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Buddleja asiatica Lour.: A valuable insight into its ethnomedicinal utilities, phytochemistry, and pharmacological activities

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ABSTRACT

The primary objective of this review involved the comprehensive collection of available information on *Buddleja asiatica* Lour. and critically analyzes collected review reports to provide the perspectives and directions for future research for the plants as a potential source of drug leads and pharmaceutical agents. Major scientific databases such as PubMed, Springerlink, SciFinder, Science Direct, Google Scholar, Research Gate, and ethnobotanical databases were searched for relevant literature. *Buddleja asiatica* Lour. comprising varieties of secondary metabolites, including flavonoids, terpenoids, phenylethanoids, carbohydrates, saponins, and steroids. Reviews of the literature on *in-vitro* and *in-vivo* investigations demonstrated the plant's isolated components' biological and pharmacological characteristics. Since the majority of the documented *in-vivo* pharmacological research was conducted on crude extracts, the bio-active constituents that give most plants their bioactivities have not been thoroughly studied.

1. INTRODUCTION

Plants are used by humans for a variety of domestic reasons, including food, medicine, and culture. Furthermore, plants have been used as medicines for many years to treat a number of illnesses in traditional medicinal systems, including Ayurveda, Siddha, Unani, and others [1]. Both conventional medicine and the contemporary healthcare system heavily rely on plants. The biological functions and medicinal advantages of plants are attributed to their secondary metabolites. A specific secondary metabolite may be unique to a species or group of species [2,3].

The genus *Buddleja*, sometimes referred to as butterfly bush, contains a number of species with diverse ecological demands. More than 100 species of *Buddleja* are found in warmer regions of the world, including Southern Asia, Africa, and America. The genus offers numerous medicinal benefits, and many of its species have been used to cure a numerous ailments all over the world [4–6]. *Buddleja* plant have long been used in phytotherapy and traditional medicine to treat bronchitis, coughing, asthma, wounds, colds, ulcers, and antispasmodics. Additionally, they are utilized as a soap substitute, to treat cholagogue, liver dysfunction, bronchial complaints, sedatives, diuretic effects, and different ophthalmic disorders. Traditional medicine has utilized *Buddleja* as a topical antiseptic and diuretic, but little research has been done on its phytochemical makeup [7]. In Chinese traditional medicine, several species have been used for the treatment of different diseases [8–13]. This plant has cultural value in addition to its medicinal applications, and it can play a significant role in ecological restoration projects [14]. Alkaloids, phenylpropanoids, sterols, iridoid glucosides, diterpenes, aryl esters, phenolic fatty acid esters, and terpenoids are among the many secondary metabolites found in plants in this family. The biological and therapeutic properties of medicinal plants are the result of special or cooperative interactions between their

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secondary metabolites. The primary functions of plant growth and development do not require these chemicals, but they are essential for defense, signaling, symbiosis, metal transport, and competitiveness [15]. The current review is carried out due to the genus *Buddleja's* numerous medicinal uses and phytochemical diversity. The primary goal of this review is to demonstrate the pharmacological and phytochemical activities of *Buddleja asiatica* Lour., and the ethnomedical utilities of the plant in various parts of the world.

1.1. Plant description

1.1.1. Leaves

Shape: Lanceolate to ovate, with a pointed tip, 5–9 × 1–2.5 cm, serrulate, tawny or whitish pubescent below, oblanceolate, acuminate-caudate, and attenuate at the base; petiole 3–9 mm long. Arrangement: Opposite or sub-opposite along the stem. Texture: Smooth or slightly hairy, with serrated margins. Colour: Dark green above, paler beneath.

1.1.2. Stem

Young stems are often quadrangular (four-angled) and may be covered with fine hairs. Older stems become woody and brown-grey.

1.1.3. Flower

Inflorescence: Dense, terminal or axillary panicles or spikes. Colour: Typically, white or pale lilac, sometimes with a yellow throat. Fragrance: Sweet-smelling, attracting butterflies and other pollinators. Blooming Season: Winter to early spring (varies by region).

1.1.4. Fruits

Fruit is a tiny, ellipsoid capsule found nearly anywhere in the state, small, dry, two-valved capsules. It contain numerous tiny seeds.

1.1.5. Seeds

Very small, winged, aiding in wind dispersal. Around 0.3 mm long seeds; subglobose, 3–4 mm long.

