on a spotting plate and few drops of Marquis Reagent was added.

2.3.2 Thin Layer Chromatography (TLC) analysis

a) Preparation of TLC plates: 50 g of silica gel G was taken, and 100 ml of distilled water was added to it, and the resulting slurry is stirred to obtain a homogeneous mixture. The slurry is loaded in the preparator and coated on the glass plates producing a uniform thickness of 0.25 mm. The plates were air dried and then incubated at 110˚ C for 45 minutes for activation. The plates were cooled at room temperature before using[9].

b) Solvent systems used: Ethyl acetate: Methanol: Concentrated Ammonia (85:10:5)

c) Chromogenic reagents used*:* Dragendorff's reagent: Mixed 2 g of bismuth subnitrate, 25 ml of glacial acetic acid and 100 ml of water to prepare a solution (1); Dissolved 40 g of potassium iodide in 100 ml of water to prepare solution (2). Mixed 10 ml of solution (1), 10 ml of solution (2), 20 ml of glacial acetic acid and 100 ml of water.

d) Thin Layer Chromatography: 2 ml chloroform was added to the sample to prepare a solution. 10 µl of aliquot samples were taken and spotted on TLC plate about 1 cm above the base of plate along with the control samples. The plates were placed in the developing chamber containing the appropriate solvent system and allowed to develop by ascending chromatographic technique. After a run of 10 cm, the plates were removed from the chamber and air-dried[9].

e) Visualization of spots*:* The developed TLC plate was sprayed with Dragendorff's reagent for development of colored spots.

2.3.3 ATR-FTIR examination

All spectral measurement were performed using a Bruker ALPHA II FTIR spectrometer equipped with a Platinum-ATR sampling module. Spectral processing was executed through OPUS 8.7 Build software. Acquisition parameters were set as follows: 24 scans at 4 cm^{-1} resolution across the 600-4000 cm^{-1} range. Prior to each measurement cycle, the ATR crystal was cleaned with iso-propanol, air-dried, and baseline- corrected using atmospheric background subtraction. Sample is placed onto the ATR crystal and spectral stability was verified through moisture interference check. Automatic baseline correction was applied using the instrument's acquisition software.

3. RESULT AND DISCUSSION

a) Liebermann's Test

Liebermann's reagent reacts with suspected material, and the appearance of bright yellow/orange colour indicates the presence of methcathinone (MCAT) or its analogues of methcathinone[8]. **Fig.2**

Fig.2 Image showing Liebermann's test-positive results.

b) Marquis Test

Marquis reagent does not react with the suspected material. Marquis reagent yielding a yellow product with methylenedioxy substituted analogues of methcathinone (3,4-MDMC) only. This test gave no colour change with any other methcathinone analogue[8].

c) Thin layer Chromatography analysis

The developed TLC plate was sprayed with Dragendorff's reagent[10] gave brown colour single spot similar to that of control sample. The Rf value for the test sample is 0.67 and for control sample 0.65. The observation of a single spot suggests that the sample is relatively pure or that only one specific amine is detectable under the chosen chromatographic conditions[11]. **Fig.3**

Fig.3 TLC Image showing brownish colored spots.

d) ATR-FTIR examination

The ATR-FTIR spectrum of Methcathinone HCl (**Fig. 4**) displays absorption band for amine salt stretch in the region of 2000-2700 cm^{-1}. Carbonyl (C=O) stretching vibration in the region of 1680-1700 cm^{-1} is the signature peak for methcathinone. Aromatic (C=C) ring stretching vibration displays in the region of ~1605cm^{-1}. C-H bending of the methyl or methylene group peak in the region of 1450-1455 cm^{-1}. The peaks within the 600-1500 cm^{-1} wavelength range can help differentiate between methcathinone isomers (2-MMC, 3-MMC, and 4-MMC) have nearly identical mass spectra but show distinctive patterns in the fingerprint region[12,13].

