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Antibacterial Activites and Anti Inflamatatory of Bougainvillea glabra- An Review

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ABSTRACT
The Nyctaginaceae family includes the climbing plant known as Bougainvillaea, or Bougainvillaea glabra, which is native to South America. Because of the colour of its bracts, which are often referred to as "flowers" and are composed of bracts, which are the striking parts, and the true flowers, which are small and white, the Bougainvillaea is widely acknowledged for its significance in horticulture. In traditional medicine, Bougainvillaea is commonly used to treat gastrointestinal disorders, respiratory conditions like bronchitis, asthma, and cough, as well as insecticidal and antibacterial properties. Information regarding the botanical description, ecological significance, phytochemistry, antimicrobial toxicology, and traditional uses of B. glabra are compiled in this review.

KEYWORDS
Bracts, traditional medicine, antimicrobial, Phytochemistry

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I. OVERVIEW

According to estimates from the World Health Organisation, 80% of people in developing nations still get their primary medical care from traditional medicines, which are primarily plant-based medications. Although many dangerous and deadly side effects have recently been reported, herbs are supposed to be safe [1]. Therefore, research into the antimicrobial qualities of herbs is desperately needed as it will aid in the treatment of a number of illnesses brought on by microbes. Numerous plant families are important sources of natural antimicrobials and serve as reservoirs for potent chemotherapeutics. Consequently, plant extracts have been utilised for a vast range of applications for thousands of years. The genus *Bougainvillae*, which belongs to the *Nyctaginaceae* (4 O'clock) plant family, contains 18 species, three of which are horticulturally important: *Bougainvillaea spectabilis*, *B. glabra*, and *B. peruviana*. *Bougainvillaea glabra* 'Snow White' is a cultivar of *B. glabra* 'Choicy' with white bracts and greenish veins[2] *Bougainvillaea glabra* 'Choicy' has been used by traditional Mandsaur practitioners in a variety of disorders such as diarrohea, stomach acidity reduction, cough and sore throat, decoction of dried flowers for blood vessels and leucorrohea, and stem decoction in hepatitis. The main component is leaves. The leaf of *Bougainvillaea glabra* 'Choicy' contains alkaloids, flavanoids, tannins, saponins, and proteins[3]. The leaves of *Bougainvillaea glabra* 'Choicy' have insecticidal activity,[4] anti-inflammatory activity,[5] and anti-diarrheal activity, anti hyperglycemic activity,[6] anti-ulcer and anti-microbial activity. As a result, the current study is an attempt in this direction, and it includes an evaluation of the antibacterial and antioxidant activity of an alcoholic extract.

TAXONOMIC CLASSIFICATION

The genus *Bougainvillaea* is a member of the *Nyctaginaceae* family, which contains approximately 33 genera and 400 species, of which Mexico reports 18 genera and approximately 110 species. The three most important and studied horticultural species are *Bougainvillaea spectabilis*, *B. glabra,* and B. peruviana. There are over 100 cultivars and hybrids that have not been studied[7].

Fig 1: *Bougainvillaea glabra*[8]

BOGANVILLEA BOTANICAL ANALYSIS

Jacques Denys Choisy, a Swiss botanist, discovered *B. glabra* in 1850 [9]. It is a perennial climbing shrub 1-7 m tall with branches with 5-15 mm long curved spines; simple leaves, dark green, somewhat glossy on the upper side, 1 cm long petiole, adaxially glabrous and abaxially pubescent, approximately 10 cm long; flowers 0.4 cm in diameter, bisexual, in a cymose inflorescence with three white to cream-colored flowers, perianth 1-2.5 cm long, slightly pubescent, with a Cardioid base and pointed tips adhered to flowers of various colours in the terminal region of the middle rib; with small, dry, one-seeded and ribbed achene fruit. Warm, semi-warm, dry, semi-dry, and temperate climates are preferred by *B. glabra* [10].

