



Paper Flower, *Bougainvillea spectabilis*: Update Properties of Traditional Medicinal Plant

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Abstract

Paper Flower, *Bougainvillea spectabilis* is reported to have medicinal values including anticancer, antidiabetic, anti-hepatotoxic, anti-inflammatory, antihyperlipidemic, antimicrobial, antioxidant and antiulcer properties. The phytoconstituents such as alkaloids, flavonoids, glycosides, phenolics, phlobotannins, quinones, saponins, tannins and terpenoids were reported as the basis of therapeutic properties. The other important constituents which contribute to the remedial properties are bougainvinones, pinitol, quercetagenin, quercetin and terpinolene. Published information on these update properties of *B. spectabilis* was gathered by the use of different database platforms, including Google Scholar, Science Direct, PubMed, SciFinder and Scopus. This review article has attempted to suggest *B. spectabilis*, to be one of the choices in the traditional medicinal plant.

Keywords: *Bougainvillea spectabilis*, Paper Flower, Property, Traditional Medicinal Plant

1. Introduction

Traditional Medicines or natural products such as plants, animals and microorganisms are the oldest form of health care in the world and used in the prevention, and treatment of illnesses¹. Traditional Medicinal Plants are rapidly growing and are used globally in various treatments for example; African traditional medicine based immune boosters and infectious diseases², Chinese traditional medicine plants for improvement of memory and cognitive function³, Indian traditional medicinal plants with antidiabetic potentials⁴, Korean traditional medicinal plants used for stroke remedy⁵, and Thai traditional medicinal plants with antimalarial activities⁶. The present review is to provide up-to-date information on the properties of *Bougainvillea spectabilis*, one of

the plants that is being investigated for diverse health benefits.

2. Morphological Characters of *Bougainvillea spectabilis*

B. spectabilis referred to as “Paper Flower” as its bracts are thin and papery. The purple or magenta color is the most common *Bougainvillea* color, but may range from white to orange (Figure 1)⁷. The stem is a woody perennial vine, with multi-trunked and large clumping stems which spread up to 2-4 m. It climbs by sending out slender arching canes armed with stiff curved thorns. During the growth, the color of the stems turns from mid-green to dull green-brown. The bark is pale and corky. The leaf is 5-10 cm long and 2-6 cm wide, with

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Fig. 1. Variety color of *Bougainvillea* spp.

ovate to rounded shapes. Leaves are deep green, leathery in texture and hairy underneath. A cluster of three flowers arise in leaf axils. They are cream in color, small, slender, with hairy tubes and surrounded by showy. The colorful bracts are crinkled, fairly large, egg-shaped, and possess colors such as rose, rusty-red, magenta and purple. The fruit is an elongated five-lobed achene less than 1-2 cm long. It is rather inconspicuous, not showy, and has a dry, hard fruit cover⁸.

3. Taxonomical Classification

The taxonomy of *B. spectabilis* is in the Kingdom (Plantae); Subkingdom (Viridiplantae); Infrakingdom (Streptophyta); Superdivision (Embryophyta); Division (Tracheophyta); Subdivision (Spermatophytina); Class (Magnoliopsida); Superorder (Caryophyllanae); Order (Caryophyllales); Family (Nyctaginaceae); Genus (*Bougainvillea*); Species (*B. spectabilis*)⁹. This genus was first discovered in Brazil in 1786 by Louis Antoine de Bougainvillea, a French navigator¹⁰. This genus has 18 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*, with three that are horticulturally important which includes *B. spectabilis*, *B. glabra* and *B. peruviana*^{11,12}.

4. Nomenclature

B. spectabilis is a native plant of South America that spread throughout the tropical and warm climates¹³. The vernacular name of *B. spectabilis* is known as paper flower (English); baganbilas (Bengali); mao bao jin, ye zi hua (Chinese); bougainvillier (French), booganbel (Hindi); buganvillea (Italian); bunga kertas (Indonesian); felila (Japanese); bouganvila (Konkani); buginvila (Malay); cherei (Manipuri); veranera (Spanish); bogambilya (tagalog); kagithala puvvu (Telugu); fuang fah (Thai); and bong giay (Vietnamese)⁷.

5. Phytochemical Constituents

The phytochemical analysis revealed the presence of alkaloid, flavonoids, furanoids, glycosides, phenols, phlobotannins, quinones, saponins, steroids, tannins and terpenoids which were extracted from stem, flowers and leaves of *B. spectabilis*¹⁴. The other active constituents are bougainvinones peltogynoids¹⁵, essential oils including methyl salicylate, terpinolene, α -(E)-ionone¹⁶, pinitol, β -sitosterol, quercetin, and quercetin-3-O-rutinoside^{17,18}. In addition, the phytochemical constituents of *B. spectabilis* leaf extract revealed that tannins (27.64%), saponins (14.08%), glycosides (11.49%), flavonoids (10.05%), alkaloids (4.10%), phytate (49.27%) and oxalate (27.65%) contents are present¹⁹.