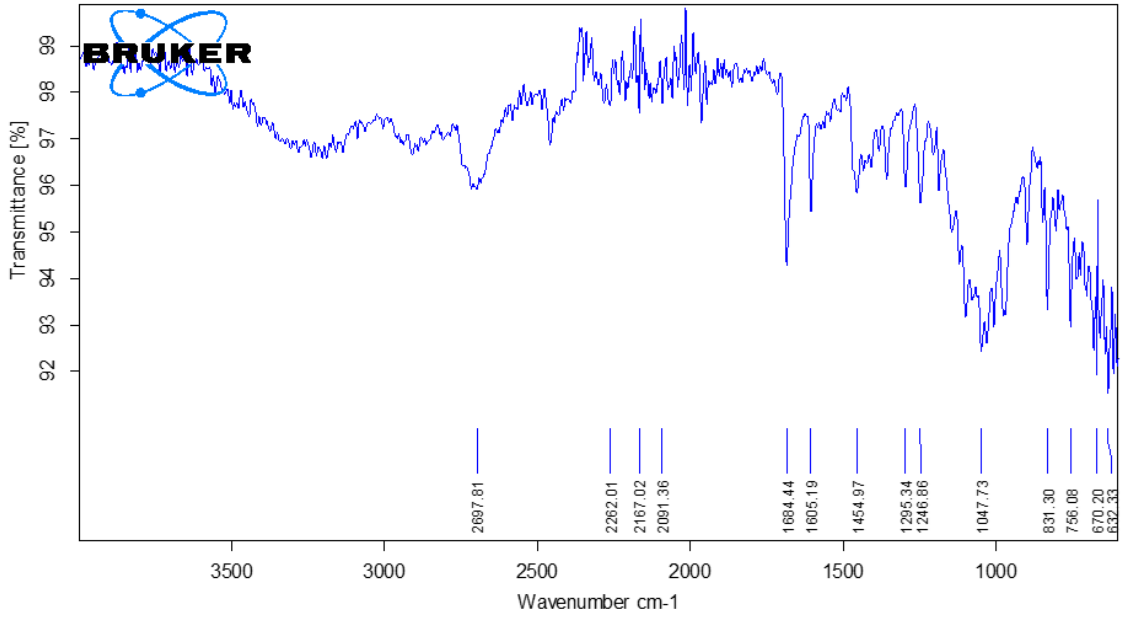

Fig.4 ATR-FTIR spectrum of case exhibit.

The ATR-FTIR spectrum of suspected sample (**Fig. 5**) displays the library match results which was executed through OPUS 8.7 Build software. The library name is ATR-LIB-FORENSICS-2-472-2.S01 and matched with the compound Methcathinone HCL whose Hit Quality Index (HQI) is 118.

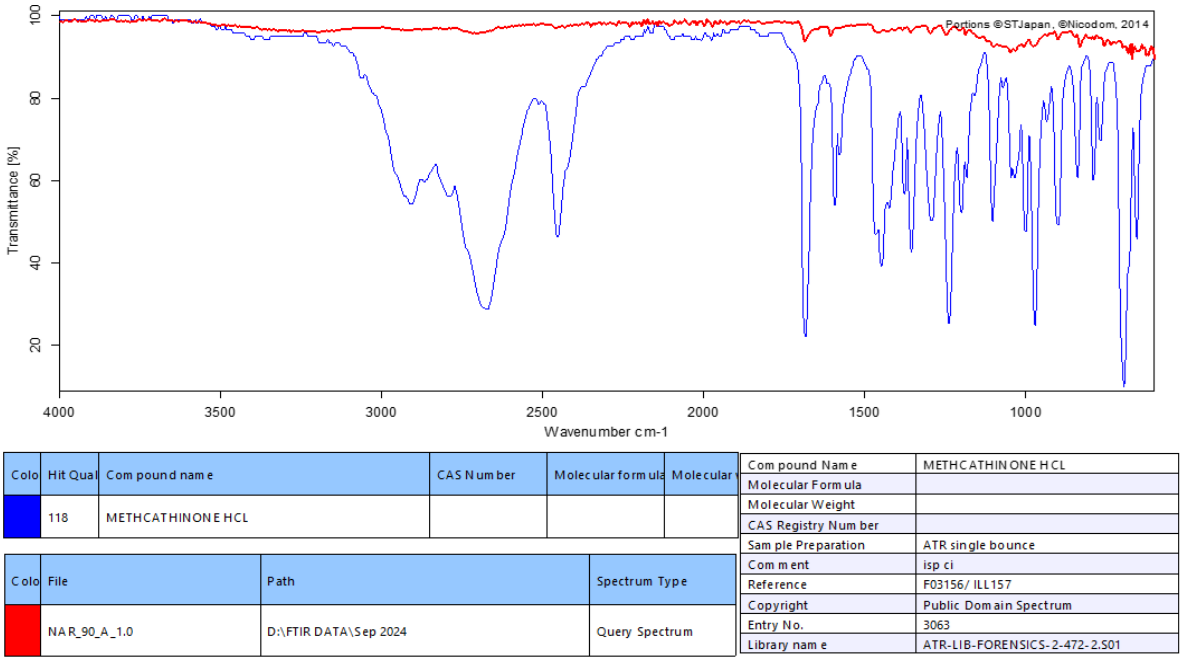

Fig.5 ATR-FTIR spectrum of case exhibit along library match result.

