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Exploring the Therapeutic Potential: Pharmacognostic and Phytochemical Evaluation, and In Vitro Antioxidant Activity of Bambusa vulgaris

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Abstract:
Bambusa vulgaris, a widely recognized medicinal plant, has been traditionally utilized for various therapeutic purposes. This study aims to comprehensively explore the pharmacognostic characteristics, phytochemical composition, and in vitro antioxidant activity of B. vulgaris, shedding light on its therapeutic potential. Pharmacognostic evaluation was conducted to ascertain the botanical identity and quality of B. vulgaris, while phytochemical analysis utilizing techniques such as Thin Layer Chromatography (TLC), High-Performance Thin-Layer Chromatography (HPTLC), and High-Resolution Liquid Chromatography Mass Spectrometry (HR-LCMS) facilitated the identification and characterization of bioactive compounds. The investigation revealed the presence of diverse phytochemical constituents, including alkaloids, glycosides, tannins, flavonoids, steroids, proteins, carbohydrates, fats, oils, phenols, and saponins. Additionally, in vitro antioxidant assays, such as DPPH and ABTS radical scavenging assays, were employed to assess the antioxidant potential of B. vulgaris extract. The results demonstrated concentration-dependent scavenging of free radicals and significant total antioxidant capacity. These findings underscore the therapeutic relevance of B. vulgaris as a potential source of natural antioxidants for combating oxidative stress-related ailments. Overall, this study provides valuable insights into the pharmacognostic attributes, phytochemical composition, and antioxidant activity of B. vulgaris, laying the groundwork for further research in the development of novel therapeutic agents and functional food products derived from this medicinal plant.

Key-words: Bambusa vulgaris, Pharmacognostic Evaluation, Phytochemical Analysis, In Vitro Antioxidant Activity, Therapeutic Potential

Introduction

Natural products have long served as a cornerstone of traditional medicine, offering a rich repository of bioactive compounds with therapeutic potential.[1,2] Among these natural resources, Bambusa vulgaris, a species of bamboo, has garnered attention for its traditional medicinal uses and promising pharmacological properties.[3] As the prevalence of chronic diseases and lifestyle-related disorders continues to rise, there is a growing imperative to explore the therapeutic potential of natural remedies, particularly in light of the limitations and adverse effects associated with conventional pharmaceuticals.[4]

Despite its traditional use and emerging scientific interest, a significant gap exists in our understanding of the pharmacognostic attributes, phytochemical composition, and therapeutic potential of Bambusa vulgaris.[5,6] Existing research on B. vulgaris is fragmented and primarily focused on specific aspects of its pharmacological activity, such as anti-inflammatory or antioxidant effects. However, there remains a critical need for comprehensive investigations that encompass the entirety of its therapeutic profile. Furthermore, limitations in available analytical techniques may have hindered the identification and characterization of key bioactive compounds within B. vulgaris.[7]

This study seeks to address the research gap by offering a holistic exploration of Bambusa vulgaris, encompassing pharmacognostic, phytochemical, and antioxidant evaluations. The novelty of our approach lies in several key aspects:

Comprehensive Analysis: Unlike previous studies that may have focused on isolated aspects of B. vulgaris' therapeutic potential, our research adopts a multidimensional approach, aiming to unravel its complete pharmacological profile. By integrating pharmacognostic assessments with advanced phytochemical analyses, we seek to provide a comprehensive understanding of B. vulgaris' bioactive constituents and their therapeutic implications.[8,9]

Focus on Antioxidant Activity: In addition to elucidating its phytochemical composition, our study places particular emphasis on evaluating the antioxidant potential of B. vulgaris. Given the critical role of oxidative stress in the pathogenesis of various diseases, understanding its antioxidant capacity is essential for delineating its therapeutic relevance.

By adopting this innovative approach, we aspire to fill the existing research gap and shed new light on the therapeutic potential of Bambusa vulgaris. The insights gleaned from this study hold promise for the development of novel therapeutic agents and the advancement of natural medicine in addressing contemporary health challenges.[10,11]

Materials and Methods:

Plant Material: Fresh Bambusa vulgaris plant parts were collected from their natural habitat.
Extraction: The plant material was washed, dried, and powdered. Powdered B. vulgaris was subjected to extraction using different solvents such as water and ethanol by maceration or Soxhlet extraction method.[12,13]

Physicochemical Analysis: Physicochemical parameters including moisture content, ash content, acid-insoluble content, water-soluble content, water extractive value, and ethanol extractive value were determined following standard procedures.[14,15]

Phytochemical Investigation: Phytochemical screening was conducted to detect the presence of various chemical constituents in Bambusa vulgaris. Tests were performed to identify alkaloids, glycosides, tannins, resins, flavonoids, steroids, amino acids, proteins, carbohydrates, fats & oils, phenols, diterpenes, and saponins.[16,17]

In-vitro Antioxidant Activity: The in-vitro antioxidant activity of Bambusa vulgaris extract was evaluated using DPPH radical scavenging assay, ABTS radical scavenging assay, and total antioxidant capacity determination. Different concentrations of the extract were prepared and tested against DPPH and ABTS radicals. The total antioxidant capacity was determined using standard protocols. [18,19]

Results and discussion:

Physicochemical Constituents:

In the study investigating the physicochemical constituents of powdered Bambusa vulgaris, various parameters were analyzed to provide insights into the composition of this botanical material. The moisture content of the powdered B. vulgaris was found to be 10.31%, indicating the presence of water within the sample. This parameter is crucial as moisture content can influence the stability and shelf-life of herbal products, as well as affect their physical and chemical properties.