6. Antibacterial Property

Umamaheswari et al.,²⁰ evaluated the antibacterial activity of various solvent extracts of the leaf of *B. spectabilis*. The bacteria used in the study were *Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus faecalis*, *Micrococcus luteus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Klebsiella pneumoniae*, *Proteus vulgaris*, *Serratia marcescens*, *Shigella flexneri* and *Vibrio cholerae*. They reported that ethanolic, methanolic, chloroform and ethyl acetate extracts showed larger diameter of the inhibition zones on all tested bacteria compared to diethyl ether and aqueous extracts. They also analyzed qualitatively by phytochemical screening for the presence of amino acids, proteins, anthroquinones, saponins, triterpenoids, flavonoids, carbohydrates, alkaloids, phytosterols, glycosidal sugars, tannins, phenols and furanoids. These phytochemicals present in extracts may be responsible for the antibacterial activity of the plant leaf extract.

Kumara Swamy et al.,²¹ evaluated the antibacterial activity of various solvent extracts of the flower of *B. spectabilis*. The bacteria used in the study were *Bacillus*, *Klebsiella*, *Proteus* and *Pseudomonas*. They reported that ethanolic and aqueous extracts showed larger diameter of the inhibition zones on all tested bacteria compared to chloroform and ethyl acetate extracts. They also analyzed qualitatively by phytochemical screening for the presence of alkaloids, flavonoids, phlobatannins, and terpenoids.

Dhankhar et al.,²² evaluated the antibacterial activity of various solvent extracts (water, methanol, acetone, chloroform, petroleum ether) of the leaf of *B. spectabilis*. The bacteria used in the study were *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Vibrio cholerae*. Maximum zone of inhibition (13.5 mm) was observed by methanolic extract against *K. pneumoniae*.

Hajare et al.,²³ evaluated the antibacterial activity of various solvent extracts of the leaf of *B. spectabilis*. The bacteria used in the study were *Escherichia coli* and *Micrococcus aureus*. They reported that the ethanolic and acetone extracts can be better than aqueous extract used topically as disinfectants primarily in first aid dressing.

7. Antihyperlipidemic Property

Adebayo et al.,²⁴ suggested that the leaf of *B. spectabilis* had beneficial effect on serum cholesterol concentration reduction. The 50, 100 and 200 mg/kg/day of *B. spectabilis* ethanolic extract was administered orally into the rat for 7 days. The plant extract significantly reduced total cholesterol, and triglyceride.

Saikia and Lama¹² reported that the leaf of *B. spectabilis* decreased serum lipid profile in rats fed with high fat diet and to compare it with a standard hypolipidaemic drug simvastatin. The 100 or 200 mg/kg/day of *B. spectabilis* methanolic extract were administered orally into the rat for 8 weeks. The plant extract showed significant reduction in total cholesterol, triglyceride, low density lipoprotein, very low density lipoprotein levels. It has also shown significant increase in high density lipoprotein.

8. Antidiabetic Property

Bhat et al.,²⁵ reported that the leaf of *B. spectabilis* showed a good oral glucose tolerance and significantly reduced the intestinal glucosidase activity by studying diabetic mice. The 100 µg of *B. spectabilis* aqueous and methanolic extracts were injected intraperitoneally into the mice for 21 days. The plant extracts showed significant increase in glucose-6-phosphate dehydrogenase activity and hepatic, skeletal muscle glycogen content. Bhat et al., also found a regeneration of insulin-producing cells and corresponding increase in the plasma insulin and c-peptide levels with the treatment of *B. spectabilis* extracts.

Jawla et al.,²⁶ reported that the stem bark of *B. spectabilis* exhibited potent hypoglycemic activity by studying in alloxan induced diabetic rats. The 100, 250 and 500 mg/kg/day of *B. spectabilis* ethanolic extract were administered orally into the rat for 7 days. The stem bark extract exhibited significant hypoglycemic activity 22.2% more than standard oral hypoglycemic drug, glibenclamide. Jawla et al.,²⁷ also isolated the antidiabetic principle from *B. spectabilis* stem bark. These constituents were pinitol, β -sitosterol, quercetin and quercetin-3-O- α -L-rhamnopyranoside.

