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Bougainvillea: A Comprehensive Review of Its Phytochemistry, Traditional Uses and Pharmacological Activities.

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ABSTRACT

With eighteen species—*B.berberidifolia*, *B.buttiana*, *B.campanulata*, *B.glabra*, *B.herzogiana*, *B.infesta*, *B.lehmanniana*, *B.lehmannii*, *B.malmeana*, *B.modesta*, *B.pachyphylla*, *B.peruviana*, *B.pomacea*, *B.praecox*, *B.spectabilis*, *B.spinosa*, *B.stipitata*, and *B.trollii*—the genus is incredibly common throughout the world. The genus *Bougainvillea*, native to South America, was first recorded in Rio in 1778 before being introduced to Europe by French military commander Louis Antoine De Bougainvillea. These are bushes that develop into small vines or trees. They also have straight or slightly bent thorns and internodes on their stems. The leaves may be petiolate, oval in shape, or have a wider base. Depending on the species, cultivar, or hybrid, the bracts and blooms have different colors. Numerous aliphatic hydrocarbons, fatty acids, fatty alcohols, volatile chemicals, phenolic compounds, peltogynoids and flavanoids, phytosterols, terpenes, carbohydrates, betalains, etc. are present. Research has demonstrated the antiviral, anti-inflammatory, anti-hyperglycemic, insecticidal, anti-ulcer, antibacterial, and anti-diarrheal properties of *Bougainvillea glabra* leaves.

Keywords: For pharmacological traits like bougainvillea's anti-oxidant and anti-diabetic qualities.

Introduction

The genus *Bougainvillea* is found worldwide. Its roughly eighteen species include *B. berberidifolia*, *B. buttiana*, *B. campanulata*, *B. glabra*, *B. herzogiana*, *B. infesta*, *B. lehmanniana*, *B. lehmannii*, *B. malmeana*, *B. modesta*, *B. pachyphylla*, *B. peruviana*, *B. pomacea*, *B. praecox*, *B. spectabilis*, *B. spinosa*, *B. stipitata*, and *B. trollii*. The only four species used for commercial purposes are *B. buttiana*, *B. glabra*, *B. spectabilis*, and *B. peruviana*.^[1] However, there are more than 100 cultivars and three hybrids, the latter of which has not yet been identified.

Ethnobotany

Taxonomical Classification:- Table:1^[2]

Kingdom	Plantae
Sub kingdom	Tracheobionta
Super division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Caryophyllidae
Order	Caryophyllales
Family	Nyctaginaceae
Genus	Bougainvillea

Common Name:-**Table-2**

Language	Common Name
Telugu	Kagithala puvvu
Hindi	Booganbel
English	paper flower
Manipuri	Cherei
Bengali	Baganbilas
Marathi	Booganvel
Konkani	Bougainvila

**Figure:1- Bougainville pink bracts****Figure:2- Bougainville white bracts****Botanical Description**

Before being shipped to Europe by French military leader Louis Antoine de Bougainville, the In 1778, the South American species *Bougainvillea* was discovered for the first time in Brazil^[3]. These are bushes that develop into tiny trees or vines. Additionally, their stems have straight or slightly curved internodes and thorns. The leaves might be shaped like an oval, petiolate, or wider at the base. Depending on the species, cultivars, or hybrid, the bracts and There are flowers on display in a range of colors. All year long, they bloom^[4]. According to botanical textbooks, some *Bougainvillea* species are found all over the world and are not specific to a species, region, cultivars, or hybrids. A more thorough investigation was carried out in the scholarly literature using these findings.

Bougainvillea hybrids

Since the genus *Bougainvillea* was first commercialised, producers have been working to produce hybrids of its species^[5]. They have produced three well-known hybrids with exceptional characteristics: *B. spectoperuviana*, *B. spectoglabra*, and *B. glabra peruviana* (*B. buttiana*). (i) *B. specto peruviana*: the databases checked indicate that there are no records of the first hybrid in the scientific literature of registration sites or scientific research works; (ii) *B. spectoglabra*: this plant is a hybrid of *B. spectabilis* and *B. peruviana*, and it has only been recorded in China^[6].