B. glabra **'S TRADITIONAL USES AND IMPORTANCE**

B. glabra involucre is widely used in traditional medicine to treat respiratory diseases and other conditions. *B. glabra* is known by many names in Mexico, including purple *bugambilia*, paper flower, and Santa Rita, but it is also known in indigenous languages such as *shpupukuishonat* (Mixtec), *katsjoxhuan* (Popolac), and *jukua*[11] . The *Bougainvillaea* bracts, which are often confused with flower petals, are the most commonly used part in Mexican traditional medicine to treat respiratory conditions such as cough, asthma, flu, and bronchitis via a variety of recipes. It has also been used to treat gastrointestinal issues like diarrhoea and dysentery, as well as to treat people with lung pain, whooping cough, drowning, urine sickness, pimples, and wound cleaning. It is used to treat inflammation and as an analgesic in Nigeria[12]. Flowers are used to treat stomachaches and nausea in Thailand [13]. *Bougainvillaea* is used to treat heartburn, sore throat, leucorrhea, blood vessels, and hepatitis in Mandsaur, India [14]. In Africa, *B. glabra* extracts are used to treat intestinal disorders [15]. *B. glabra* extracts, also known as "glory of the garden," have been shown to increase collagen production, inhibit tyrosinase and TNF activity, and be antioxidant, antimicrobial, antiviral, insecticide, larvicide, antidiabetic, antilipidemic, antihyperglycemic, hepatoprotective, antiulcer, anthelmintic, antipyretic, antifertility, and anticancer[16].

Other studies have focused on *Bougainvillaea* betalains for use as food, cosmetic, textile, and pharmaceutical pigments due to their antioxidant and non-toxic properties. There are currently some natural bougainvillea-based syrups on the market to treat respiratory tract discomfort, but these products are generally used only as supplements because no scientific studies to ensure efficacy and safety have been conducted [17]. Due to its ramifications and abundant colourful inflorescences that create a surprising appearance on walls, gates, or pergolas in gardens, *B. glabra* is classified as one of the plant species of great horticultural importance worldwide [18]. Despite its wide range of traditional applications, research into *B. glabra* 's chemical and pharmacological properties is limited[19].

ANTIMICROBIAL AGENTS THERAPY

Microorganisms are the leading cause of infectious disease mortality worldwide. Currently, the spread of diseases caused by pathogenic microorganisms is a risk factor for public health. These diseases are treated with antibiotics, but due to their scarcity and current microorganism resistance, the use of phytochemical compounds from plants has been chosen for its medicinal properties due to their antimicrobial functions[20]Perales et al. [21] The Kirby-Bauer diffusion method was used to test the antimicrobial activity of 95% ethanolic extracts of *B. glabra* leaves, stems, roots, and flowers against two Gram-positive bacteria *Bacillus subtilis* and *Staphylococcus aureus*, as well as two Gram-negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa*. Because Gram-negative bacteria lack an external membrane, the extracts are guaranteed to have a greater effect on them[22].

Aqueous-methanol extraction was used to test the antioxidant and antibacterial activity of betacyanins from *B. glabra* bracts. The antimicrobial activity of Ampicillin was tested using the well diffusion technique against the bacteria *B. subtilis, P. aeruginosa, and E. coli*[23].

