

Therapeutic Effects of *Boesenbergia rotunda*

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Abstract: *Boesenbergia rotunda* (L.) (Fingerroot), formerly known as *Boesenbergia* or *Kaempferiapandurata* (Roxb). Schltr. (Zingiberaceae), is distributed in south-east Asian countries, such as Indonesia, Malaysia and Thailand. The rhizomes of this plant have been used for the treatment of peptic ulcer, as well as colic, oral diseases, urinary disorders, dysentery and inflammation. As people have started to focus more on natural plants species for their curative properties. *B. rotunda* is a native ingredient in many Asian countries and is used as a condiment in food. It is also used as traditional medicine to treat several illnesses, consumed as traditional tonic especially after childbirth, beauty aid for teenage girls, and as a leukorrhea preventive remedy for women. Its fresh rhizomes are also used to treat inflammatory diseases, in addition to being used as an antifungal, antiparasitic, and aphrodisiac among Thai folks. Moreover, AIDS patients self-medicate themselves with *B. rotunda* to cure the infection. With the advancement in technology, the ethnomedicinal usages of herbal plants can be explained through in vitro and in vivo studies to prove the activities of the plant extracts. The current state of research on *B. rotunda* clearly shows that the isolated bioactive compounds have high potential in treating many diseases.

Keywords: Zingerberaceae, anti fungal, anti parasitic, Chalcones, flavonoids.

1. Introduction

Boesenbergia rotunda is a ginger species that grows in Southeast Asia, India, Sri Lanka, and Southern China. This species belongs to the family of Zingiberaceae. It was previously categorised under the *Kaempferia* genus by Baker. However, it is now classified under the *Boesenbergia* genus [1]. *B. rotunda* is a common edible ingredient in many Asian countries such as Malaysia, Thailand, Indonesia, India, and China. It is normally cultivated at small home ranches and used as a condiment in food such as curry and soup due to its aromatic flavour, which promotes appetite [2]. The fresh rhizome has a characteristic aroma and slightly pungent taste [3].

B. rotunda offers many important health benefits, for instance, relief of stomachache, anti-flatulence, the eradication of ringworm and the promotion of appetite [4,5]. Bioactive compounds from rhizome extracts have been identified and classified mainly into two major groups, avanones (e.g., alpinetin, pinostrobin, and pinocembrin) and chalcones (e.g., boesenbergin, cardamonin, panduratin A, and 4-hydroxypanduratin A) [6,7,8]. Flavonoid compound named pinostrobin, three flavanones, pinostrobin, pinocembrin and alpinetin and two chalcones, cardamonin and boesenbergin A were isolated from the rhizomes of *B. rotunda* [9].

As regards its biological activities, the rhizomes of this plant have been used for the treatment of oral diseases, colic and gastrointestinal disorder, diuretic, dysentery, inflammation and aphrodisiac [10]. Extract obtained from the perennial herb *Boesenbergia rotunda* (BR) are used for treating human disorders in organs, but other than the liver [11].

Phytochemistry:-

This plant has been identified to contain various essential oils (EOs) and also several flavonoid compounds that have demonstrated many biological activities. Most of its flavonoids have unique features with some prenyl substituents integrated in their main structures. A

panduratin derivative are prenylated flavonoids from *B. pandurata* that showed broad range of biological activities, such as strong antibacterial activity [9-11], anti-inflammatory, and anti-cancer.

Flavonoids:

2',4'-dihydroxy-6'-methoxy chalcone 14 and a major chalcone in *B. pandurata* rhizome 15; pinocembrin chalcone, a known 2',4',6'-trihydroxychalcone 15; helichrysetin, a known 2',4',4'-trihydroxy-6'-methoxychalcone all these comes under unprenylated flavonoids. 2',4'-dihydroxy-3'-(1'-geranyl)-6'-methoxychalcone and (1'R,2'S,6'S)-2-hydroxyisopanduratin A, and several known prenylated chalcones, namely (\pm)-6-methoxypanduratin A, and (-)-nicolaioidesin B all these comes under prenylated flavonoids [12,13,14]

Essential oil:

The major compounds of EOs that were isolated by various methods and solvents were - terpinene, geraniol, camphor, -ocimene, 1,8-cineole, myrcene, borneol, camphene, methyl cinnamat, terpineol, geranial and neral [15,16,17]. Some EOs were also presented but in very small amounts, such as nerolidol, citral, limonene, and 11-dodecen-1-ol [18]

Miscellaneous compounds:

There are various miscellaneous compounds were found in *B. rotunda*. dihydro-5,6-dehydrokawain and 5,6-dehydrokawain, a new prenylated phenylbenzoic acid, geranyl-2,4-dihydroxy-6-phenethylbenzoate [19] and a known compound, 2,4-dihydroxy-6-phenethylbenzoic acid methyl ester [20]. Two new compounds from prenylated prenylpropanoids, panduratin H were also found in rhizome of *B. rotunda* [21].