1.1.6. Roots

Fibrous root system, sometimes forming suckers for vegetative spread.

2. METHODOLOGY

We conducted a thorough literature search using online scientific databases such as PubMed, Scifinder, Science Direct, Google Scholar, and Research Gate; no systematic review software was used in this review. In the first stage, general search phrases such as *B. asiatica* Lour. (Fig. 1) were used to gather overall information on the review topic. After this, our search was reduced from the broad term to a concise once, like searching only for plants bio-active constituents, plant ethno-medicinal utilities, and their pharmacological activities; these were the major data inclusion criteria. To guarantee the data's applicability, the search was limited to publications released from 1970 to 2024. To further refine the search and optimize findings, Boolean Operators such as "AND," "OR," and "NOT" were employed. For instance, "AND" was used to combine key terms of inclusion, such as "PHYTOCHEMISTRY", "ETHNO-MEDICINAL UTILITY", "PHARMACOLOGICAL ACTIVITY", while "OR" helped gather articles containing any one of several specified terms, like "*B. asiatica* Lour." Or "BUTTERFLY BUSH". This helped us to gather the articles that were only necessary and can support to exclude unnecessary topics for our review work.

3. ETHNOMEDICINAL UTILITY

In traditional medicine systems, *B. asiatica* Lour. is used to induce abortions and cure a number of ailments, such as skin itching, headaches, pain, diarrhea, fever, hypotension, and respiratory disorders. In traditional Chinese medicine, *B. asiatica* has been medicinally used to cure fever, pains, diarrhea, respiratory illnesses like bronchitis and asthma, and skin itch [16], also cancer [17] and articular rheumatism [18]. In India, the plant was being used as an abortifacient [19]. In Arunachal Pradesh plant's juice and paste are used for Diarrhea, Beverage's fermentation, and also is other parts of India, it is being used for a similar purpose [20]. In other parts of India, it was recorded that this plant was used to treat skin complaints [21]. In some parts of the Nepal the decoction of the plant's leaves was done to treat abortifacient [22]. In other part of the world, like Myanmar, when combined with rice water, a paste made from roots is used as a tonic [23]. In Vietnam, the plant was being used as a fish poison and in the treatment of the headache [24]. Plant's root and leaves was being used to treat head tumors [25], and the infusion formed from the plant's roots was used for malaria [26]. The hypotensive effect of leaves on dogs and cats was discovered, most likely due to alpha-adrenoceptor blocking action [27]. An essential oil that was taken from the leaves showed antibacterial and antifungal properties [28], and it has been discovered that the flowers can cure edema and cystitis [29]. It was recently discovered that Tibeto-Burman women in Thailand use it as a traditional medicinal plant [30] and also used in the treatment of TB and fever [31,32].

4. MAJOR BIO-ACTIVE CONSTITUENTS OF *B. ASIATICA* LOUR WITH THEIR STRUCTURES

A total of 105 bio-active constituents are reported from *B. asiatica* Lour. as of now. These are some of the bio-active constituents found in *B. asiatica* Lour., there are many more constituents present in this plant, but in this paper, we have highlighted only some active constituents because these constituents are responsible for showing the pharmacological action on the human body [33,34]. The bio-active constituents study identified a wide range of chemical classes, such as fatty acids, glycosides, esters, steroids, terpenoids, flavonoids, carbohydrates, and saponins.

5. PHARMACOLOGICAL ACTIVITY

5.1. Antioxidant activity

Bio-active constituents with antioxidant qualities, such as flavonoids and phenolic compounds, are found in *B. asiatica*. These secondary metabolites are essential for

preventing oxidative damage and avoiding the harm that free radicals due to cells [35,36]. Based on [37] conducted 10 distinct *in-vitro* free radical scavenging tests, such as nitric oxide free radical scavenging (96.2 µg/ml), DPPH (IC50 = 15 µg/ml), H_2O_2 scavenging activity (35.2 µg/ml), hydroxyl radical scavenging activity (52.2 µg/ml), superoxide anion radical scavenging activity (40.98 µg/ml), metal ion chelation assay (43.6 µg/ml), xanthine oxidase inhibitory activity (55.6 µg/ml), lipid peroxidation assay (136.2 µg/ml), and CUPRAC (cupric ions reducing) assay (18.02 µg/ml). Based on this documented *in-vitro* antioxidant activity, *B. asiatica's* in [38] *In-vivo* antioxidant qualities were assessed by giving it orally to healthy rats for 21 days. The findings showed that the tested increased ferric reducing ability of plasma, decreased lipid peroxidation, and superior antioxidant effects were demonstrated by dosages of the methanol extract of the whole plant (250 and 500 mg/kg) ($p < 0.05$), increased antioxidant enzyme activity, suggesting that it has the capacity to be a powerful free radical scavenger.

