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LETTER TO THE EDITOR

Concerns and Observations on Mehndi Oil Poisoning: A Call for Awareness

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Mehndi oil is a mixture of essential oils derived from plants such as Eucalyptus (Eucalyptus globulus), Tea tree (Melaleuca alternifolia), Ravensara (Ravensara aromatica), and Cajeput (Melaleuca cajuputi). Eucalyptus oil contains eucalyptol, α-pinene, myrcene, cineole, fenchone, α-terpinolene, camphor, and β-terpinyl acetate [1,2]. Tea tree oil contains various terpene compounds, with terpinen-4-ol being the most prominent [3,4]. Ravensara oil is rich in estragole (methyl chavicol) and eucalyptol [5]. Cajeput oil's main active components are cineole and terpineol [6]. Commercially available mehndi oil typically contains terpenes like eucalyptol (40-80%), limonene (5-15%), and alpha-terpineol (3-7%), which enhance henna's dye release.

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Eucalyptus oil is commonly used to relieve respiratory issues such as cough and cold, soothe sore muscles, and act as a natural insect repellent and disinfectant. Tea tree oil, Ravensara oil, and Cajeput oil are often used in skincare for treating acne and fungal infections, as well as in hair care to fight dandruff. Additionally, all these essential oils are used as antiseptics in wound care.

Mehndi oil enhances the colour and longevity of mehndi, a natural dye used for cosmetic purposes in the Indian sub-continent. The oil is rich in terpenes, which interact with the hennotannic acid (lawsone) in mehndi leaves (Lawsonia inermis) to create a deeper and more vibrant stain. Lawsone dissolves well in mehndi oil compared to water due to its chemical properties *(like dissolves like).* It is pertinent to mention that lawsone has several applications ranging from

cosmetics to biomedicine and its therapeutic potential is being actively investigated by the research community [7].

Commercially available Mehndi oil preparations (Figure 1) are usually smooth, light, non-greasy in consistency; transparent to pale yellow and sometimes orange in colour depending on the concentration of its constituents and have a characteristic camphoraceous aroma. However, the labels on mehndi oil products often do not explicitly list all the ingredients in the mixture, which may include various artificial compounds beyond the essential oils/standard ingredients typically used, intended to serve the same purpose.

A 33-year-old male employee at a tattoo shop in a metropolitan city accidentally ingested about 30-70 ml of a transparent liquid, mistaking it for water. The liquid, later identified as mehndi oil, had been transferred to a water bottle for regular use at his work place. Mehndi oil (which is sometimes referred to as tattoo oil), used to enhance stain brightness, is a mixture of various essential oils as mentioned above. After ingestion, the individual experienced multiple episodes of vomiting and was taken to a nearby hospital for initial treatment. He was then admitted to a tertiary care hospital in an altered state of consciousness with a poor Glasgow Coma Scale (GCS = 6) score and was irritable. Within a few hours, his condition deteriorated before any blood/radiological investigations could be performed. Despite resuscitative efforts, he succumbed due to aspiration pneumonitis (clinician's notes) approximately nine hours after the incident and three hours after being admitted to the tertiary care hospital. An autopsy was subsequently conducted in this case as it was mandated by the law.

The postmortem examination revealed several significant findings. There was marked laryngeal oedema, and the trachea contained pinkish white froth. The oesophagus showed the presence of a yellow, tenacious fluid. The liver, lungs, and kidneys were congested, and the stomach contained approximately 200 ml of dark yellowish fluid with a camphor-like odour, along with congested mucosa and haemorrhagic patches (Figure 2).

Microscopic examination revealed pulmonary oedema, interstitial oedema, inflammation with focal lymphoid aggregates, and congested blood vessels in the lungs. The liver showed sinusoidal and central vein dilatation with congestion. Both kidneys exhibited congestion with areas of acute tubular necrosis. The stomach had lymphoid aggregates in the lamina propria and submucosa (Figure 3).

Chemical analysis of the preserved viscera (stomach and its contents, proximal part of small intestine and its contents, liver with gall bladder, kidneys and blood) identified the presence of Alpha pinene, a terpenoid compound. The cause of death in this case was attributed to Alpha pinene toxicity (mehndi oil/eucalyptus oil poisoning).

