



Biological Activities of Different Species of the Genus *Phyllostachys*

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Abstract

The Genus *Phyllostachys* (bamboo) is widespread all over the world. Through history, bamboo has been an important source of food and medicine in China and South East Asia. Almost all parts of the bamboo plant such as rhizome, culm and bark shaving, shoots, leaves, roots and seeds are having clinical applications. Recently, bamboo gained attention around the world because of its nutritive and therapeutic values and the important role it plays in the food, pharmaceutical and cosmeceutical industry. Bamboo leaves and shoots have tremendous therapeutic potential and can provide health care in a safe and eco-friendly way. In this review, we summarize the most important biological activities of different species of the genus *Phyllostachys*.

Keywords: *Phyllostachys*; different species; biological activities.

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Introduction

Traditional medicine around the world is extensively based on herbal medicine. The use of the whole extract or the active ingredients obtained from plants have long been used before the discovery of modern medicine. (Mathur & Hoskins, 2017). Accordingly, exploration and pharmacological screening of the active ingredients isolated from plants can provide us with the basis for developing lead molecules through the discovery of herbal drugs. (Koparde *et al.*, 2019). Plants are the most important source of natural medicine, because of their chemical and structural diversity and the biodiversity of their components. Till now, plants are considered as the most important source of novel biologically active compounds which are isolated from plants or even semi-synthesized from naturally derived ingredients. Despite the current obsession with synthetic chemistry as a vehicle for important drug

development and processing, the contribution of plants to the treatment and prevention of diseases is still enormous. 11% of drugs considered as basic and essential by the world health organization (WHO) were solely of flowering plant origin. (Veeresham, 2012).

Bamboo plant is commonly used in folk medicine for their antipyretic, anti-inflammatory, and diuretic effect (Chongtham *et al.*, 2011). The therapeutic use of bamboo leaves for treating arteriosclerosis, hypertension, cardiovascular disease, and cancer have been also reported (Park *et al.*, 2007). Additionally, antioxidant and angiotensin-converting enzyme inhibition activity were also proven (Park *et al.*, 2010; Zhang *et al.*, 2008). In this review we will summarize the most important reported biological activities of different species of the genus *Phyllostachys*.



Phyllostachys viridiglaucescens



Phyllostachys nigra



Phyllostachys edulis



Phyllostachys heterocykla



Phyllostachys bambusoides



Phyllostachys prominens

Figure 1: Photos of selected species of the genus *Phyllostachys* which possess proved biological activities (<https://www.gardenia.net/plant/phyllostachys>)

Table 1. Biological activities reported in genus *Phyllostachys*:

I- Anticancer activity			
Active Compounds / extracts	Details	Species	Reference
Tricin flavonoid	<i>in vitro</i> activity against human-derived malignant MDAMB-468 breast cancer cells and human MDA-MB-468 breast cancer cells.	<i>P. nigra</i> var. <i>henonis</i>	(Hudson <i>et al.</i> , 2000; Cai <i>et al.</i> , 2004; Jiao <i>et al.</i> , 2007)
Ethanol extract	Potent effect against the development of 7,12 dimethylbenz[a]anthracene (DMBA)-induced breast cancer model in female rats.	<i>P. edulis</i>	(Lin <i>et al.</i> , 2008)
II- Antibacterial and Antimicrobial activity			
2,6-dimethoxy- <i>p</i> -benzoquinone	Activity against Gram-positive bacteria	<i>P. heterocycla</i> var. <i>pubescens</i>	(Nishina <i>et al.</i> , 1991)
Supercritical CO ₂ Extract	Antimicrobials and antioxidants as ethoxyquin, a sesquiterpene, and a cyclohexanone derivative were identified.	<i>P. heterocycla</i>	(Quitain <i>et al.</i> , 2004)
Two peptides Pp-AMP 1 and Pp-AMP 2	Antimicrobial activities against some pathogenic bacteria and fungi	<i>P. pubescens</i>	(Fujimura <i>et al.</i> , 2005)
The essential oils obtained by steam distillation	Active against <i>Staphylococcus epidermidis</i> and <i>E. coli</i>	- <i>P. heterocycla</i> cv. <i>Pubescens</i> - <i>P. heterocycla</i> cv. <i>Gracilis</i> , - <i>P. heterocycla</i> cv. <i>Heterocycla</i> - <i>P. kwangsiensis</i>	(Jin <i>et al.</i> , 2011)
Dichloromethane extract	Antibacterial activity against <i>Staphylococcus aureus</i>	<i>P. pubescens</i>	(Tanaka <i>et al.</i> , 2011)
• Stigmasterol. • Dihydrobrassicasterol.	Inhibited the growth of <i>Staphylococcus aureus</i> .	<i>P. pubescens</i>	(Tanaka <i>et al.</i> , 2013)
Ethanol and the hot water extracts	Antibacterial activity against <i>Staphylococcus aureus</i>	<i>P. pubescens</i>	(Tanaka <i>et al.</i> , 2014)
• Tricosane, cedrol. • Hexadecanoic acid.	Antibacterial activities against Gram-negative bacteria <i>Escherichia coli</i> , Gram-positive bacteria <i>Bacillus subtilis</i> and <i>Saccharomyces cerevisiae</i> .	<i>P. heterocycla</i> cv. <i>pubescens</i>	(Tao <i>et al.</i> , 2018)
Essential oils from leaves	Effect against Gram-positive (<i>Bacillus subtilis</i> and <i>Staphylococcus aureus</i>) and Gram-negative	<i>P. heterocycla</i> cv. <i>pubescens</i>	(Tao <i>et al.</i> , 2019)