5.2. Antihepatotoxic activity

6-O-(3″,4″-dimethoxycinnamoyl) catalpol is a newly isolated chemical that was obtained from the defatted alcoholic extract of *B. asiatica* Lour. aerial parts. After an intraperitoneal injection of CCl4 at a dose of 25 µl/100 g, there was a considerable increase in the levels of aspartate aminotransferase (AST) and alanine aminotransferase (ALT). On the other hand, silymarin at a dose of 100 mg/kg significantly decreased the ALT level, which was comparable to the impact of the polar fractions of *B. asiatica's* roots and aerial parts. Furthermore, administering polar fractions of the roots and aerial parts resulted in a significant decrease in the AST level that was comparable to silymarin [39,40].

5.3. Anti-microbial activity

The agar diffusion method using filter paper disc demonstrated the *in-vitro* inhibitory ability of these essential oils, specifically β-caryophyllene oxide, citronellol, and β-caryophyllene, against specific harmful fungi such as *Aspergillus flavus, Aspergillus fumigatus*, *Curvularia parasadii*, *Trichoderma viride*, and *Trichophyton rubrum*, as well as bacteria such as *Salmonella sp*., *Salmonella paratyphi strains*, *Salmonella typhi H*, *Shigella flexneri*, *Shigella shiga*, and *Vibrio cholerae*. Significant antibacterial and antifungal activity was demonstrated by *B. asiatica* crude extracts and their chloroform, ethyl acetate, and n-butanol fractions against bacteria, with a zone of inhibition against several fungi with a linear growth range of 25 to 80 mm, such as *A. flavus, Fusarium solani,* and *T. longifus,* and against fungi with a range of 3 to 29 mm, such as *Escherichia coli, S. flexneri,* and *Sternostoma boydi* [41].

5.4. Anti-fungal activity

The agar well diffusion method was used to measure the antifungal activity. Amphotericin and miconazole were the standard medications utilized in this procedure. The raw extract and DMSO (50 mg/5 ml) were used to dissolve fractions F1 through F3. A test tube containing 5 ml of sterile Sabouraud's dextrose agar medium was allowed slanting at room temperature overnight after the sample solutions (400 µg/ml) were added. After that, the slant was infected with the fungal culture. After 7 days of incubation at 29°C, growth inhibition was noted in the samples [42].

5.5. Cytoprotective activity

Buddleja asiatica's aerial portions were extracted in methanol, yielding 11 recognised chemicals and a novel iridoid glycoside called *Buddlejasiaside A*. It showed strong cytoprotective activity against glutamate-induced cell death in mouse hippocampus neuronal cells (HT22) at a dosage that is half as effective as possible (EC50) of 14.8 µM, indicating its potential as a neuroprotective agent. In contrast, 6-O-(p-hydroxybenzoyl)-ajugol demonstrated significant cytoprotection with an EC50 of 38.9 µM, suggesting its potential therapeutic utility. Methoxydalbergione (EC50 of 4.8 µM) was used as a positive control to confirm the results and guarantee accuracy when evaluating cytoprotective effects. These results imply that additional study is required to completely comprehend the mechanisms of action and potential applications of 6-O-(p-hydroxybenzoyl)-ajugol in the treatment of neurodegenerative diseases [43,44].

5.6. Ca++ antagonist action

Using high K+ (80 mM), which is known to cause smooth muscle contraction by opening voltage-dependent calcium channels, the preparations were depolarized to ascertain if calcium channel blockage causes the antispasmodic action of the plant components. When high K+ was introduced to the tissue bath, a protracted contraction was induced, demonstrating calcium influx and persistent depolarization. The entire *B. asiatica* plant was extracted over 7 days at room temperature using 65 l of methanol. *Buddleja asiatica* was evaluated on high K+ (80 mM) caused contraction, which was relaxed by the plant extract at 0.1, 0.3, and 1.0 mg/ml by 6.7% ± 4.4%, 32.7% ± 9.8%, and 100% (mean ± SEM, $n = 3$), respectively. This



Figure 1. Fully grown *B. asiatica* Lour.

plant's spasmolytic effect is similarly mediated by the same mechanism [45].