Although mehndi oil is considered safe for topical application, it exerts systemic toxicity when accidentally ingested. The toxic effects of eucalyptus oil, which is one of its major constituents, typically manifest quickly within a few minutes and include symptoms such as a burning sensation in the mouth and throat, abdominal pain, and spontaneous vomiting. Early central nervous system (CNS) effects may include dizziness, lack of coordination, and confusion, which can progress to loss of consciousness within 10 to 15 minutes. While convulsions are rare in adults, they

are more frequently observed in children. In adults, fatal outcomes are generally associated with the ingestion of around 30 ml, although cases of death have been reported with as little as 4 to 5 ml [1]. True eucalyptus oil, derived directly from the eucalyptus tree, does not contain camphor. However, eucalyptus oil produced from the cineole fraction of camphor laurel (often referred to as "fake eucalyptus oil") may contain camphor. Similar to eucalyptus oil, camphor also has epileptogenic properties [2].

Accidental ingestion of eucalyptus oil in children has been reported to lead to seizures, while in adults, although seizures are less common, toxicity can manifest as severe metabolic acidosis, neutrophilic leucocytosis, and mild elevation of liver enzymes. Overall, epileptogenicity followed by CNS depression has been highlighted in previous case reports. The use of gastric lavage or activated charcoal is not advocated due to equivocal outcomes. There is no specific antidote for eucalyptus oil poisoning, and treatment is supportive [1,2]. Interestingly, several studies also indicate the antimicrobial and anti-inflammatory properties of eucalyptus oil. However, the concentration and dosing of the substance require strict caution [8].

Tea tree oil (TTO) another major constituent in mehndi oil, is used in cosmetic and pharmaceutical products. Its major constituents include terpinen-4-ol and 8-cineole, among others. Terpinen-4-ol is a bactericidal substance known to destroy cell walls and affect protein or DNA synthesis [9].

The outcomes of TTO consumption vary from mild skin irritation to systemic toxicity. However, no deaths have been reported due to TTO poisoning so far. Clinical symptoms include central nervous system depression characterized by an unsteady "drunk" state, and ataxia in children, unconsciousness, unresponsiveness, often accompanied by hallucinations in the elderly. Other less serious manifestations include urticaria and hypersensitivity responses. Irritant reactions are often concentration-dependent and do not rely on previous exposure to the irritant. TTO is a known contact allergen and can cause dermatitis.

Tea tree oil (TTO) has been proposed as a treatment for otitis externa and otitis media due to its antimicrobial properties. However, studies in guinea pigs have shown that TTO can cause ototoxicity, as well as hepatotoxicity and nephrotoxicity. Despite these findings in animal studies, no such toxic effects have been observed in humans under typical usage conditions. Several studies have assessed the toxic effects of TTO and its components on human cell lines in vitro, though data on the ecotoxicity of TTO are limited. The toxicity of TTO against fish, amphibians, insects, worms, and other aquatic and terrestrial species or ecosystems has not been thoroughly assessed [10].

Ravensara oil is as a flammable liquid and poses toxicological risks, including dermal and ocular irritation, skin sensitisation with prolonged exposure, and potential germ cell mutagenicity and carcinogenicity. It also presents an aspiration hazard upon inhalation, leading to potential pulmonary injury, and is environmentally hazardous with ecotoxicity concerns. Cajeput oil, while also causing dermal and ocular irritation, primarily presents risks upon ingestion, where it can lead to systemic toxicity. Chronic exposure may result in respiratory discomfort, though data on its mutagenic,

carcinogenic, and teratogenic potential remains insufficient.

The misconception that 'eucalyptus oil' and 'tea tree oil' being considered as an 'innocuous herbal remedy' should be reconsidered, as both eucalyptus oil and tea tree oil are known to cause systemic toxicity with lethal outcomes and consequences when ingested. The lethal dose (LD50) data of the major ingredients of mehndi oil are mentioned in Table 1 [11-14]. The therapeutic potential of the essential oils mentioned above remains an area of ongoing research. Their bioactive compounds are being studied for potential benefits in areas such as antimicrobial, anti-inflammatory, and analgesic effects.

This may be the first documented case of fatal mehndi oil poisoning, as all previously reported cases involve poisoning from individual components such as eucalyptus oil or tea tree oil. An important toxic manifestation of clinical concern is laryngeal edema, a feature commonly encountered in super-vasmol (hair dye) poisoning in South Asian clinical toxicology practice. Like with hair dye poisoning, an early intervention with tracheostomy may play a significant role in decreasing the mortality along with supportive care.