	(<i>Escherichia coli</i>) bacteria and yeast (<i>Saccharomyces cerevisiae</i>) by causing disruption to the membrane integrity of the pathogen.		
Water-soluble neutral polysaccharides	Growth inhibition against <i>E. coli</i> , <i>S. aureus</i> and <i>B. subtilis</i>	<i>P. pubescens</i> Mazel	(Xiao et al., 2020)
III- Antioxidant activity			
<ul style="list-style-type: none"> • Tricin • Taxifolin 	Antioxidative activity was evaluated by the peroxide value (POV) method.	<i>P. pubescens</i>	(Katsuzaki et al., 1999)
<ul style="list-style-type: none"> • Chlorogenic acid. • Caffeic acid. • Luteolin-7-glucoside 	Antioxidant activity related to free radical scavenging activity while the prooxidant activity resulted from the reducing power of extract phenolic compounds in presence of transitional metal ions.	<i>P. nigra</i> Var. <i>Henonis</i>	(Hu et al., 2000)
<ul style="list-style-type: none"> • 3-<i>O</i>-(3'-methylcaffeoyl) quinic acid. • 5-<i>O</i>-caffeoyl-4-methylquinic acid. • 3-<i>O</i>-caffeoyl-1-methylquinic acid. 	Strong antioxidant activity measured by scavenging the stable 1,1-diphenyl 1-2-picrylhydrazyl (DPPH) free radical and the superoxide anion radical (O ²⁻) in the xanthine/xanthine oxidase assay system.	<i>P. edulis</i>	(Kweon et al., 2001)
Phyllostadimer A	Strongly inhibited liposomal lipid peroxidation	<i>P. edulis</i>	(Suga et al., 2003)
Lignophenol derivatives	Potent neuroprotective activity against oxidative stress	<i>P. bambusoides</i>	(Akao et al., 2004)
<i>n</i> -butanol soluble extract	Strong antioxidant activity measured by scavenging the stable DPPH free radical	<i>P. pubescens</i> <i>P. bambusoides</i>	(Mu et al., 2004)
Supercritical CO ₂ Extract	Antimicrobials and antioxidants as ethoxyquin, a sesquiterpene, and a cyclohexanone derivative were identified.	<i>P. heterocycla</i>	(Quitain et al., 2004)
Luteolin 6- <i>C</i> -(6''- <i>O</i> - <i>trans</i> -caffeoyl)glucoside)	Antioxidative activity measured in Photochem [®] apparatus	<i>P. nigra</i>	(Jung et al., 2007)
<ul style="list-style-type: none"> • Orientin. • Homoorientin. • Vitexin. • Isovitexin. 	Strong antioxidant activity and inhibitory efficacy on transition metal ions and <i>in vitro</i> free radicals inducing deterioration of macromolecules.	<i>P. nigra</i> var. <i>henonis</i>	(Hu, et al., 2000; Zhang et al., 2008)
Ethyl acetate and butanol fractions of	High antioxidant activity using a 2,2- diphenyl-1-	<i>P. pubescens</i>	(Park et al., 2010)

methanolic extract	picrylhydrazyl (DPPH) radical scavenging assay	<i>P. nigra</i>	
Luteolin 6-C-(6''-O-trans-caffeoylglucoside)	Significant attenuation of the negative effects of l-buthionine-(S,R)-sulfoximine (BSO) plus glutamate or hydrogen peroxide to RGC-5 cells. Replenishment of the reduced glutathione level.	<i>P. nigra</i>	(Lee et al., 2010)
Bamboo shoot extracts	Strong DPPH radical scavenging activity.	<i>P. pubescens</i> <i>P. nigra</i>	(Park et al., 2011)
The essential oils obtained by steam distillation	Antioxidant activity using a 2,2- diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay	<i>P. heterocycla cv. Pubescens</i> <i>P. heterocycla cv. Gracilis</i> - <i>P. heterocycla cv. Heterocycla</i> - <i>P. kwangsiensis</i>	(Jin et al., 2011)
Water extracted polysaccharides	Strong inhibitory effects on superoxide radical and hydroxyl radical.	<i>P. edulis</i>	(Zhang et al., 2011)
<ul style="list-style-type: none"> • Trans-coniferyl alcohol. • <i>p</i>-coumaric acid. • <i>n</i>-feruloyl serotonin. • Caffeic acid ethyl ethe. • Tricin. • Coumaryl alcohol. • Coumaric acid ethyl ether. • Ferulic acid ethyl ether 	Significant DPPH radical scavenging Ability.	<i>P. nigra</i>	(Shang et al., 2014)
Ethanol extracts and the hot water extracts	Antioxidant activity measured by the following assays: The ORAC assay which is based on hydrogen atom transfer reactions, The ABTS inhibition rates which are based on the electron-transfer ability of the sample's components and SOD-like activity which is based on the antioxidative enzyme-like activity of the sample's components.	<i>P. pubescens</i>	(Tanaka et al., 2014)
<ul style="list-style-type: none"> • Amarusine A. • 5-O-caffeoylquinic acid, 3,5,3',5'- 	The DPPH (1,1-diphenyl-2-picrylhydrazyl) assay showed radical scavenging activity	<i>P. prominens</i>	(Xu et al., 2016)

