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THE GENUS *Begonia* (*Begoniaceae*): A REVIEW OF PHARMACOLOGICAL STUDIES

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ABSTRACT
Begonia, which is widely known as a traditional medicinal plant by the people of Morowali Regency, Central Sulawesi, Indonesia, is an herb that comes from the *Begoniaceae* family. Currently, many studies have proven that the *Begonia* genus has several pharmacological activities, including antifungal, antibacterial, anti-oxidant, antiviral, analgesic, anti-diarrheal, and anticancer. Currently, there is no detailed evaluation report regarding the potential to show the effectiveness of plants from the genus *Begonia*; therefore, this review article discusses the potential pharmacological activity of plants from the genus *Begonia*.

KEYWORDS: *Begonia*, Pharmacological studies, Antifungal, Antibacterial, Antioxidant, Antivirus, Analgesic, Anti-diarrheal, Anticancer.

INTRODUCTION
Medicinal plants have served as medicinal tools for the management of acute and chronic diseases since ancient times.[1] More than 300 plants have been recognized as having therapeutic potential.[2] The use of medicinal plants continues to increase throughout the world, is the first choice in the treatment of various diseases, and has the lowest side effects.[3,4] *Begonia* is a genus of *Begoniaceae* that grows and is distributed locally in several areas in Central Sulawesi, Indonesia, and is generally known as "Benalu Batu".[5] This plant is easily recognized because it has distinctive characteristics, such as upright, bushy, or creeping grass, with hairy stems and unevenly shaped leaves.[6] *Begonia* genus is reported to have various antifungal, antibacterial, antioxidant, antiviral, analgesic, anti-diarrheal, and anticancer properties.[7] Currently, there is no detailed evaluation report regarding the potential to show the effectiveness of plants from the genus *Begonia*; therefore, this review article discusses the potential pharmacological activity of plants from the genus *Begonia*.

TAXONOMIC CLASSIFICATION
Kingdom : Plantae
Sub Kingdom : Viridiplantae
Infa Kingdom : Streptophyta
Devision : Tracheophyta
Super Division : Embryophyta
Class : Magnoliopsida
Sub Class : Dilleniidae
Ordo : Violales
Famili : *Begoniaceae*
Genus : *Begonia*

PHARMACOLOGICAL STUDIES
Antifungal
Antifungals are agents that can prevent fungal growth. Antifungal has two meanings, namely fungicide and fungistatic. Fungicides are defined as compounds that can kill fungi, while fungistatics can inhibit the growth of fungi without killing them.[8] Ngazizah et al., reported that *Begonia hirtella* inhibited the growth of *Candida albicans* at concentrations of 250, 300, 350, 400, 450, and 500 µg/mL.[9] The antifungal effect of *B. hirtella* is that the terpenoid compounds contained in it are fat-soluble, so they can penetrate the fungal cell membrane, affect its permeability, and cause disruption to the structure and function of the cell membrane.[10]

Antibacterial
Infectious diseases are a cause of death and development in developing countries, including Indonesia. The source of transmission can be identified through vectors, namely air, anvectorsobjects, and also humans themselves.[11] In Indonesia, bacterial infections are still an infectious disease and are also the leading cause of death in children under 5 years of age. Bacterial infections are also the cause of death in children under 1 year by 31%

and in children aged 1-4 years by 25%.[12] Currently, there is a lot of excessive use of antibiotics and improper use, which can cause resistance, so alternative treatments are needed,[13] one of which is using plants from the genus *Begonia*. Jeeva and Antonisamy reported that *Begonia floccifera* at a concentration of 125µg/mL inhibited the growth of *Bacillus cereus*, *Staphylococcus aureus*, *Escherichia coli*, *Proteus mirabilis*, and *Klebsiella pneumonia*. Even though, it is preliminary research, the results of this research can provide information for further research regarding *B. floccifera* as a plant that has antibacterial potential.[14]