Table 1. Vernacular name of *B. asiatica* Lour.

Sl. No.	language/system of medicine	Local name
1.	English	Asian butterfly bush or white butterfly bush/Dogtail
2.	Hindi	Ninda
3.	Tamil	Karkkattan
4.	Oriya	Ninda
5.	Assamese	Bonsini
		Agiachita
		Posutia
		Bonchini
6.	Bodo	Kundamora
7.	Mishing	Markong-abang
8.	Bengali	Budbhota, Neemda, Bhimsenpati
9.	Nepali	Bhimsenpati/Newarpati

5.7. Antinociceptive activity

The ethanolic extracts of *B. asiatica* bark and leaves showed *in-vivo* antinociceptive and muscle relaxant characteristics, suggesting their potential therapeutic advantages. Significant dose-dependent antinociceptive effect, with a maximal pain reduction of 70% and 67% at 300 mg/kg intraperitoneally. After 90 minutes of treatment at 300 mg/kg i.p., the ethanolic extract of leaves and barks had the highest muscular relaxant effects in the chimney test, at 66.66% and 53.33%, respectively. After 90 minutes of administration at 300 mg/kg intraperitoneally, the ethanolic extract of leaves and barks produced a maximal muscular relaxant effect of 60% and 73.33%, respectively, in the traction test. The extracts dramatically decreased muscular contractions and pain perception, pointing to potential processes involving opioid receptor activation, calcium channel blockage, or neurotransmitter modulation. To investigate their pharmacological uses, more research is required [46].

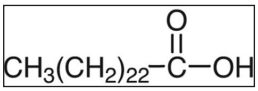
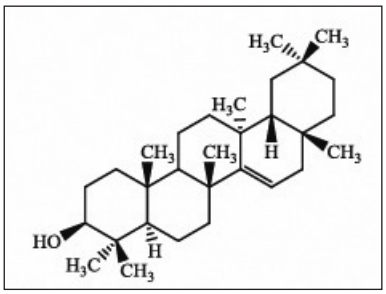
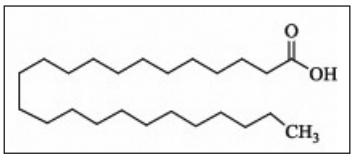
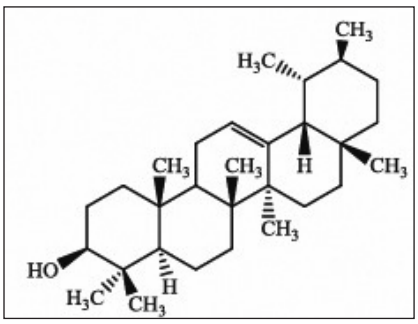
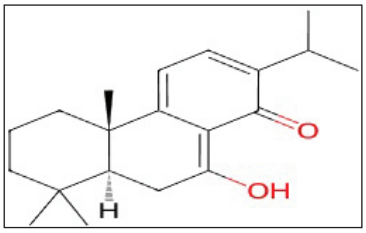
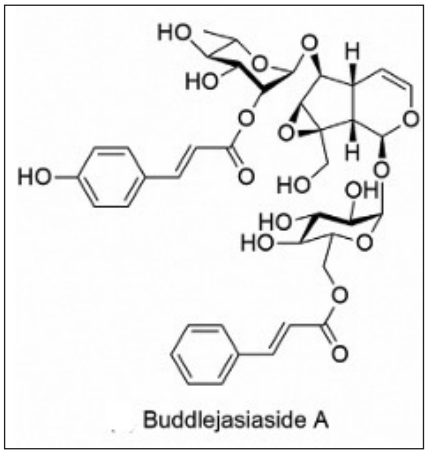
5.8. Anti-acetylcholinesterase and anti-butylcholinesterase (BChE) activity

When compared to common medications (miconazole and amphotericin-B, respectively), the essential oil from

