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Ipomoea Obscura: Traditional Uses, Phytochemistry, And Pharmacological Potential

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KEYWORDS

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ABSTRACT:

Ipomoea obscura (L.), commonly known as "Laksmana" in Ayurveda, is a perennial climber from the Convolvulaceae family, valued for its ethnomedicinal applications across Africa, Asia, and the Pacific Islands. Traditionally, it has been used to treat various ailments, including dysentery, ulcers, hemorrhoids, swelling, respiratory issues, and vision problems. Phytochemical studies have identified a rich array of bioactive compounds in I. obscura, including glycosides, alkaloids, flavonoids, steroids, essential oils, and phenolic acids. Notably, the plant contains indole alkaloids like Ipobscurine A-D and tropane alkaloids such as Calystegine B-1 to B-4 and C-1, which exhibit significant pharmacological activities, including anti-inflammatory, antioxidant, anticancer, nephroprotective, antiangiogenic, and antimicrobial effects. The essential oil of I. obscura is particularly rich in sesquiterpene hydrocarbons, with Bulnesene, β-humulene, and Seychellene being the predominant compounds. Recent research has also explored the green synthesis of silver and zinc oxide nanoparticles using the plant's aqueous leaf extract, demonstrating promising antifungal and anticancer activities. This review summarized the traditional uses, phytochemical profile, pharmacological properties, and/or therapeutic potential of I. obscura, underscoring its significance as a subject for future research and the development of novel botanical drugs.

Introduction

Ipomoea obscura (L.), commonly called "Laksmana" in Ayurveda, is a notable species within the Convolvulaceae family. This slender, perennial climber is distinguished by its small, heart-shaped leaves with an acuminate apex and a corolla comprising five fully fused petals. Native to Africa, Asia, and Pacific Islands regions, *I. obscura* thrives in disturbed habitats, often growing on fences or as ground cover (1). Beyond its ornamental appeal, this plant holds substantial ethnomedicinal significance. Traditionally, Ayurveda has harnessed the medicinal properties of *I. obscura* to treatvarious ailments. It has been effectively employed against dysentery, and its leaves are applied as a paste to ulcers, hemorrhoids, and swellings. The seeds and fruits of the plant are used as cleansing agents to alleviate breathing difficulties, relieve pain, and enhance vision. The plant extract is combined with gingelly oil to treat conditions such as colds, asthma, and dry cough by widening blood vessels to relieve pain (2)(3)(4)(5).

Phytochemical investigations have revealed that *I. obscura* contains diverse bioactive compounds, including glycosides, reducing sugars, alkaloids, flavonoids, steroids, essential oils, and phenolic acids. Notably, the plant is rich in indole alkaloids like Ipobscurine A, B, C, and D and tropane alkaloids such as Calystegine B-1, B-2, B-3, B-4, and C-1. These compounds have demonstrated significant pharmacological activities, including anti-inflammatory, antioxidant, anticancer, nephroprotective, antiangiogenic, and antimicrobial effects (6)(7). Notably, the essential oil of *I. obscura* contains a rich composition of various bioactive compounds. The primary constituents include Bulnesene (23.8%), β-humulene

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 2800-2808 | ISSN:2251-6727

(13.7%), and Seychellene (11.2%). Additionally, the oil contains several other compounds in smaller quantities, such as α-guaiene (8.3%), β-caryophyllene (7.1%), γ-terpinene (4.2%), Hexadecanoic acid (3.0%), and β-elemene (2.7%). The essential oil predominantly comprises sesquiterpene hydrocarbons, accounting for approximately 78.4% of its composition (8)(9). Keeping view on this, we have summarized and discussed the ethnomedicinal applications, detailed phytochemical composition, pharmacological activities, and therapeutic potential of the plant *Ipomoea obscura*. By bridging traditional knowledge with contemporary scientific research, we highlight this remarkable plant's multifaceted benefits and medicinal prospects.