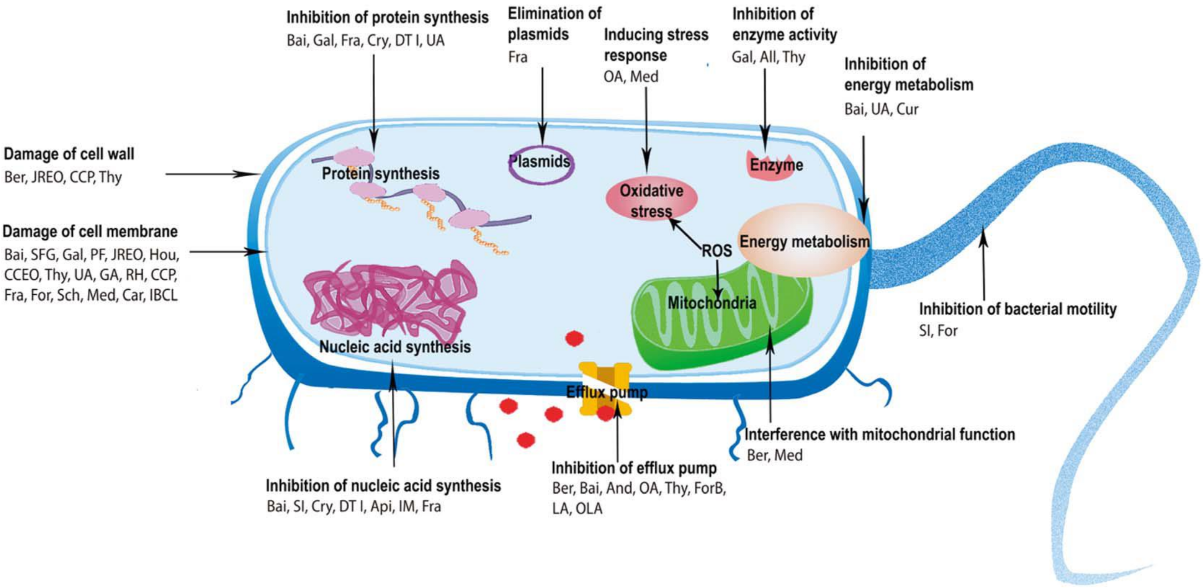

Fig 2: Mechanism of Action of Antibacterial Activity[24]

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[25] carried out a flower extraction with 95% methanol for 2 weeks at room temperature to evaluate the antimicrobial and antioxidant activity of the *B. glabra* flower. Later fractions of the extract were subjected to successive extractions of n-Hexane and carbon tetrachloride. The disc diffusion method was used to assess antimicrobial activity against *S. aureus, B. cereus, P. aeruginosa, and E. coli*, with the antibiotic Imipenem serving as a positive control and each solvent serving as a negative control. The extract contained alkaloid, flavonoid, tannin, phenolic compound, reducing sugar, amino acid, and protein, according to preliminary phytochemical analysis. The presence of hydrophobic flavonoids that penetrate the nonpolar core of the bacterial cell membrane or hydrophilic flavonoids that form hydrogen bonds with the polar groups of membrane lipids may explain the extract's antimicrobial activity; additionally, the presence of quercetin causes DNA breakage and inhibits bacterial gyrase. Tannin inhibits bacterial growth by chelating iron and inhibits cell wall synthesis by inactivating enzymes. While phenolic acids harm Gram-positive bacteria's cell membranes and the cytoplasm of Gram-negative bacteria, gallic acid changes the hydrophobicity, charge, and permeability of the membrane [26]. Saponin, on the other hand, causes the release of proteins and enzymes, whereas alkaloids inhibit cell division [27]. [28] prepared 96% ethyl alcohol infusions of *B. glabra* leaves and flowers, which were stored in the refrigerator for 2 months. The disc diffusion method (Kirby-Bauer technique) was used to measure antibacterial activity against strains of *S. aureus, P. aeruginosa, and E. coli*; each susceptibility test included a control to rule out the possibility that 96% ethyl alcohol had antibacterial activity.

ACTIVITY AGAINST BIOFILM

In recent years, it has been reported that bacteria commonly live in biofilms rather than planktonic forms under natural conditions [29]. Biofilms are bacterial communities that adhere to surfaces and are covered by an extracellular matrix composed of extracellular polymeric substances (EPS) such as polysaccharides, proteins, lipids, and extracellular DNA [30]. The presence of EPS prevents biofilm removal from requiring up to 1000 times higher antibiotic concentrations than planktonically grown bacteria, which causes approximately two million illnesses and more than 23,000 deaths per year due to resistant bacteria [31]. The high rate of antibiotic resistance in biofilms is still unknown, but researchers are looking for new antimicrobial agents, such as plant extracts, antimicrobial nanoparticles, antimicrobial proteins and peptides (AMP), and antimicrobial enzymes[31]. Secondary metabolites have antibiofilm activity, according to studies, because they change the structure of the biofilm, causing bacterial detachment, as well as inhibit adherence and affect the morphology of the biofilm [11]. Flavonoids have antibiofilm activity, which allows bacterial aggregation by membrane fusion but then reduces absorption of active nutrients, causing death; additionally, they interact with sortases enzymes of Gram-positive bacteria's cytoplasmic membrane, catalysing the assembly of cells that allows infection. Tannic acid, on the other hand, reduces the formation of biofilms by inhibiting the expression and activity of the urease gene. A polyphenol extract inhibits glycosyltransferase (GTF) activity, which affects the formation of the S. mutans biofilm. The reduction in virulence gene expression caused by eugenol prevents adhesion and biofilm formation.