Mutations

Most *Bougainvillea* cultivars were produced by "budspots" selection or mutation breeding. Since traditional cross-breeding is impossible due to the lack of flowers, mutation breeding is the only method that can be used to develop double bracted *Bougainvillea*. It is also a crucial technique for adding variability to flower crops and shortens the time required to establish a new variety^[7]. As a result of mutations between different forms of three fundamental species, several bract colors have emerged, ranging from white to yellow, orange, magenta, red, purple, and violet^[8]. The variation in bract color is based on the related amount of these pigments. Both qualitative and quantitative changes in pigment composition were responsible for variations in bract color^[9]. "Bougainvillea mutation studies were carried out at the National Botanical Research Institute in Lucknow and the Bhabha Atomic Research Center in Bombay"^[10].

Distribution

The Great Bougainvillea, also called *Bougainvillea spectabilis*, is found in tropical and subtropical regions of South America, especially Brazil, Peru, Bolivia, and Argentina's Chubut Province. It grows well in a range of environments, such as coastal areas, dry, rocky slopes, and tropical forests. In order to produce its vivid and colorful bracts, the plant prefers regions with well-drained soil and sufficient sunlight ^[11]. *Bougainvillea Spectabilis* is a highly versatile plant that thrives in both rural and urban settings. It is commonly observed in gardens, parks, and by the side of the road. Because of its wide range, it has been brought to many parts of the world, where its hardiness and striking blooms have made it a popular plant to grow. This species is found in countries in Asia, Africa, and Oceania and thrives in warm climates ^[12].

Collection and Cultivation

Bougainvillea Spectabilis prefers full sun, well-drained soils, and pH levels that are slightly acidic to neutral. Once established, it can withstand drought and dry conditions. The plant may be harmed or even die in cold weather due to its sensitivity to frost. Cuttings are a common method of propagating *Bougainvillea Spectabilis*. Hardwood or semi-hardwood cuttings, typically 4 to 6 inches long, are obtained during the growing season. These cuttings are placed in a medium that drains properly after being treated with rooting hormone. Using bottom heat and spray may improve success rates even though rooting may take several weeks. In vitro propagation techniques have also been developed for mass multiplication ^[13].

Synonyms

In the different countries where they are found, the *Bougainvillea* is also known by other common names: *Buganvilla* (Spain), *Bugambilia* (Mexico, Guatemala, Cuba, and the Philippines), *Pokok bunga kertas* (Malaysia), *Napoleon* (Honduras), *Veranera* (Colombia, Nicaragua, El Salvador, Costa Rica, and Panama), *Trinitaria* (Colombia, Panama, Puerto Rico, Dominican Republic, and Venezuela), *Santa Rita* (Argentina, Bolivia, Brazil, Pataguinha, Roseta, Riso, Pataguinha, Pau-depapel (Brazil), or *Papelillo* (Northern Peru) ^[14].

Traditional uses

**B. buttiana*, *B. glabra*, and *B. spectabilis* are used in traditional medicine to treat pertussis and coughing.

For dysentery, bronchitis, and asthma, *B. glabra* is advised ^[15].

*It is sometimes recommended for blackheads, pimples, rust, and stomachaches.

**B. spectabilis* is used to treat lung pain, snoring, bronchitis, and other respiratory disorders.

*The traditional use of other *Bougainvillea* species and hybrids in medicine has not been studied in the literature.

*However, because both species are found and documented in Morelos, Mexico, and are used to treat whooping cough and cough, the hybrid *B. buttiana* was mistaken for *B. buttania* ^[16].

Chemical composition

Since 1970, a lot of research has been done on the chemicals found in the plants of this group ^[17]. Scientists looked at different parts of the *Bougainvillea* plant, like stems, leaves, bracts, flowers, bark, roots, and even parts without flowers. They tested these parts using various methods to find out what kinds of chemicals are present. Chemical substances for species or hybrids have been isolated, identified, and clarified. Chemical compound structures were drawn using the Marvin program ^[18].