Methodology

The search aimed to identify relevant studies and literature on the ethnomedicinal applications, phytochemical composition, pharmacological activities, and therapeutic potential of the plant *Ipomoea obscura*. The databases used included PubMed®, Google Scholar®, Scopus®, ResearchGate®, Web of Science®, Multidisciplinary Digital Publishing Institute (MDPI)®, Science Direct®, Scopus (Elsevier). The search, limited to English studies, was conducted until August 2024. Key search terms included *Ipomoea obscura*, ethnomedicinal uses, phytochemistry, pharmacology, and therapeutic potential. Relevant publications were critically reviewed, and concluding remarks were drawn from the gathered data.

Ethnomedical Uses

The genus *Ipomoea* L. is widely recognized for its nutritional, medicinal, and ethnomedical applications, with several species being valuable in traditional medicine.The leaf juice of Ipomoea has been traditionally administered in cases of snake bites and dysentery, highlighting its role in emergency and digestive health treatments. In addition to the leaves, the seeds of this plant are also valued in traditional medicine. They are used as a natural cleaning agent to purify the body. Moreover, the seeds ease respiratory difficulties, relieving those suffering from conditions that impair breathing. Additionally, they are used to alleviate pain, making them a natural analgesic. The seeds are also said to have properties that improve vision, further underscoring the plant's broad therapeutic potential in traditional healing practices (10)(11).It is valued in Ayurveda for treating dysentery, open sores, and pustules. Leaf paste is applied to ulcers, hemorrhoids, and swelling. Seeds and fruits act as cleansing agents, easing breathing difficulties and pain. The plant is also ornamental, with attractive climbing flowers. The whole plant is traditionally used for stomach ulcers, coughs, asthma, colds, pain, conception, rheumatoid arthritis, wounds, sprains, and stomach aches (12).

Chemical Constituents

The methanolic seed extract of *I. obscura* was separated to yield five indole alkaloids, including three novel compounds: Ipobscurines B, C, and D. These newly identified alkaloids are characterized as serotonin hydroxycinnamic acid amide-type conjugates, with a distinctive structural feature where a second phenylpropanoid moiety forms an ether bond with the 5-OH position of the indole nucleus. Oxidative phenolic coupling between the phenylpropanoid moieties of Ipobscurine B leads to the formation of two 21-membered macrolactams with a phenol ether structure: the trans–cis isomers Ipobscurines C and D. Furthermore, the total synthesis and comparative analysis of racemic erythro- and threo-ipobscurine B 4′,4′′-dimethyl ethers confirmed that the natural (–)-ipobscurine B has an erythro configuration (13). Another study reported the presence of α-bulnesene, α-humulene, seychellene, α-guaiene, β-caryophyllene, γ-terpinene, hexadecanoic acid and β-elemene from the aerial parts of the plant using gas chromatography (9). The active compounds in the ethanolic leaf extract of *I. obscura* (L.) were identified, including their retention time, molecular formula, molecular weight, and percentage composition. Using the library, several compounds were predicted: 2-cholestanone, 3-phenyl, lycopene, chlortetracycline, oleic acid, demeclocycline, tetracycline, heptadecane, 9-hexyl, cholestane-3,5-dichloro-6-nitro, urso-deoxycholic acid, octadecane, 3-ethyl-5-(2-ethylbutyl), and ethyl iso-allocholate (14). The mineral analysis of *I. obscura* leaves indicated a higher potassium concentration than other minerals, with significantly low levels of zinc and no detectable manganese. Additionally, the vitamin composition analysis revealed the presence of vitamins A, B_1, B_2, B_3, and C in the leaves (15). Leaves of *I. obscura* may serve as a valuable source of phytochemicals, including flavonoids such as kaempferol and quercetin and terpenoids like β-sitosterol and lupeol. These compounds were identified using

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 2800-2808 | ISSN:2251-6727

HPTLC fingerprinting, FTIR, NMR, and UV spectroscopy (16).

Pharmacological significance

Anti-inflammatory activity

A study Hamsa and Kuttan evaluates the anti-inflammatory effects using both *in-vitro* and *in-vivo* models. A methanolic extract of *I. obscura* (10 mg/kg b.w.) was administered intraperitoneally to mice before inducing inflammation (acute and chronic). The extract significantly reduced paw edema in animals for carrageenan, dextran, and formalin-induced inflammation. It also inhibited lipopolysaccharide (LPS)-induced production of nitric oxide (NO), C-reactive protein (CRP), and proinflammatory cytokines in peritoneal macrophages, notably reducing TNF-α production. The anti-inflammatory effects of *I. obscura* are likely due to the inhibition of critical enzymes and mediators such as inducible nitric oxide synthase (iNOS), Cyclooxygenase-2 (COX-2), and proinflammatory cytokines (17).