Therapeutic effects:-

Over the years, using various approaches and technologies, researchers have successfully isolated an array of bioactive compounds from *B. rotunda*.

Antimicrobial activities:-

Helicobacter pylori is a prominent Gram-negative bacteria that causes gastritis, dyspepsia, and peptic ulcer and has been linked to the development of gastric and colon cancer. Widespread claims of the antimicrobial activities of *B. rotunda* prompted scientists to further evaluate the potential of this plant in preventing the infection of *H. pylori* [22]. *B. rotunda* contain essential oil, boesenbergin, cardamonin, pinostrobin, 5, 7-dimethoxy avone, 1, 8-cineole, and also panduratin. *B. rotunda* extract has strong antibacterial activity against oral bacteria, enterococci and staphylococci [23-25].

Pathogenic bacteria are a group of bacteria that induce diseases in humans and plants. Spoilage bacteria are another group of bacteria that cause food spoilage through fermentation and decomposition of food products. There has been a rising concern pertaining to food safety and diseases caused by these pathogenic microorganisms, and hence, a renewed interest in finding new antimicrobial agents to combat these pathogens.

The MIC value for all plant extracts was between 8 and 10% (v/v) against Gram-negative bacteria, while fingerroot showed the highest inhibitory activity against three pathogenic bacteria; *L. monocytogenes*, *B. cereus*, and *S. Aureus*. Meanwhile, galangal extract showed strongest inhibition against spoilage bacteria *L. plantarum* and *L. cellobiosus*. Both galangal (at 8% (v/v)) and fingerroot (at 10% (v/v)) exhibited bactericidal effect against *E. coli* population at 36 and 9 hours, respectively, while 8% (v/v) turmeric extract showed bacteriostatic effect [26]. *Panduratin A* of *B. rotunda* was also found to possess antimicrobial activity against *Staphylococcus* strains with both comparable to the most potent antibiotic, vancomycin [27].

Antiparasitic activity:-

The inhibitory activity of *B. rotunda* against *Giardia lamblia*, a protozoan parasite that causes giardiasis has been discussed here. Giardiasis is the inflammation of the small intestine which causes diarrhoea and nutrient deficiencies, although this parasitic infection can cause chronic diarrhoea in HIV patients. The chloroform extracts of *B. rotunda* and five other herbs, which were *Alpinia galanga*, *Eclipta prostrata*, *Piper betle*, *Piper chaba*, *Zingiber zerumbet*, and the methanol extracts of *B. rotunda* and *E. prostrata A. galanga* (chloroform extract) had the highest inhibition activity with an MIC [28]. The Finger root of *cBoesenbergia rotunda* contains 1-3% of essential oil. Several aroma components from its rhizomes contained high levels of 1-8 cineol, camphor, q-borneol, methyl cinnamate, gera- niol, and camphene being the most important. Trace components are q-pinene, zingiberene, zingiberone, curcumin, and zedoarin [28].

Oral infection:-

Biofilm formation on teeth surfaces is caused by multiple species of oral bacteria, the primary colonisers being mutant *Streptococci* [29]. Biofilm formation is associated with several acute and chronic infections such as dental caries, gingivitis, and periodontitis and potentially contributes to antibiotic treatment failure against *Streptococcus*

pyogenes [30,31]. A study conducted by Yanti *et al.* on the ethanolic extract of *B. rotunda* revealed the suppressive effect of this extract on the expression of matrix metalloproteinases (MMPs) 2 and 9, both of which are over expressed by gingival fibroblasts that are activated by *Porphyromonas gingivalis* during chronic periodontitis [32]. In 2009, the study conducted by Yanti *et al* shows that bacterial biofilms are comprised of micro colonies surrounded by a rigid inter microbial matrix for barrier protection. *B. rotunda* might disrupt biofilm cells at the outer edge of the biofilm that are in direct contact with the agent, this releases the dead cells to the periphery [33]. *C. albicans* is a diploid fungus responsible for oral thrush or oral candidiasis and is a common infection observed in HIV patients. Several studies have demonstrated the potential antifungal role of *B. rotunda* in inhibiting *C. albicans* growth. A study conducted by Cheeptham and Towers [34].