CONCLUSIONS

The successful identification of Methcathinone (MCAT) in this case study highlights an evolving trend in the local illicit drug market toward synthetic cathinones. Establishing standardized analytical workflows combining TLC along with the ATR-FTIR empowers forensic laboratories to provide timely, scientifically backed testimony. Such frameworks are vital for strengthening the judicial response to the distribution of designer drugs and enhancing the overall efficacy of law enforcement in the state.

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AUTHOR'S CONTRIBUTION

SD and PT examined the case exhibits. SD has done the writing and drafting of the manuscript under the supervision of PT and AKG. All authors reviewed the results and approved the final version of the manuscript.

CONSENT FOR PUBLICATION

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Gonçalves, J. L., Alves, V. L., Aguiar, J., Caldeira, M. J., Teixeira, H. M., & Câmara, J. S. (2021). Structure assignment of seized products containing cathinone derivatives using high resolution analytical techniques. *Metabolites*, *11*(3), 144. https://doi.org/10.3390/metabo11030144

2. UNODC**.** (2023). Recommended Methods for the Identification and Analysis of Synthetic Cathinones in Seized Materials. *Laboratory and Scientific Section*.

3.National Centre for Drug Abuse Prevention https://www.nisd.gov.in/drug_abuse_prevention.html

4. Sikk, K., & Taba, P. (2015). Methcathinone "Kitchen chemistry" and permanent neurological damage. *International Review of Neurobiology*, *120*, 257–271. https://doi.org/10.1016/bs.irn.2015.02.002

5. Wang, Y., Wang, N., & Zhao, S. (2025). Neurobehavioral Disorders and Cognitive Impairment in methcathinone exposure: A Systematic Review of literature. *Current Neuropharmacology*, *23*(12), 1575–1580. https://doi.org/10.2174/011570159x387589250318041633

6. Narcotics Control Bureau (NCB), India https://narcoticsindia.nic.in/ImportantSeizure/seizure2024.pdf

7. Mangombo, ZA., Mthembi, PM., Maleke, AK., & Modise, PM., (2014). Detection and Identification of 3, 4 Methylenedioxy methcathinone (Methylone) As an Illicit Drug Using GC-MS, LC-(TOF)-MS, ATR-FTIR and FT-Raman in the Forensic Science Laboratory in South Africa. *International Journal of Interdisciplinary Research and Innovations Vol. 2, Issue 3, pp: (56-64)*.

8. Toole, K., Fu, S., Shimmon, R., Kraymen, N., & Casamento, S. (2012). Color tests for the preliminary identification of methcathinone and analogues of methcathinone. *UTS ePRESS (University of Technology Sydney)*. http://hdl.handle.net/10453/22080

9. Randerath, K. (1979). Thin Layer Chromatography, *Academic Press, New York, London,* pg 176.

10. DeRuiter J., Hayes, L., Valaer A., Clark CR., Noggle FT. (1994). Methcathinone and designer analogues: Synthesis, stereochemical analysis, and analytical properties. *Journal of Chromatographic Science 32: 552-564*

11. Askal, H. F., Khedr, A. S., Darwish, I. A., & Mahmoud, R. M. (2008). Quantitative thin-layer chromatographic method for determination of amantadine hydrochloride. *PubMed*, *4*(2), 155–160. https://pubmed.ncbi.nlm.nih.gov/23675083

12. Yu, Y., Chen, T., Yuan, L., Sun, M., & Wu, Y. (2025). Detection of common drug metabolites in urine using attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR). *Forensic Science Medicine and Pathology*, *21*(4), 1617–1625. https://doi.org/10.1007/s12024-025-01017-4

13. Clarke, E.G.C., Dal Cason, T., Drug Enforcement Administration, Lurie, I., Moffat, A.C. Sr., & O'Neil, M. (2005). *METHCATHINONE*. https://swgdrug.org/Monographs/METHCATHINONE.pdf