<p>tetramethoxy-4-hydroxyl-(8-O-cinnamyl alcohol)-7-O-glucoside.</p> <ul style="list-style-type: none"> • 4, 4', 9'-trihydroxyl-3, 5, 3', 5'-tetramethoxy-7, 7'-monoepoxylignan-9-O-glucoside. • 3,5- dimethoxy-4,4'-dihydroxyl-9-O-benzylacrylicester-phenylpropano-7-O-glucopyranoside. • Luteolin-7-O-glucoside. • Luteolin-8-C-α-L-arabinose. • Isoorientin. • Tricin-7-O-β-D-glucoside. • Tricin-5-O-β-D-glucoside. • Isovitexin-2''-xylopyranoside. 			
Water-soluble neutral polysaccharides	DPPH and ABTS free radical scavenging rate assays exhibited high antioxidant activity	<i>P. pubescens</i> Mazel	(Xiao et al., 2020)
IV- Hypolipidemic effect			
Bamboo shoot oil (BSO)	Significant decrease in the levels of total cholesterol, triacylglycerol, low-density lipoprotein-cholesterol, phytosterol, lipoprotein lipase, hepatic lipase and atherogenic index in serum.	<i>P. pubescens</i> <i>P. nigra</i>	(Lu et al., 2010)
Triterpenoid-rich extract from bamboo shavings (EBS)	Reduction of the serum total cholesterol (TC) and total triglyceride (TG) levels.	<i>P. nigra</i> var. <i>henonis</i>	(Jiao et al., 2007)
V- Hypoglycemic and antidiabetic activity			
Luteolin 6-C-(6''-O-trans-caffeoylglucoside)	Strong aldose reductase and advanced glycation end products inhibition	<i>P. nigra</i>	(Jung et al., 2007)
Arabinogalactan (PBSS2)	<i>In vitro</i> Caco-2 cells assay exhibited inhibition in glucose absorption in time dependent manner at a relative high concentration.	<i>P. heterocycla</i>	(Liu et al., 2018)

VI- Cardiovascular activity			
Orientin	Significant potent cardioprotective effect on I/R- and H/R-treated myocardium and cardiomyocytes.	<i>P. nigra</i>	(Fu <i>et al.</i> , 2006)
<ul style="list-style-type: none"> • Triterpenoid-rich extract from bamboo shavings (EBS). • Friedelin. 	Reduction in the systolic pressure of spontaneously hypertensive rats without affecting heart rate.	<i>P. nigra var. henonis</i>	(Jiao <i>et al.</i> , 2007)
Methanolic extract	Significant ACE inhibitory activity	<i>P. pubescens</i> <i>P. nigra</i>	(Park <i>et al.</i> , 2010)
VII- Prebiotic activity			
Water-soluble heteropolysaccharides-protein complexes	Increasing the numbers of <i>Bifidobacterium adolescentis</i> and <i>Bifidobacterium bifidum</i> , which contribute to production of organic acids.	<i>P. praecox</i>	(He <i>et al.</i> , 2016)
VIII- Melanin-biosynthesis-inhibition activity			
Ethanol extracts and the hot water extracts	Significant inhibition on melanin biosynthesis and cell proliferation of B16 melanoma cells	<i>P. pubescens</i>	(Tanaka <i>et al.</i> , 2014)
IX- Anti-Allergy Activity			
Ethanol extracts and the hot water extracts	Significant inhibition of the production of IgE in Peripheral Blood Lymphocytes.	<i>P. pubescens</i>	(Tanaka <i>et al.</i> , 2014)
X- Anti-Inflammatory Activity			
Leaf extract and isoorientin	High anti-inflammatory activity was examined on tumor necrosis factor alpha-induced overproduction of interleukin 8, vascular endothelial growth factor, interleukin 6 in immortalized human keratinocytes. wound-healing effects were evaluated in 3T3-swiss albino mouse fibroblasts.	<i>P. edulis</i>	(Wedler <i>et al.</i> , 2014)

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