Chemical composition	Class of compound	Specific part of plant	Species
Aliphatic hydrocarbons	alkanes, alkenes, and cyclo alkanes,	Bracts with flower	<i>Bougainvillea xbuttiana</i>
Fatty alcohols and acids	fatty acids and fatty alcohols	Leaves, branches, roots	<i>Bougainvillea xspectabilis</i>
		Bracts with flower	<i>Bougainvillea xbuttiana</i>
Volatile Compounds	aldehydes, ketones, phenols, oxides, esters, and alcohols	Leaves and branches	<i>Bougainvillea xspectabilis</i>
		Bracts with flowers	<i>Bougainvillea xbuttiana</i>
Phenolic Compounds	Polyphenols and flavonoids	Bracts and flowers	<i>Bougainvillea xbuttiana</i>
		Flowers	<i>Bougainvillea glabra</i>
Peltogynoids and flavonoids	Flavonoids and related phenolic	Bracts and flowers	<i>Bougainvillea xbuttiana</i>

Chemical composition	Class of compound	Specific part of plant	Species
	compounds	Flowers	Bougainvillea glabra
Phytosterols, Terpenes and Carbohydrates	Phytosterols, Terpenes and Carbohydrates	Bracts and flowers	Bougainvillea xbuttaina
		Leaves and bracts	Bougainvillea glabra
		Stem, bark leaves and branches	Bougainvillea spectabilis ^[19] .
Betain	Betain pigments	Bracts	Bougainvillea buttiana
	(Vascular pigments)	Bracts	Bougainvillea glabra ^[20] .

Pharmacological activities

Two species, B. glabra and B. buttiana, were found to have pain-relieving effects. The study looked at how effective it was when these species were taken by mouth. In male Wistar rats, the tail technique

Pharmacological activity	Purpose
Analgesic Activity	In male Wistar rats, using the tail method, the methanol extract from B. glabra showed the highest percentage of pain relief, which was 79.88%. The analgesic efficacy of B. buttiana (var. The ethanol extract from orange was tested in female CD1 mice using formalin and acetic acid. The extract showed blocking effects in both stages of the formalin test, but the pain-relief percentage for the acetic acid method was 95.65%^[21]. Another study used acetic acid to check how well B. buttiana (var.) works as a pain reliever. Rose ethanol extract given by mouth to BALB/c mice in formalin and tail immersion models. The extract provided a powerful pain-relieving effect with each method used^[22].
Anti-inflammatory activity	Methanolic leaf extracts lessen both acute and chronic inflammation, probably by modifying pro-inflammatory cytokine levels and fictitious pathways associated with ATP-sensitive potassium channels, glutamatergic signaling, and cyclic guanosine monophosphate (cGMP) signaling. The flower's extracts demonstrated effectiveness in preventing inflammation-related biochemical markers and shielding organs such as the kidney, liver, and brain^[23].
Anti-pyretic activity	Rats that received methanol extracts from B. glabra by mouth showed a significant reduction in fever^[24].
Anti-microbial activity	The agar diffusion method and the dilution method are two common ways to check the biological properties of plant extracts, like antibacterial and antifungal effects^[25].
Anti-viral Activity	The proteins from the leaves of B. buttiana were tested against several RNA viruses, such as sunhemp rosette virus, tobacco mosaic virus, and tobamo viruses. This shows a big opportunity to control vegetable viruses. By stopping the virus from growing, this cleaning process might show that lysine is an inhibitor of N-glycosidase activity in tobacco 25S rRNA ribosomes, as found in another study^[26].

Pharmacological activity	Purpose
Anti-diabetic and Anti-oxidant activity	In streptozotocin-induced diabetic animals, the aqueous leaf extract demonstrated anti-hyperglycemic and anti-hyperlipidemic properties. This effectiveness was because of better antioxidant levels, which meant more glutathione (GSH) and superoxide dismutase (SOD) and less lipid peroxidation, measured by thiobarbituric acid reactive substances (TBARS). It's interesting to note that the extract did not exhibit toxicity during subchronic dosing in addition to normalizing biochemical markers in the liver and kidney ^[27,28] .
Cardiotonic Activity	The frog heart was used in a special setup to test how well the water extract from <i>B.glabra</i> strengthens the heart. Heart rate, cardiac output, and contraction force were some of the measurements that were looked at. HR and CO increased as a result of this extract ^[29] .
Anti-fertility activity	In albino Swiss male and female mice that were given the ethanol extract from <i>B.spectabilis</i> by mouth, their testosterone and estrogen levels went down, along with their sperm count, how well the sperm worked, and how well the sperm moved ^[30] .
Anti-diarrheal	Male Wistar rats that were given an oral dose of acetone extract from <i>B.glabra</i> "Choicy" leaves demonstrated a clear antidiarrheal effect.
Anti ulcer	Male Wistar rats were used to check how well the acetone leaf extract of <i>B.glabra</i> "Choicy" works against ulcers, and the extract showed a strong ability to reduce ulcers ^[31] .
Anti helmenthic	Methanol extracts from <i>B.glabra</i> were used to test their effectiveness against <i>Pheretima posthuma</i> for anthelmintic activity ^[32] . Ethanol extracts from <i>Eisenia fetida</i> and <i>Eudrilus eugeniae</i> were compared with the standard drugs metronidazole and albendazole. All extracts from <i>B.glabra</i> can kill and make worms paralyzed ^[33] .
Thrombolytic	An aqueous extract of <i>B. glabra</i> 's green leaves and a methanol extract of its leaves of <i>B.Spectabilis</i> showed the ability to dissolve blood clots in the blood of healthy people in a lab test ^[34] .