9. Antifertility Property

Mishra *et al.*,²⁸ evaluated the effect of the 800 mg/kg/day of oral administration of *B. spectabilis* leaves on reproductive organs and fertility of male and female Swiss albino mice for 30 days. They reported that this plant can reduce the caudal epididymal sperm count from 5.05×10^6 per ml in the control group to 0.65×10^6 per ml in the treatment group (87.13%). From histology study, this plant treatment revealed the reduction in the size of seminiferous tubules along with the thickness of germinal epithelial cells and the hypertrophy of interstitial cells of leydig. Moreover, the lumen of the tubules was found to be devoid of sperms. In female, it disrupted the estrous cycle, prolonged metaestrus phase from 10.6 h in the control group to 25.0 h in the treated group. The most significant change has been due to 145.28% increase in metaestrus phase along with 75.44% in estrus and 11.43% in diestrus phase. Both the hormones, testosterone and estrogen levels were significantly decreased.

Hembrom *et al.*,²⁹ evaluated the effect of 800 mg/kg/day of oral administration of *B. spectabilis* leaves on the fertility of male Swiss albino mice for 50 days. This plant caused significant increase in the anodic protein concentration in seminal plasma of mice, collected from cauda epididymis (3.74 mg/ml) compared to the control group (2.37 mg/ml). This significant rise of anodic protein adds more negative charges on the sperm surface membrane that inhibits capacitation and fertilizing ability of the sperm. The other mechanism of this plant is to increase the M-isozymes of LDH from 3.31 units/ml/hr in the control group to 5.68 units/ml/hr in the treatment group. It suggests a shift in the tissue respiration from aerobic to anaerobic condition resulting in more conversion of pyruvate into lactate in the seminal plasma and adversely affects the sperm metabolism in the epididymis.

Ikpeme *et al.*,¹⁹ evaluated the effect of 150, 300, 450 and 600 mg/kg/day of oral administration of *B. spectabilis* leaves on reproductive organs and fertility of male rats for 65 days. Results on the sperm parameters revealed significant reduction in the sperm count (9.38×10^6 per ml in control group to 6.76×10^6 per ml in treatment group), viability (86.55% in control group to 63.91% in treatment group) and motility (65.75% in

control group to 42.75% in treatment group). Sperm head abnormalities were also significant in the different groups with the highest recorded at 600 mg/kg (8.75%) compare to that of control (2.75%). The testes weight was significantly reduced from 1.38 g in control to 1.10 g in treatment group.

10. Antioxidant Property

Chaires-Martinez *et al.*,³⁰ evaluated the antioxidant activity of aqueous and hydroalcoholic extracts from leaf and stem of *B. spectabilis*. It was found that stem aqueous extract from *B. spectabilis* produced more 1,1-diphenylpicrylhydrazyl free radical (DPPH) absorbance reduction (95.66%), with an IC_{50} (the concentration to inhibit the oxidation of DPPH by 50%) values of 0.03 μ g/mL.

Venkatachalam *et al.*,³¹ determined the phytochemical content and radical scavenging assays of methanolic and aqueous extracts of *B. spectabilis* leave. It was found that the methanolic extract showed greater amount of phytochemicals and higher antioxidant activity than aqueous extract.

Dhankhar *et al.*,³² evaluated the antioxidant activity of various solvent extracts (water, methanol, acetone, chloroform, petroleum ether) of *B. spectabilis* leave. The result showed that aqueous extract of the plant exhibited a potential antioxidant activity as tested by the metal chelating assay, superoxide radical scavenging activity and nitric oxide radical scavenging activity.

11. Anti-inflammatory Property

Mandal *et al.*,³³ evaluated the acute anti-inflammatory activity of methanolic extract of *B. spectabilis* leave by using carrageenan and dextran, whereas chronic anti-inflammatory activity was evaluated by Freund's adjuvant-induced arthritis model. The 20 and 50 mg/kg of *B. spectabilis* had shown significant anti-inflammatory effects 20.6% and 67.6%, respectively, on carrageenan-induced acute inflammatory models. In dextran-induced edema, the effect was 30% and 66%, respectively. In arthritic model, the 50 mg/kg of this plant showed significant chronic anti-inflammatory effect 38.46% in comparison to the standard drug dexamethasone.

12. Antiulcer Property

Malairajan *et al.*,³⁴ evaluated the antiulcer activity of ethanolic extract of *B. spectabilis* leaves. Its antiulcer activity was studied in three rat models: 1. Aspirin induced gastric ulcer which was compared with ranitidine; 2. Ethanol induced ulcer which was compared with sucralfate; and 3. Water immersion stress induced ulcer which was compared with omeprazole. The mechanism for the pharmacological action like antisecretory, cytoprotection, proton pump hypothesis was evaluated. The results showed that the ethanolic extract of *B. spectabilis* showed reduction in gastric volume, free acidity, total acidity and the ulcer inhibition was found to be 100%. The plant extract showed significant cytoprotective effect 89.71% and the extract showed protection index 72% in water immersion stress induced ulcer.

In conclusion, this review article has attempted to suggest *B. spectabilis*, to be one of the choices in the traditional medicinal plant.

13. Conflict of Interests

The authors do not have any conflict of interest to declare.

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