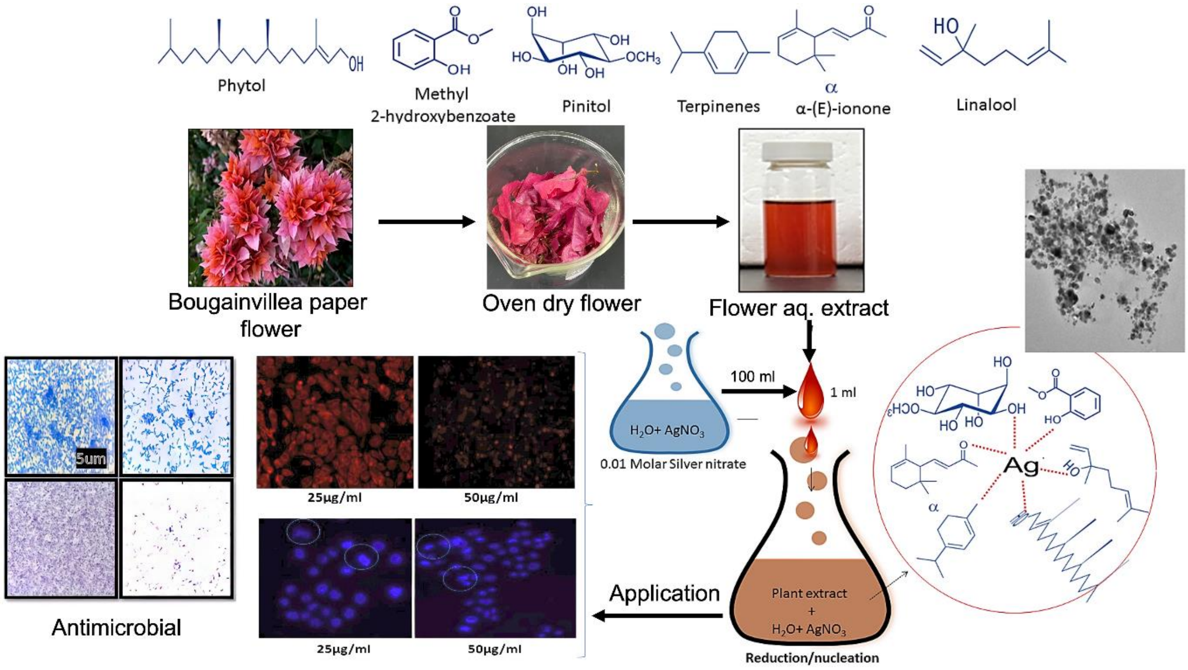

Fig 3: Formation and expression of biofilm activity[32]

Despite the potential of *B. glabra* extracts for antibiofilm activity due to the presence of a variety of metabolites, *Bougainvillaea* sp. flowers had an inhibitory effect on the development of S. aureus and E. coli biofilms at a concentration of 100 g/mL for 48 hours. According to [7], ZnO-NPs have antimicrobial activity by producing reactive oxygen species (ROS), which cause cell death and alter the stability of the cell membrane; they also inhibit the EPS of biofilms and bind and inhibit DNA and enzymes.

ANTI- CANCER

Herbal medicines have been used and continue to be used as the primary source of medical treatment in developing countries for many years. Plants have been used in medicine for centuries because of their natural antiseptic properties. As a result, research has focused on the potential properties and applications of terrestrial plant extracts for the development of potential nanomaterial-based drugs for diseases such as cancer.[33]. Many plant species are already being used to treat or prevent cancer development. Plant-derived drugs are sought after for anticancer treatment because they are both natural and widely available. They are easily administered orally as part of the patient's diet. Furthermore, because they are naturally derived from plants, they are generally more tolerated and non-toxic to normal human cells. Exceptions include cyanogenetic glycosides, lectins, saponins, lignans, lectins, and some taxanes [34]. If plant-derived drugs show selectivity in research, are non-toxic to normal cell lines, and have cytotoxicity in cancer cell lines, they can be advanced to clinical trials.

Therapeutic advancement. Plant-derived drugs can be classified into four types based on their activities: methytransferase inhibitors, DNA damage prevention drugs or antioxidants, histone deacetylase (HDAC) inhibitors, and mitotic disruptors 30. Table 1 shows the origins, anticancer activity, and clinical trial development of the compounds under consideration.