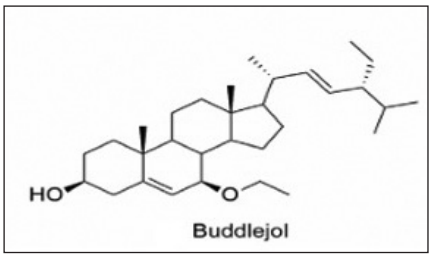
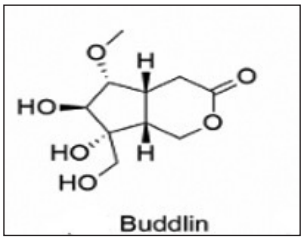
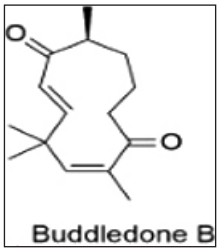
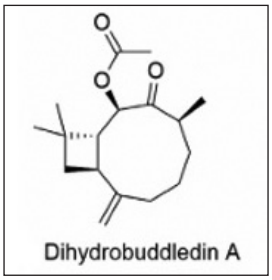
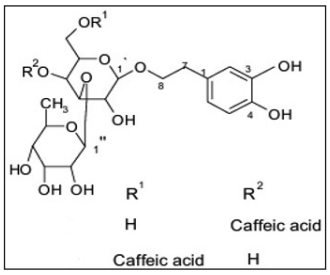
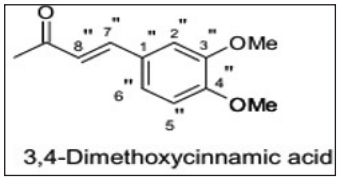
Table 2. Ethnopharmacological uses of *B. asiatica* Lour.

Sl. No.	Disease condition	Country/Region used as folk medicine	Part(s) used	Traditional preparation and dose	Route of administration (ROA)	Ref.
1.	Fever, malaria (antipyretic), Abortifacient, Skin diseases (wounds, boils, eczema), Digestive disorders (diarrhoea, dysentery), Respiratory ailments (cough, asthma).	India (Himalayan Region & Northeast India)	Leaves	Leaves crushed and applied topically or consumed as a decoction.	Topical and oral	[9,21]
2.	Rheumatism and joint pain (anti-inflammatory), Headache (leaf juice applied on forehead), Stomachache (decoction of roots or leaves).	Nepal	Leaves	Leaves and roots boiled for oral consumption or poultice.	Topical and oral.	[22,59]
3.	Liver disorders (jaundice, hepatitis), Infections (antimicrobial properties)	China	Leaves	Decoction of leaves or roots taken orally.	Oral.	[6]
4.	Wound healing, Anti-parasitic, Postpartum recovery	Philippines	Leaves	Fresh leaves crushed and applied or consumed as tea.	Topical and oral.	[59]
5.	Anti-inflammatory (arthritis, muscle pain), Antipyretic (fever reduction), Insect repellent (burning leaves to repel mosquitoes).	Thailand	Leaves	Leaves boiled for drinking or used in steam therapy.	Topical and oral both.	[6]
6.	Cold and flu (leaf decoction), Toothache (chewing leaves for relief), Antiseptic (leaf paste for cuts)	Pakistan	Leaves	Fresh leaves chewed or made into a paste	Topical and oral	[9]
7.	Snakebite antidote (root extract used), Anti-diarrheal, Mental health (sedative properties for anxiety)	Myanmar	Root	Root extract consumed or applied on bites.	Oral or topical	[52]
8.	Hypertension (leaf decoction as antihypertensive), Diuretic (promotes urination), Anti-diabetic (traditional use for blood sugar control).	Indonesia	Leaves	Leaves brewed into tea.	Topical or oral.	[60]
9.	Skin infections (fungal, bacterial), head tumour, Digestive issues (indigestion, bloating), Detoxification (liver cleanser).	Vietnam	Leaves	Leaf extract consumed or used in baths	Topical or oral.	[9]
10.	Rheumatism (leaf poultice), Anti-malarial, Aphrodisiac (root decoction).	Malaysia	Leaves & root	Leaves heated and applied to joints. Root decoction consumed.	Oral or topical.	[9]

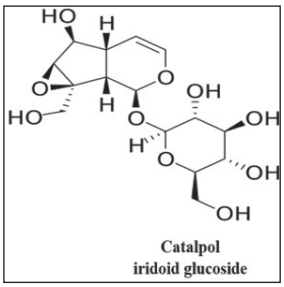
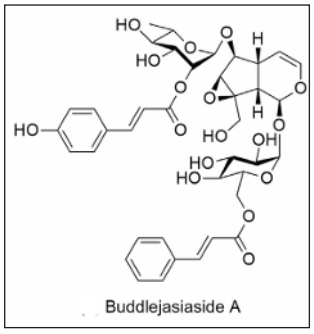
Table 3. Major bioactive constituents of *B. asiatica* Laur.