Another study by Rathod and Mathad evaluated the phytoconstituents, antioxidant, and anti-inflammatory activities of aqueous extracts from fresh and dry leaves of *I. obscura*. The results show fresh leaves contain flavonoids, phenols, tannins, alkaloids, and glycosides, while dry leaves contain higher levels of flavonoids, phenols, alkaloids, and glycosides but slightly lower tannins. Fresh leaves exhibited superior antioxidant activity compared to dry leaves, as estimated by the reducing power assay. However, dry leaves showed higher anti-inflammatory activity, particularly in human red blood cell membrane stabilization (HRBC) stabilization and albumin denaturation assays, outperforming fresh leaves and the standard drug, Diclofenac. The study concludes that the aqueous extracts of fresh and dry leaves of *I. obscura* are rich in antioxidants and exhibit significant anti-inflammatory properties due to various phytoconstituents, justifying their use in traditional medicine (18).

Anti-microbial activity

The antibacterial activity was carried out in various bacterial strains (pathogenic to humans) in different parts of the plant extract (leaves, stem, and seed). The results have demonstrated significant antibacterial activity, inhibiting the growth of various bacteria. Among these, the stem extract exhibited the highest antibacterial potential compared to the leaf and seed extracts. In particular, all three extracts showed considerable inhibition against *Salmonella* sp., with greater zones of inhibition diameter. Given that *Salmonella* is a known causative agent of liver disorders such as dysentery and diarrhea, these findings suggest that *I. obscura* may possess hepatoprotective properties. This investigation highlights that the plant extract is a rich source of chemical diversity, including steroids, alkaloids, phenolics, flavonoids, and other bioactive compounds, making it a promising candidate for medicinal screening (6). Another study by Srinivasan *et. al*. stated the antimicrobial activity of successive extracts of *I. obscura* by cup plate method.All three extracts of *I. obscura* showed moderate antibacterial and antifungal activity against six microbial strains. The likely antimicrobial mechanism is due to alkaloids binding to and inhibiting cell wall synthesis (19).

The antifungal activity of the silver nanoparticles was prepared using the leaf extract of *I. obscura* and checked against *Aspergillus flavus*, *Didymellabryoniae*, *Fusarium moniliforme*, and *Fusarium oxysporum*. It inhibited the growth of all the tested pathogens. Among them, *D. bryoniae* was found to be more prominent than the standard. Hence, the antifungal activity of biosynthesized nanoparticles indicates their potential application in managing plant diseases caused by agriculturally essential fungi. These nanoparticles could be effective in agricultural disease management, offering a promising alternative to conventional fungicides (20).

Angiotensin-converting enzyme 2 (ACE2) and main protease (MPro) are critical proteins in the attachment and replication of the SARS-CoV genome within host cells. This study used GC-MS analysis to identify eleven potent bioactive compounds from the ethanolic leaf extract of *I. obscura* (L.). These compounds were subjected to molecular docking studies against ACE2 and MPro to assess their antiviral effects against SARS-CoV. The results demonstrated that among the 11 compounds, Urso-deoxycholic acid, Demeclocycline, Tetracycline, Chlorotetracycline, and Ethyl iso-allocholate exhibited significant viral inhibitory activity. Therefore, the chemical constituents of *I. obscura* (L.) may effectively inhibit coronavirus replication in host cells (14).

Journal of Chemical Health Risks

www.jchr.org

JCHR (2025) 15(6), 2800-2808 | ISSN:2251-6727

Free radical scavenging activity

Srinivasan *et. al*. estimated the free radical scavenging activity of the whole plant extract of *I. obscura* (L.). *In-vitro* results of all three extracts (methanol, water, and petroleum ether) showed high, moderate and low free radical scavenging activity for all the anti-oxidant parameters. Moreover, total phenolics content expressed as gallic acid equivalent in mg/g of extracts was highest in the methanolic extract. Finally, they concluded that the observed activity might be due to the presence of the phytochemicals (21).