Toxicology

Glabra "Choicy" leaves were repeatedly extracted using several solvents like acetone, ethanol, and water.

To check for toxicity, both male and female albino rats were given this extract by mouth. The animals did not seem to have died, based on the results^[35]. Mice were given the treatment through their stomach to check how harmful the water-based extract from *B.spectabilis* leaves was^[36]. The hemoglobin concentration (Hb), packed cell volume (PCV), red blood cell count (RBC), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular volume (MCV), white blood cell count (WBC), and platelet count (PLC) were tested in albino male rats (*Rattus norvegicus*) using leaves from *B.spectabilis* that were extracted with ethanol. Hb, RBC, and PCV levels dropped significantly when the extract was given by mouth^[37]. In another study, male and female albino Swiss mice that received oral aqueous extracts of *B.spectabilis* leaves showed a major decrease in hemoglobin, red blood cell, and hemocrit levels. Anemia can also happen because of this ^[38]. Wistar albino rats that received ethanol extracts from the root bark were also used to check for acute toxicity. The study found that the rats did not show any harmful effects^[39]. However, male Wistar rats became poisoned after taking the *B.spectabilis* methanol extract by mouth^[40]. Additional research found that giving male Swiss mice the methanol extract of *B.spectabilis* by mouth did not harm their liver or kidneys ^[41]. Brine shrimp called *Artemia salina* were used to check if the flowers of *B.spectabilis*, in different colors like white, orange, shocking pink, red, and violet, were toxic when extracted with methanol ^[42]. The results showed that *Artemia* was not harmed by these extracts ^[43]. Female CD1 and/or BALB/c mice were also used to test the toxicity of ethanol extracts from the bracts of *B.x buttiana*. The findings demonstrated that these extracts were not harmful to two distinct mouse strains^[44].

Conclusion

Bougainvillea spectabilis has become more interesting to researchers in recent years. There are many plant chemicals and the possible ways they might work in the body. It is often seen as just a decorative item. However, many studies have found that different parts of the plant contain natural active ingredients. These are substances that occur naturally in the plant, such as flavonoids, phenolic compounds, terpenoids, and other secondary metabolites. Research shows these compounds have several health benefits, like acting as antioxidants, fighting bacteria, reducing inflammation, helping with diabetes, and possibly even fighting cancer. Early research suggests that *B. spectabilis* could be a possible natural source of treatment. But there are several important limitations to this area of study. Also, most well-designed in vivo and/or clinical studies on *B. spectabilis* have not been conducted yet. The way the substance is removed, which parts of the plant are used, and the conditions of the test or experiment vary. Because different researchers use these different methods, it creates another source of inconsistency in the studies of *B. spectabilis*, making it hard to reach broad, reliable conclusions. There is not much information available about how these medicines work. Some features of *B. spectabilis* show that more research is needed later on. There is still interest in what this plant can be used for. It has been mentioned that *B. spectabilis* could be used in medicines, beauty products, and food, especially because of its helpful qualities. This plant has strong antioxidant and active health benefits. The substances in the plant may be useful for various purposes. The creation of products that are applied to the skin, use natural colors, and include active ingredients that are beneficial for health. However, the use of *B. spectabilis* in real-world use, it's limited because there aren't enough studies on toxicity, no standard guidelines, and not enough clinical proof. So, future research on *B. spectabilis* should pay attention to the areas that are not yet well understood about the plant. Such studies will help show how effective and safe *B. spectabilis* is. Even though *B. spectabilis* shows a lot of potential, more research is needed to figure out how what works in the lab can be used in real life.

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