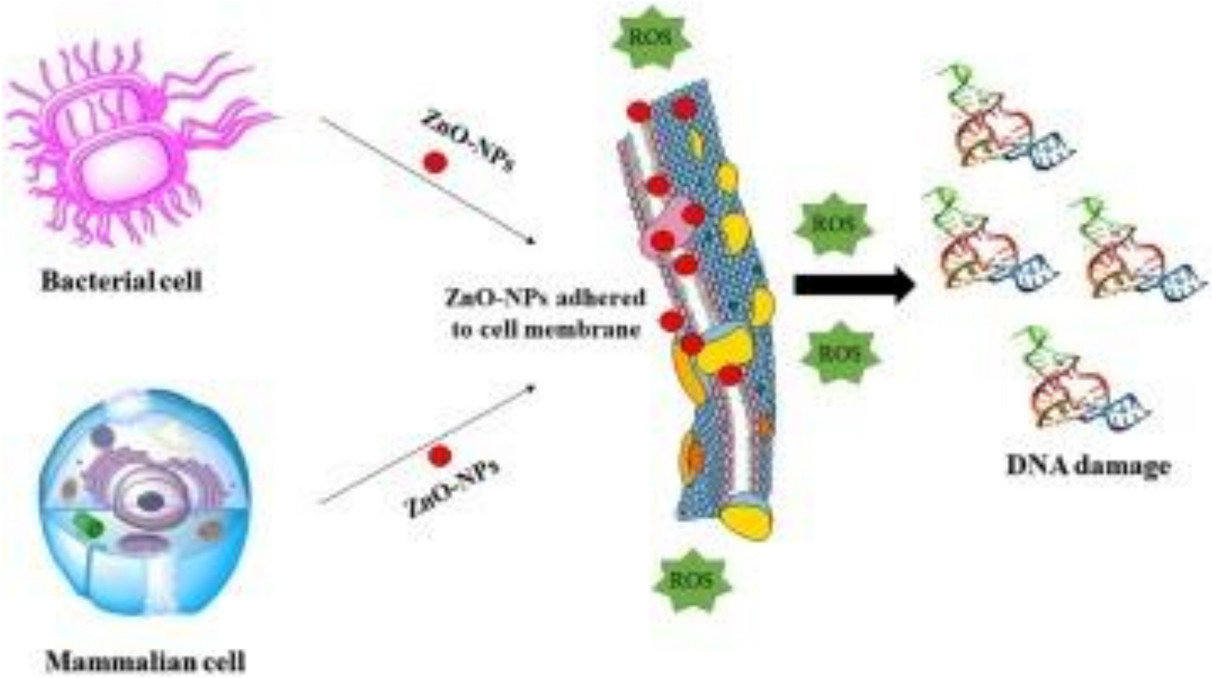

Fig 4: Graphical view of Anti-Cancer Activity[34]

HDAC inhibitors include compounds such as sulforaphane, isothiocyanates, isoflavones, and pomiferin. They stop carcinogenic proteins from working. Sulforaphane, for example, has been shown to inhibit key targets in breast cancer proliferation. HDAC inhibition by sulforaphane resulted in decreased expression of ER, EGFR, and HER-2 in breast cancer cell lines. HDAC inhibitors reactivate epigenetically silenced genes that are functional for chromatin acetylation in cancer cells, allowing the cells to enter programmed cell death (apoptosis). Plant-derived compounds that inhibit HDAC may improve chemotherapeutic sensitivity in human cancers.[35].

Vinca alkaloids derivatives, vincristine, vinblastine, vinorelbine, vindesine, and vinflunine are drugs that inhibit microtubule dynamics by binding to -tubulin. Microtubule disruptors include taxanes such as paclitaxel and its analogue docetaxel[36]. These substances prevent cell cycle phase transitions from metaphase to anaphase, resulting in cell cycle arrest and apoptosis[37]. Paclitaxel was one of the first drugs to have a significant impact on cancer treatment, and vincristine and vinblastine were two of the first drugs isolated[33].