Sl.No.	Nature of bioactive constituents	Part obtained from	Bioactive constituents	Structure	Biological activities	References
1.	Fatty acid	Leaves, flowers, aerial parts	lignoceric acid		Brain development	[61]
2.	Triterpenoid	Roots, flowering parts	Taraxerol		Anti-inflammatory, antioxidant, anticancer antimicrobial	[62,63]
3.	Steroid	Flowering parts, roots	Stigmasterol		Anti-inflammatory, anticancer, antioxidant, Anti-diabetic and cholesterol-lowering	[64,65]
4.	Triterpenoid	Leaves, flowers, aerial parts	Alpha amyrin		Anti-inflammatory, antioxidant, and anticancer, anti-diabetic and hypolipidemic, gastroprotective, hepatoprotective	[66]
5.	Diterpene/ Terpenoids	Roots	Buddlejone		Antioxidant, anti-inflammatory, antimicrobial, antiviral, and ant-inflammatory, anti-proliferative	[67,68]
6.	Iridoid glycoside	Flowers	*Buddlejasiaside A*		Antioxidant, anti-inflammatory, antimicrobial	[69]

Continued

Sl.No.	Nature of bioactive constituents	Part obtained from	Bioactive constituents	Structure	Biological activities	References
7.	*Sterol*	Whole plant	Buddlejol	 Buddlejol	Alpha-chymotrypsin inhibitor, antioxidant, cytotoxic, antihepatotoxic, antimicrobial, anti-inflammatory, cholinesterase	[70]
8.	Cyclopentanoid lactone	Roots, stems, leaves	Buddlin	 Buddlin	Antioxidant, anti-inflammatory, antibacterial, antimutagenic	[71]
9.	Terpenoid	Flower	Buddledone-B	 Buddledone B	Antimicrobial	[72]
10.	Sesquiterpenoids	Whole plant	Dihydrobuddledin	 Dihydrobuddledin A	Anti-inflammatory, antioxidant, cholinesterase inhibitor, antibacterial	[73]
11.	Polyphenol	Leaves, flowers, aerial parts	Caffeic acid	 Caffeic acid Caffeic acid H	Anticancer, antioxidant, anti-inflammatory	[74,75]
12.	Phenolic acid	Flowering parts, roots	3,4 Dimethoxycinnamic	 3,4-Dimethoxycinnamic acid	Anti-inflammatory, antioxidant and antimicrobial	

Continued

Sl.No.	Nature of bioactive constituents	Part obtained from	Bioactive constituents	Structure	Biological activities	References
13.	Iridoid glucoside	Aerial flowering parts	Catalpol	 Catalpol iridoid glucoside	Anti-diabetic, anti-inflammatory, anti-oxidant, cardiovascular protective, neuroprotective, anticancer	[76,77]
14.	Iridoid glycoside	Leaves, flowers	Buddlejasiaside A	 Buddlejasiaside A	Anti-inflammatory, Cytoprotective antimicrobial	[78]

leaves of *B. asiatica* shown exceptional inhibitory effects against acetylcholinesterase (AChE) (IC50 5.2 µM) and butyrylcholinesterase (IC50 27.9 µM). Additionally, another investigation demonstrated a minor inhibitory effect of butylcholinesterase and AChE, with IC50 values of 30.94 and 35.94 [47].

5.9. Hypotensive activity

Intravenous administration of an aqueous solution of chloralose to cats under anesthesia, *B. asiatica* alcoholic extract (20–40 mg/kg) caused a dose-dependent drop in blood pressure. Within a minute of the extract's ingestion, its hypotensive action became apparent. The extract exhibited its peak activity at 2 minutes. The symptoms of hypotension lasted for forty minutes. It was intriguing that these dosages, which caused a noticeable drop in blood pressure, had no discernible effect on breathing. Prior administration of atropine (1.0 mg/kg intravenously), mepyramine (5.0 mg/kg intravenously), or cyproheptadine (1.0 mg/kg intravenously) to the cats did not alter the hypotensive effects of the *B. asiatica* alcoholic extract [48].