Antioxidant

The shift in people's lifestyles to become practical and instantaneous, especially in fulfilling needs such as instant food or fast food, can trigger the formation of free radical compounds.[15] Free radicals are molecules that lose electrons so that the molecule becomes unstable and tries to return electrons from other molecules or cells.[16, 17] In the body, free radicals are very reactive and can interact through destructive oxidation reactions with certain body parts and cells, which are composed of protein, fat, DNA, carbohydrates, and RNA, thereby triggering the development of various chronic degenerative diseases, including coronary heart disease, cancer, and aging.[18,19] Cell damage caused by these radicals can become more extensive due to the weakening of the cellular antioxidant defense system. All biological systems have built-in antioxidant defense mechanisms that remove damaged molecules, but these mechanisms can be inefficient. Therefore, the intake of antioxidant foods is very important to protect cells from damage caused by free radicals.[20,21] *Begonia* medicalis plant is reported to have potent antioxidant activity, with IC_{50} ranging from 2.61-8.26 µg/mL.[22] Apart from that, *Begonia barbata* plant also showed very strong antioxidant activity, with an IC_{50} of 6.22 µg/mL for the dichloromethane fraction, an IC_{50} of 8.29 µg/mL for the ethyl acetate fraction, and an IC_{50} of 29.92 µg/mL for the petroleum-ether fraction.[23]

Antiviral

Viral infections affect three to five million patients each year. Medicinal plants have been used for medicinal purposes since ancient times and are known for their antiviral properties and more tolerable side effects, providing an alternative to commonly used antiviral drugs that often show limited efficacy and serious side effects. Therefore, treatment based on medicinal plants can be an appropriate alternative for treating viral diseases.[24-26] *Begonia medicinalis* plant was reported to have potent antiviral activity on MT-4 cells infected with HIV, with an IC_{50} of 0.04 µg/mL.[22] Therefore, the results of this report can support the application of *B. medicinalis* as herbal medicine with antiviral properties.

Analgesic

Pain can be defined as an unpleasant sensory and emotional experience associated with actual or potential tissue damage.[27] Noxious stimuli usually initiate pain and transmit it through special nerve networks to the central nervous system, where it is interpreted as pain.[28] Currently, there are many types of traditional medicinal plants used to treat pain, one of which is *Begonia barbata* plant. Several studies showed that giving 200 and 400 mg/kg of *B. barbata* to mice that were in pain from heat and acetic acid could lower their pain perception.[23] The analgesic effect of *B. barbata* is thought to be because this plant can inhibit the production of prostaglandins, which cause pain.[23]

Anti-diarrheal

Diarrhea is defined as three or more loose stools associated with abnormally loose or liquid stools. In addition, stool frequency, consistency, and weight are also taken into account to identify diarrhea.[29] Currently, treatment of diarrhea is limited by contraindications to unsafe antidiarrheal drugs, ineffectiveness, and/or the development of resistance.[30] Medicinal plants are the most important and sometimes the only source of treatment for diarrhea. Because medicinal plants are culturally accepted, easily accessible, and cheap compared to modern medicine.[30,31] Haque et al., reported that *B. barbata* administration at doses of 200 and 400 mg/kg inhibited castor oil-induced diarrhea in mice. The antidiarrheal effect of the *B. barbata* plant may be due to the phenolic content it contains,[23] such as flavonoids, which can inhibit intestinal motility and hydroelectrolytic secretion,[32] and tannins, which can change the properties of proteins in the intestinal mucosa by forming tannate proteins, which can reduce secretion and also reduce intracellular Ca^{2+} influx or activation of the calcium pumping system, thereby inducing muscle relaxation.[33]

Anticancer

Researchers have widely explored drug development using natural products,[34] and often utilize these natural products in cancer research. Plants play an important role in the medicinal system for treating diseases through their herbal compounds, either in single or combined form.[35, 36] Several plants have provided useful drugs for the treatment of various types of cancer,[37] one of which is *Begonia medicinalis*. Administration of *B. medicinalis* was reported to be effective in killing several cancer cells with an LC_{50} for cervical cancer (HeLa) cells of 289.69 µg/mL, breast cancer cells (MDA-MB) of 1753.57 µg/mL, and colon cancer cells (HT-29) of 154.17 µg/mL.[38]

CONCLUSION

The use of herbal medicines is currently growing, including pharmacological practices that can prevent and treat disease. Through the exploration of plant biopharmaceuticals and nutraceuticals, herbal medicines have reached the international market. Several plants of *Begonia* genus exhibit versatility through a number of pharmacological activities. Information about currently existing plants of *Begonia* genus can be used as basic

data for further research to discover the active compounds contained and newer and more complete pharmacological activities.

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