Combinations of drugs derived from plant extracts of vinca alkaloids, Taxus diterpenes, Podiphyllum lignans, and Camptotheca alkaloids may enhance their anticancer effects and efficacy as therapeutic agents.[38]Extracts from Urtica membranaceae, Artemesia monosperma, and Origanum dayi Post were studied in [38] to see how they affected cancer cell lines from lung, breast, colon, and prostate cancers. The study found that plant extracts containing a combination of anticancer compounds were capable of killing cancer cells while having no effect on normal human lymphocytes and fibroblasts. This makes plant extracts more appealing as therapeutic agents than chemically derived agents, which cause toxic complications in cancer treatment. Plant extracts induced apoptosis, as evidenced by an increased sub-G1 phase population of cells with lower DNA content and chromatin condensation [39].

ANTI-INFLAMMATORY

The B. spectabilis Willd. plant contains anti-inflammatory biochemical compounds such as o-dihydrodrophenols, anthocyanin, lignin, and proline [40]. In Kolli Hills, Tamil Nadu, it is also used as a traditional medicine to treat inflammation [45]. The stem bark of B. spectabilis Willd. contains eight peltogynoids, including Bougainvinoes (A-H). These compounds have been shown to be cytotoxic to five cancer cell lines, including KB, Hela S-3, HT-29, and HepGL [41]. According to the findings, plant leaf extract contains bougainin protein, which has ribosome-inactivating protein (RIP) characteristics and is immunotoxic [40]. Inflammation is a protective response to tissue injury. Similarly, the presence of inflammatory cells after the reaction has completed can cause a variety of diseases. As a result, it is necessary to deactivate the plant's cells and compounds that are responsible for inhibiting both acute and chronic inflammation.

TOXICOLOGY RESEARCH

Because the belief that natural treatments are safer is not always true, it has been decided to assess the toxicity of medicinal plants in order to ensure greater safety in the development of new drugs [6]. The cytotoxicity of methanolic and dichloromethane extracts of *B. glabra* flowers against various cancer cell lines, including breast cancer (MDA-MB-231, MCF-7), cervical cancer (CaSKi), prostate cancer (DU-145), and colon cancer (SW-480), revealed that the methanolic extract had the highest activity against the CasKi line, while the dichloromethane extract had moderate activity [6]. Certain phenolic compounds have been shown to induce apoptosis in cancer cell lines; this may be due to the polarity of the compounds. The acute and subchronic toxicity of *B. glabra* methanolic extracts was studied in albino Wistar rats for 90 days at doses of 250, 500, and 1000 mg/kg for the subchronic test. The animals were sacrificed at the end of this period, and haematological, biochemical, and histopathological parameters were evaluated, with no significant differences compared to the control.

II. SUMMARY AND FUTURE PERSPECTIVE

Ethnobotany is a tool that has enabled the discovery and selection of medicinal plants that are a novel alternative for infection treatment. Because of the current increase in microbial resistance to antibiotics, medicinal plants represent the largest reserve of phytochemical compounds available to combat this problem; however, this reserve currently requires numerous studies to correctly identify the secondary metabolites, as well as their mechanisms of action on bacterial growth inhibition. The phytochemical profile of *B. glabra* involucre contains a variety of compounds, primarily betalains and phenols, providing a new opportunity to study their potential as antimicrobial agents and antibiofilm, but there are currently no studies that demonstrate the minimum inhibitory concentration (MIC), minimum bactericidal concentration (MBC), and half maximal inhibitory concentration (IC50) values required to validate the antibacterial activity with adequate congruence.

Current research should not only focus on the extracts' antimicrobial activity, but also on their antibiofilm activity, because this adherence confers greater resistance to antibiotics and no drugs specifically target this infection mechanism. Because *B. glabra* acts on planktonic bacteria, its potential as an antibiofilm should be investigated. Simultaneously, using scanning electron microscopy to determine how the phytochemistry of *B. glabra* extracts affects the structure of bacterial cell morphology and biofilms is an option. The use of *B. glabra* as a therapeutic agent based on traditional medicine still presents several challenges. First, in order to understand its potential, it is necessary to correctly identify the plant organ, which allows for the identification of the diversity of secondary metabolites present, in order to enhance its therapeutic properties. Finally, it is critical to emphasise the potential of this ornamental plant, not only for beautifying landscapes but also for mitigating another current issue, namely air pollution in large cities.

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