Obesity Treatment

Boesenbergia rotunda (L) Mansf. has been used for the treatment of gastrointestinal disorders including peptic ulcer [35]. *Boesenbergia rotunda*, previously determined to be a novel natural AMP-activated protein kinase (AMPK) activator. The activation of AMPK will increase the fatty acid oxidation by activating fatty acid oxidation-related genes. This process will prevent lipid synthesis via reduction of sterol regulatory element-binding protein-1c (SREBP-1c) and PPAR γ phosphorylation. When 50mg/kg/day of *panduratin A* was applied, it showed increased fatty acid oxidation, resulting in weight loss, and reduced fat pad mass as observed in the in vivo obese mouse model. Moreover, these mice showed reduction in fatty liver and an improvement in the serum lipid profiles. Myofibre proportion and mitochondria content in muscles were significantly increased, enhancing running endurance [36].

Antioxidant activities

Molecular oxygen plays a central role in the pathogenesis and therapy of the wound. The overproduction of reactive oxygen species (ROS) results in oxidative stress, thereby causing cytotoxicity and delayed wound healing. Therefore, eliminating ROS could be an important strategy to heal chronic wounds. The *B. rotunda* extract was screened for its possible antioxidant activity through two methods, DPPH and FRAP assays. The DPPH free-radical scavenging activity of the *B. rotunda* extract was not as strong as the potent antioxidants, vitamin E and butylated hydroxytoluene. However, these results indicate that the *B. rotunda* ethanolic extract exhibited moderate antioxidant activity toward scavenging free radicals [37].

Wound healing

Over 80% of the world's population depends upon traditional medicine to treat various skin problems, including wound infections [38]. The ethnomedical use of plant preparations in rural areas for treating wounds is reported for plants from South Africa, Turkey [39], Vietnam, and Thailand [40]. A wound is the disruption of the cellular and anatomic continuity of tissue [41]. All wounds disrupt the local environment and the homeostasis within the tissue, which results in bleeding, the contraction of vessels, coagulation, the activation of tissue complement, and other inflammatory responses [42].

Antifungal activity

C. albicans is generally accepted to be an opportunistic fungus which is the most frequent cause of denture stomatitis in denture wearing patients. *C. albicans* possesses various virulence factors, such as the secretion of proteolytic enzymes and the ability to inhibit the immune defense of the host, giving it a growth advantage over other yeasts [43]. The reduction of *C. albicans* adhesion on acrylic surfaces by *B. pandurata* extract may be explained in several ways. Firstly, an important factor affecting candidal adhesion is the surface free energy of acrylic as this may be interfered with the extract components adsorbed [44]. Another factor influencing the adhesion is the cell surface hydrophobicity of the microorganism. It may be speculated that *B. pandurata* extract establishes changes in cell surface properties of the yeasts, such as interfering with the production of extracellular matrix or a fibrillar floccular layer, leading to modulation of the cell surface hydrophobicity [45].

2. Conclusion

B. rotunda is a native ingredient in many Asian countries and is used as a condiment in food. It is also used as traditional medicine to treat several illnesses, consumed as traditional tonic especially after childbirth, beauty aid for teenage girls, and as a leukorrhea preventive remedy for women. Its fresh rhizomes are also used to treat inflammatory diseases, in addition to being used as an antifungal, antiparasitic, and aphrodisiac among Thai folks. Its leaves are used by locals to alleviate food allergic and poisoning. Moreover, AIDS patients self-medicate themselves with *B. rotunda* to cure the infection. With the advancement in technology, the ethnomedicinal usages of herbal plants can be explained through in vitro and in vivo studies to prove the activities of the plant extracts. The current state of research on *B. rotunda* clearly shows that the isolated bioactive compounds have high potential in treating many diseases. With the development of medicinal chemistry and bioinformatics, we are well on our way to successfully develop plant-based drugs. Molecular progressions further encourage scientists to delve deeper into the biosynthetic pathways of *B. rotunda* bioactive compounds to obtain a bigger picture of the whole process, which in turn could accelerate the development of better and stronger drugs to counter the diseases in the future.

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4. Conflict of Interest

nil

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