5.10. Anti-diabetic activity

The DNS and starch-iodine assay methods were also used to perform the α-amylase inhibition assay. *Buddleja asiatica* methanolic extract showed a little α-amylase inhibitory effect [49]. In another study with other species, the hexane fraction of *B. saligna* demonstrated modest α-amylase inhibitory activity alpha-glucosidase inhibitory (IC_{50} = 260 µg/ml). The hexane fraction's alpha-glucosidase inhibition safety index values were 0.007 [50]. Among the plant samples studied, *C. papaya* fruits had the highest α-Amylase inhibitory activity, while *B. asiatica* and *S. pinnata* leaves showed a moderate level of activity [51].

5.11. Other pharmacological uses

Its application as an abortifacient; leaves decoction or extracts from it have been shown to cause uterine contractions, which may result in the termination of a pregnancy [52]. Because of its potential to increase metabolism or reduce hunger, it has also been investigated as a natural weight loss aid [53]. It has long been used to reduce labor pains and promote postpartum recuperation during childbirth. It is also used to treat headaches because of its analgesic and anti-inflammatory properties, which provide a natural pain treatment option [54].

6. DISCUSSION

After taking evidence from various literature, we found that *B. asiatica* (Fig. 1) is a plant belonging to family Scrophulariaceae and known by different vernacular names (Table 1), which is used ethno-medically in various parts of the world and have numerous pharmacological properties [55]. Earlier studies on the plant revealed that its leaves contained phenols, flavonoids, glycosides, and terpenoids [56,57]. Among the several secondary metabolites (Table 3) of plants, phenolics are a broad class of bio-active constituents that include families of substances, including phenolic acids, flavonoids, phenylpropanoids, lignins, tannins, and quinones [58]. We have explored the ethnomedicinal utilities of *B. asiatica* (Table 2) as compared to different country traditional uses. As discussed above, in pharmacological activity qualities like Antioxidant, antibacterial, cytoprotective, antinociceptive, hypotensive, anti-cholinesterase, Ca++ antagonist, and antihepatotoxic are all displayed by *B. asiatica*. Researchers will be able to identify key locations for using *B. asiatica* components with the aid of this study. Reviews of the literature on *in-vitro* and *in-vivo* investigations demonstrated the plant's isolated components'

biological and pharmacological characteristics. Since the majority of the documented *in-vivo* pharmacological research were conducted on crude extracts, the bio-active constituents that give most plants their bioactivities have not been thoroughly studied. Few researchers have looked at this field. Consequently, a novel hypothesis on the application of these substances for all species and the identification of more bio-active constituents could be developed to increase the advantages of *B. asiatica* as fresh sources for complementary and alternative medicine and other pharmacological *in-vitro* and *in-vivo* applications [59,79].

7. CONCLUSION

This study highlights the urgent need for more research to confirm the precise positive effects of *Buddleja asiatica* Lour by providing a thorough overview of the pharmacological and ethno-medicinal applications as well as the bioactive constituents of the plant. The valuable plant *Buddleja asiatica* Lour. offers a wide range of nutritional and therapeutic uses. This versatile plant has several uses and contains a wide range of phytochemicals as well as substantial amounts of minerals and vitamins, all of which are essential for fostering wellbeing. It has garnered a lot of attention because of its many therapeutic qualities, including its anti-inflammatory, antioxidant, antitumor, antibacterial, diarrhoeal, hepatoprotective, antidiabetic, and anticancer activities. Nevertheless, it has the potential to produce important insights and additional developments. Additionally, it's critical to resolve the remaining obstacles to the scientific analysis of its therapeutic uses. For example,

1. Pharmacokinetic and pharmacodynamic studies as well as an analysis of the toxicity of isolated compounds are required in order to evaluate and compare the therapeutic benefits of plant phytochemicals. model *in viv*o with sufficient control groups. Identification and isolation of powerful compounds can be facilitated by analysing the doses and comparing them to recognised benchmarks.

2. It is required to conduct a full and comprehensive analysis of *Buddleja asiatica* Lour.& numerous pharmacological and phytochemical activities as well as its traditional therapeutic uses. This will make it possible to do a thorough scientific analysis of the documented literature & efficacy, offering additional support.

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9. AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agreed to be accountable for all aspects of the work. All the authors are eligible to be an author as per the International Committee of Medical Journal Editors (ICMJE) requirements/guidelines.

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This study does not involve experiments on animals or human subjects.

13. DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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15. USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that they have not used artificial intelligence (AI)-tools for writing and editing of the manuscript, and no images were manipulated using AI.

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