It is advisable that mehndi oil, eucalyptus oil, and tea tree oil be packaged in a way that prevents copious amounts from being dispensed at once. Fixed-volume, single-use containers should be employed to avoid transferring these substances to other containers where they might be mistaken for water, leading to accidental ingestion, as seen in this case. Additionally, incorporating specific dyes or indicator colors into these substances could help prevent confusion with water. However, this raises concerns about the commercial viability of such products, as incorporating indicator dyes may impact their efficacy, which is another area that requires further research.

There is a need for regulatory reform about the packaging, labeling, and sale of these substances, with clear indications of their toxicity on the containers/ depiction of hazard signs, symbols. Clinicians should also be made aware of such poisoning cases and their signs and symptoms to help prevent fatalities.

Table 1. LD50 values of key essential oils commonly used as ingredients in Mehndi oil/Tattoo oil

S. No	Compound	LD50
1	Eucalyptus oil	3320 mg/Kg BW
2	Tea Tree oil	1.9-2.6 ml/Kg BW
3	Ravensara oil	Eucalyptol: 2480 mg/Kg BW Estragole: 1230 mg/Kg BW
4	Cajeput oil	3870 mg/Kg BW

Figure 1. Representational images of **A** Eucalyptus oil (yellow-tinged to transparent), **B** Tea tree oil (pale yellow to transparent), and **C** Mehndi oil (transparent to brown).

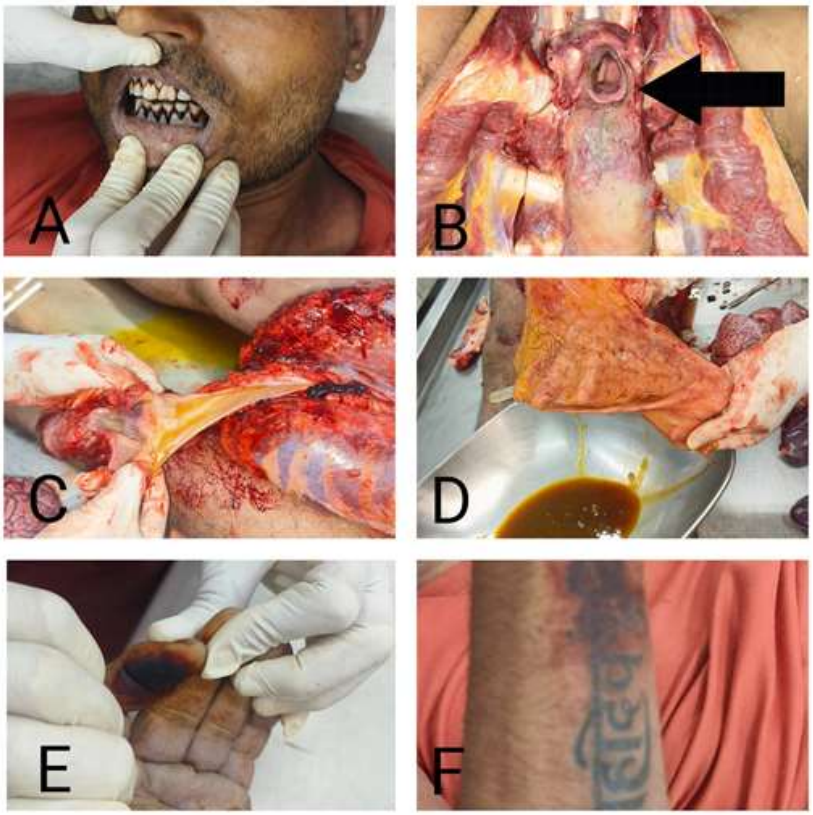

Figure 2. Autopsy findings **A** Reddish brown staining of teeth due to tobacco abuse **B** Laryngeal oedema, **C** Yellowish tenacious fluid in oesophagus **D** Haemorrhagic stomach mucosa **E** Fingers showing mehndi stains (occupational stigmata) **F** forearm showing mehndi stains (occupational stigmata).