Cytotoxic and genotoxicproperty

Srinivasan *et. al*. explored the cytotoxic activity of successive extracts from *I. obscura* (L.). using 3-(4,5-dimethylthiazolyl-2)-2,5-diphenyltetrazolium bromide (MTT) and Sulforhodamine B (SRB) assay on both cancerous and normal cell lines. The methanolic extract demonstrated superior cytotoxicity, with a 50% cell death concentration (CTC_{50}) being more effective against cancerous cells than other extracts. The observed cytotoxicity is likely due to indole alkaloids inducing apoptosis pathways. These findings suggest that phytochemicals in *I. obscura* have promising potential for use in chemoprevention and chemotherapy strategies (19). Another study explored the antioxidant, genotoxic, and cytotoxic properties of zinc oxide nanoparticles (ZnO-NPs) synthesized using aqueous leaf extract of *I. obscura* (L.) Ker Gawl. UV-visible spectral analysis confirmed the formation of ZnO-NPs, with characteristics typical of zinc nanoparticles. Scanning electron microscopy (SEM) revealed that these nanoparticles were nanosized and showed notable agglomeration. The ZnO-NPs demonstrated significant radical scavenging activity (RSA), indicating their antioxidant potential. Genotoxicity assays on onion root tips showed that the ZnO-NPs significantly inhibited cell division at the mitotic stage. Additionally, cytotoxicity studies on HT-29 cells revealed that the ZnO-NPs effectively arrested cell division in the early G_0/G_1 phase and induced apoptosis. These findings suggest that ZnO-NPs synthesized from *I. obscura* leaf extract have promising potential for cytotoxic applications (22).

Hepatoprotective activity

A study by Meena and Santhi aimed to evaluate the hepatoprotective and antioxidant activity of *I. obscura* leaf extract against CCl_4-induced hepatotoxicity. Liver damage caused by CCl_4 is well-documented, primarily due to its metabolic activation and the formation of trichloromethyl free radicals, leading to lipid peroxidation, membrane damage, and, ultimately, cell death. The extract of *I. obscura* demonstrated significant antioxidant properties by enhancing the levels of malondialdehyde (MDA), superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), with the effect being dose-dependent. Additionally, the extract showed protective effects by stabilizing liver enzyme activities [aspartate aminotransferase (AST) and alanine aminotransferase (ALT)] and preserving the integrity of the cell membrane. These findings support the traditional use of *I. obscura* in treating liver ailments, highlighting its potential as a complementary therapy in liver disease management(23).It has been reported that the antimicrobial activity of *I. obscura* extracts against *Salmonella sp*., a known causative agent of liver diseases such as diarrhea and dysentery, suggests that this plant may possess hepatoprotective properties (6).

Immunomodulatory activity

A studyinvestigated the immunomodulatory effects of *I. obscura* and its indole alkaloid fraction, Ipobscurine, on cell-mediated immune responses. The research demonstrates that both *I. obscura* and Ipobscurine enhance cytotoxic T lymphocyte (CTL) activity, natural killer (NK) cell activity, antibody-dependent cell-mediated cytotoxicity (ADCC), and antibody-dependent complement-mediated cytotoxicity (ACC) in normal and tumor-bearing mice. Furthermore, the treatment significantly boosts the production of interleukin-2 (IL-2) and interferon-gamma (IFN-γ), key cytokines in immune response regulation. These findings suggest that I. obscura and Ipobscurine have the potential to enhance immune function, inhibit tumor growth, and serve as alternative cancer therapies (24). Synthetic chemotherapeutic agents often have immunosuppressive and cytotoxic side effects, leading to undesirable consequences. Botanical-based immunomodulators are frequently used as supportive or adjuvant therapies to mitigate these effects. The methanolic extract of the medicinal plant *I. obscura* has demonstrated significant immunomodulatory activity in BALB/c mice. After five intraperitoneal doses (10 mg/kg body weight), the extract notably increased total white blood cell count, bone marrow cellularity, and α-esterase positive cells.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(6), 2800-2808 | ISSN:2251-6727

Additionally, when administered with sheep red blood cells (SRBC) as an antigen, the extract enhanced the spleen's circulating antibody titers and plaque-forming cells (PFC). The treatment also significantly reduced levels of proinflammatory cytokines and nitric oxide production in lipopolysaccharide-stimulated macrophages. These findings highlight the potential of *I. obscura* as an effective immunomodulatory agent (25).

Anti-arthritic activity

The bioactive components of *I. obscura* leaves have been analysed, revealing a variety of chemical compounds responsible for their therapeutic applications. Phytochemical screening of both ethanolic and aqueous extracts of the leaves identified the presence of tannins, saponins, flavonoids, terpenoids, polyphenols, glycosides, and coumarins. However, steroids, triterpenoids, and anthraquinones were absent in the aqueous extract. Notably, a significant amount of flavonoids and total phenols were observed in the leaves. The extracts exhibited potential *in-vitro* anti-arthritic activity, confirmed by protein denaturation assay. The alcoholic extract of *I. obscura* leaves has demonstrated significant anti-arthritic activity, as confirmed through protein denaturation methods using egg albumin and bovine serum albumin. This suggests that the extract has the potential to inhibit protein denaturation, a critical factor in the development of arthritic conditions (26).

Nephroprotective activity

A study evaluated the nephroprotective effects of *I. obscura* leaf powder on gentamicin-induced nephrotoxicity in rats. Gentamicin, known for causing nephrotoxicity by inhibiting protein synthesis in renal cells, leads to acute tubular necrosis and potential renal failure. The administration of *I. obscura* leaf powder demonstrated protective effects against this damage, improving renal function and reducing the indicators of nephrotoxicity. Histopathological analysis further supported these findings, showing reduced renal lesions in treated animals. The nephroprotective activity is likely due to the bioactive phytoconstituents in *I. obscura*, warranting further studies to isolate and identify these compounds (27). Cyclophosphamide (CP) is commonly used in cancer treatment but can cause urotoxicity and nephrotoxicity, manifesting as haemorrhagic cystitis and renal damage. Another study investigated the protective effects of *I. obscura* against CP-induced uro-and nephrotoxicity in animal models. Swiss albino mice were administered an acute dose of CP (1.5 mmol/kg body weight, intraperitoneally) with and without concurrent treatment with an alcoholic extract of *I. obscura* (10 mg/kg body weight, intraperitoneally) for 5 days. The extract mitigated CP-induced toxicity, as evidenced by reduced blood urea nitrogen (BUN), serum creatinine levels, and increased body weight. The extract also enhanced kidney antioxidant defences, including glutathione (GSH), superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx). Histopathological examinations revealed a significant reduction in CP-induced tissue damage in the bladder and kidneys of treated animals. Additionally, the extract countered the effects of CP on cytokine levels, increasing interferon-gamma (IFN-γ) and interleukin-2 (IL-2), while reducing elevated tumor necrosis factor-alpha (TNF-α). These findings suggest that *I. obscura* effectively ameliorates CP-induced bladder and renal toxicities by modulating oxidative stress and inflammatory responses (28).

Anti-angiogenic activity

A study investigated the anti-angiogenic effects of *I. obscura* (L.) Ker-Gawl extract and its primary compound, Ipobscurine-A (IPO-A). Utilizing both *in-vivo* and *in-vitro* models, the research demonstrated that *I. obscura* extracts and IPO-A significantly inhibited endothelial cell proliferation, migration, invasion, tube formation, andVascular endothelial growth factor (VEGF)-induced sprouting from rat aorta. *In-vivo*, *I. obscura* extract effectively reduced neo-vessel formation induced by B16F10 melanoma cells in C57BL/6 mice. The treatment also decreased serum levels of pro-inflammatory cytokines and VEGF while increasing anti-angiogenic factors like metallopeptidase inhibitor 1 (TIMP-1) and Interleukin-2 (IL-2). These findings suggest that *I. obscura* extract and IPO-A suppress tumor-specific angiogenesis by downregulating pro-angiogenic and upregulating anti-angiogenic factors (8).