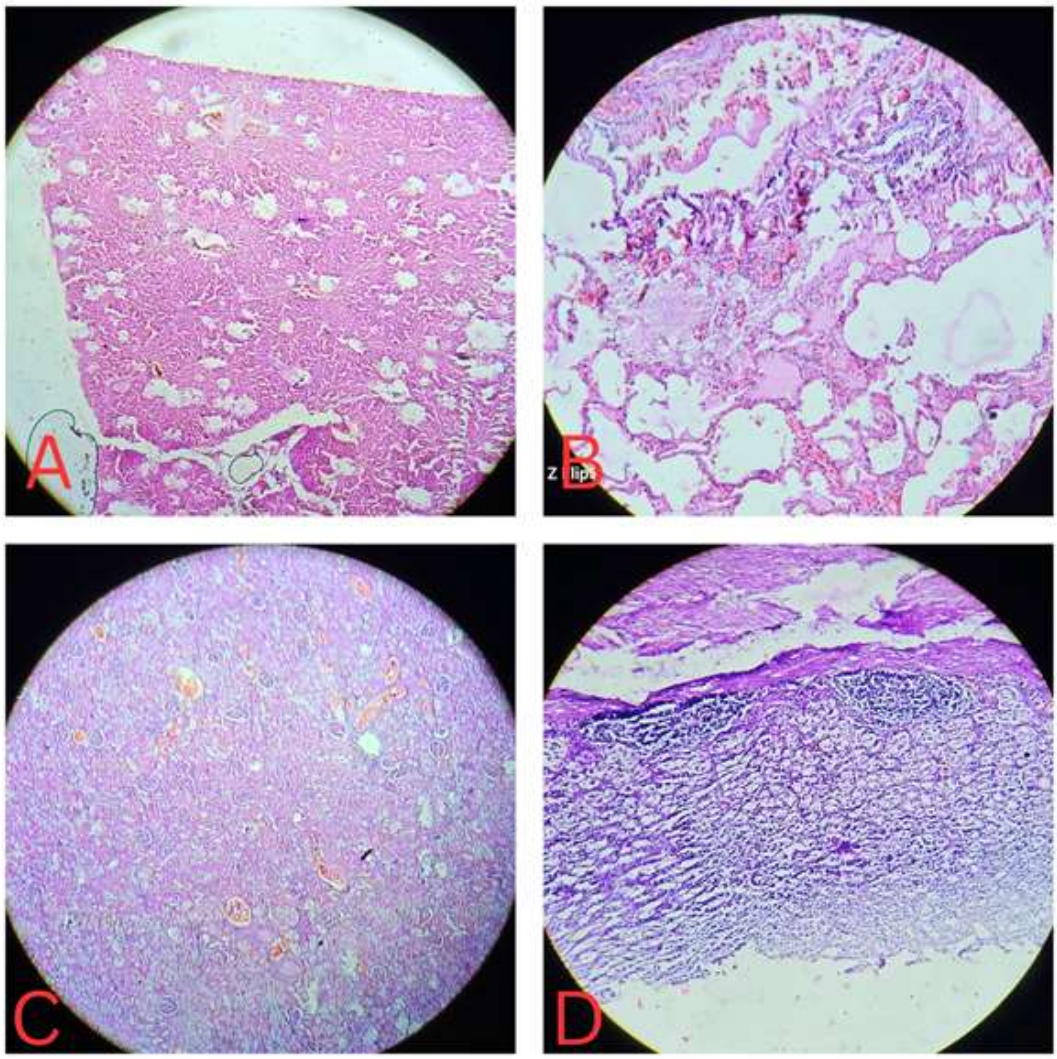

Figure 3. Histopathological Findings **A** Liver showing sinusoidal dilatation and congestion H&E 10X, **B** Lung showing oedema and inflammatory infiltrates H&E 10X, **C** Renal tissue showing congestion and acute tubular necrosis H&E 10X, **D** Stomach showing lymphoid aggregates H&E 10X.

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Limitations

Information regarding the deceased's general health condition prior to the incident was unavailable, and a quantitative analysis of alpha-pinene in the blood (both antemortem and postmortem) could not be performed due to limited resources. Additionally, the sample of Mehndi oil involved in this fatality was not subjected to toxicological analysis.

Conflicts of interest

The authors declares that they do not have conflict of interest.

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Ethical Considerations

Addressed by the authors.

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