Novel formulation of *Ipomoea obscura*

Nanotechnology is a diverse and transformative discipline with the potential to revolutionize various scientific fields. The growing importance of nanoparticles stems from their exceptional surface area-to-volume ratio, which gives rise to unique properties and behaviors (29)(30). Considering the environmental

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and biological hazards posed by the toxic chemicals involved in the production of synthetic metal-oxide nanoparticles, the focus has increasingly shifted toward biologically synthesized nanoparticles. These nanoparticles are recognized for their stability, environmentally friendly nature, and additional biological properties, making them a preferable and safer alternative in various applications (31)(32).Zinc oxide nanoparticles (ZnO-NPs) have attracted more attention than other metal-oxide nanoparticles due to their wide range of applications across various scientific fields, particularly in biological contexts (33)(34)(35). The biosynthesis of nanoparticles using plant extracts has garnered significant interest due to the wide availability of natural sources in the environment. Plants are rich in secondary metabolites, which serve as effective reducing and capping agents during the nanoparticle synthesis process (36)(37)(38). Murali et al., developed Zinc Oxide Nanoparticles through green synthesis using the Obscure Morning Glory Plant *Ipomoea obscura* (L.) Ker Gawl aqueous leaf extract. The Phyto-fabricatd Zinc Oxide Nanoparticles were of size ~ 24.26 nm with 88.11% purity. The phyto-fabricated ZnO-NPs demonstrated dose-dependent radical scavenging activity (RSA), achieving an IC50 of 0.45 mg/mL. Genotoxicity studies on onion root tips revealed that these nanoparticles significantly inhibited cell division at the mitotic stage, resulting in a mitotic index of 39.49%. Additionally, cytotoxicity studies on HT-29 cells showed that the phyto-fabricated ZnO-NPs effectively arrested cell division as early as the G0/G1 phase, with 92.14% of cells affected. After 24 hours of incubation, 73.14% of the cells exhibited early apoptotic symptoms. The results confirm that the phyto-fabricated ZnO-NPs could serve as a powerful alternative to the synthetic drugs currently used for cytotoxicity (22). Similarly, Silver and its salts have been recognized for their antimicrobial properties since ancient times, traditionally used to treat skin ulcers, bone fractures, support wound healing, and purify water and air. When ionic silver is converted into nanoparticles, it may offer enhanced antimicrobial properties due to its small size and high surface-to-volume ratio, resulting in distinct chemical and physical characteristics compared to its bulk form (39)(40).Thejesh Kumar et al., prepared the silver nanoparticles by green chemistry approach using leaf extract of *I. obscura*. Synthesized silver nanoparticle were of size 46 nm and cubic shape. The preparation showed good fungicidal activity against *Didymellabryoniae*, *Fusarium oxysporum*, *Fusarium moniliforme* and *Aspergillus flavus*(20).

Conclusion

Plants of the genus *Ipomoea* have been used in folk medicine for centuries to treat a wide range of conditions, including inflammation, pain, colic, constipation, and digestive disorders. Among these, *Ipomoea obscura* has recently attracted scientific interest due to its traditional use in treating dysentery, ulcers, hemorrhoids, swelling, cough, asthma, rheumatoid arthritis, wounds, and stomachaches. This species is known for its diverse pharmacological properties, including antimicrobial, antibacterial, antifungal, antioxidant, hepatoprotective, anti-inflammatory, antidiarrheal, nephroprotective, cytotoxic/anticancer, and antitumor activities. Researchers are now focusing on extracting various phytochemicals such as alkaloids, flavonoids, glycosides, phenols, saponins, polyphenols, steroids, terpenoids, coumarins, and cardioglycosidesfrom different solvents like petroleum ether, methanol, ethanol, and ethyl acetate. These compounds, with their antioxidant properties, may help prevent or slow the progression of diseases caused by free radicals. The development of phytomedicines from *I. obscura* is promising, particularly as synthetic drugs often carry risks of adverse or toxic reactions.Additionally,green synthesis of silver and zinc oxide nanoparticle using aquous leaf extract of the plant exhibited good antifungal and anticancer activity. Further studies on the structure-activity relationships of these phytoconstituents and the isolation of active compounds could lead to novel botanical drugs, making *Ipomoea obscura* a compelling subject for future research.

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Declarations of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Journal of Chemical Health Risks

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