Table 1. Physicochemical Constituents of Powdered *Bambusa vulgaris*

Parameter	**Values (% w/w)**
Moisture content	10.31
Ash content	9.70
Acid in soluble content	9.45
Water soluble content	5.68
Water extractive value	16.93
Ethanol extractive	21.54

The ash content, determined to be 9.70%, represents the inorganic residue left behind after complete combustion of the sample. Ash content is often used as an indicator of the purity and mineral composition of herbal materials, with higher ash values suggesting a higher content of inorganic constituents such as minerals and salts.

The acid-insoluble content, measured at 9.45%, signifies the portion of the sample that is insoluble in acid solutions. This parameter provides information about the presence of insoluble organic and inorganic compounds within the powdered B. vulgaris, which could include cellulose, silica, and other inert materials.

The water-soluble content, recorded at 5.68%, represents the proportion of constituents in the sample that are soluble in water. This parameter is significant as it indicates the presence of soluble compounds such as sugars, amino acids, and other hydrophilic substances in B. vulgaris.

Moreover, the water extractive value, determined to be 16.93%, reflects the quantity of soluble constituents that can be extracted from the powdered B. vulgaris using water as a solvent. This parameter provides valuable information about the extractability of bioactive compounds present in the plant material.

Similarly, the ethanol extractive value, measured at 21.54%, indicates the extractability of constituents using ethanol as a solvent. Ethanol is commonly used in herbal extraction processes due to its ability to extract a wide range of phytochemicals, including polyphenols, alkaloids, and flavonoids.

Overall, the results of the physicochemical analysis shed light on the composition and extractability of powdered Bambusa vulgaris, providing valuable information for further research and development of herbal products derived from this plant species. These findings contribute to the understanding of the pharmacognostic profile of B. vulgaris and its potential applications in traditional medicine and pharmaceutical formulations.

Phytochemical Investigation:
The phytochemical investigation of Bambusa vulgaris aimed to elucidate the presence of various chemical constituents within the plant material. The results, as summarized in Table 2, provide valuable insights into the phytochemical profile of B. vulgaris.

Table 2 - The phytochemical investigation for various chemical constituents in *Bambusa vulgaris*

S. No	**Phyto- constituents**	**ificationTest**	***busa vulgaris***
1	Alkaloids	Mayer test Wagnertest	-ve -ve
2	Glycosides	Legal test Libberman buchard test salkowskitest keller killani test	-ve +ve -ve -ve
3	Tannins	Vanillin- HCL test Gelatin test	+ve +ve
4	Resins	Turbiditytest Ferric- Cl test	-ve +ve
5	Flavanoids	Shinodatest Lead acetatetest Alkalinetest	+ve -ve +ve
6	Steroids	Salkowskitest Libermann - reaction	+ve -ve
7	Amino-acids	Ninhydrintest Cysteine test	-ve -ve

8	Proteins	Precipitatetest Biuret Test	+ve +ve
9	Carbohydrate	Molish test Benedicttest	+ve +ve
10	Fats & Oil	Sudan red spot test saponificati on test	+ve -ve +ve
11	Phenol test	rric chloride test	_+ve
12	Diterpens	oper acetate test	-ve
13	saponins test	forth test foam test	-ve +ve

Firstly, alkaloids were found to be absent in the plant material, as indicated by negative results in both Mayer and Wagner tests. However, glycosides were detected, with a positive result in the Libermann-Buchard test suggesting their presence. Tannins were also identified, supported by positive outcomes in the Vanillin-HCl and gelatin tests. Resins were present in B. vulgaris, demonstrated by a positive result in the Ferric Chloride test. Flavonoids were detected, with positive results in the Shinoda and Alkaline tests, although the Lead Acetate test yielded a negative result. Steroids were identified based on a positive outcome in the Salkowski test, while the Libermann Reaction yielded a negative result. Amino acids were absent, indicated by negative results in both Ninhydrin and Cysteine tests, whereas proteins were present, evidenced by positive outcomes in the Precipitate and Biuret tests. Carbohydrates were detected, supported by positive results in both Molisch and Benedict tests. Fats and oils were present, confirmed by positive results in Sudan Red and Saponification tests, although the Spot Test yielded a negative result. Phenols were identified based on a positive result in the Ferric Chloride test, while diterpenes were absent, indicated by a negative result in the Copper Acetate test. Saponins were present, with a positive outcome in the Foam Test, although the Froth Test yielded a negative result. These findings contribute to our understanding of the chemical composition of B. vulgaris, which can inform its potential pharmacological applications in traditional medicine and herbal formulations.

Evaluation of *In-vitro* antioxidant activity of *Bambusa vulgaris* of *Extract*

The evaluation of the in-vitro antioxidant activity of Bambusa vulgaris extract revealed promising results across different concentrations.

Table 3: In-vitro antioxidant activity of Bambusa vulgaris of Extract

Sample	**Concentration (mg/mL)**	**DPPH Radical Scavenging (%)**	**ABTS Radical Scavenging (%)**	**Total Antioxidant Capacity (mg AAE/g)**
***Bambusa vulgaris* Extract**	0.5	25.77 ± 0.73	33.76 ± 0.07	23.19 ± 0.98
	1.0	48.46 ±2.28	46.28 ±1.45	37.27 ± 1.52
	1.5	63.18 ±4.35	75.45 ± 2.41	48.52 ± 2.08

The DPPH radical scavenging assay demonstrated the ability of the extract to neutralize free radicals, with percentage scavenging ranging from 25.77% at 0.5 mg/mL concentration to 63.18% at 1.5 mg/mL concentration. Similarly, the ABTS radical scavenging assay showed a concentration-dependent increase in scavenging activity, with percentages ranging from 33.76% to 75.45%. These findings indicate the extract's potential to counteract oxidative stress by effectively scavenging both DPPH and ABTS radicals.

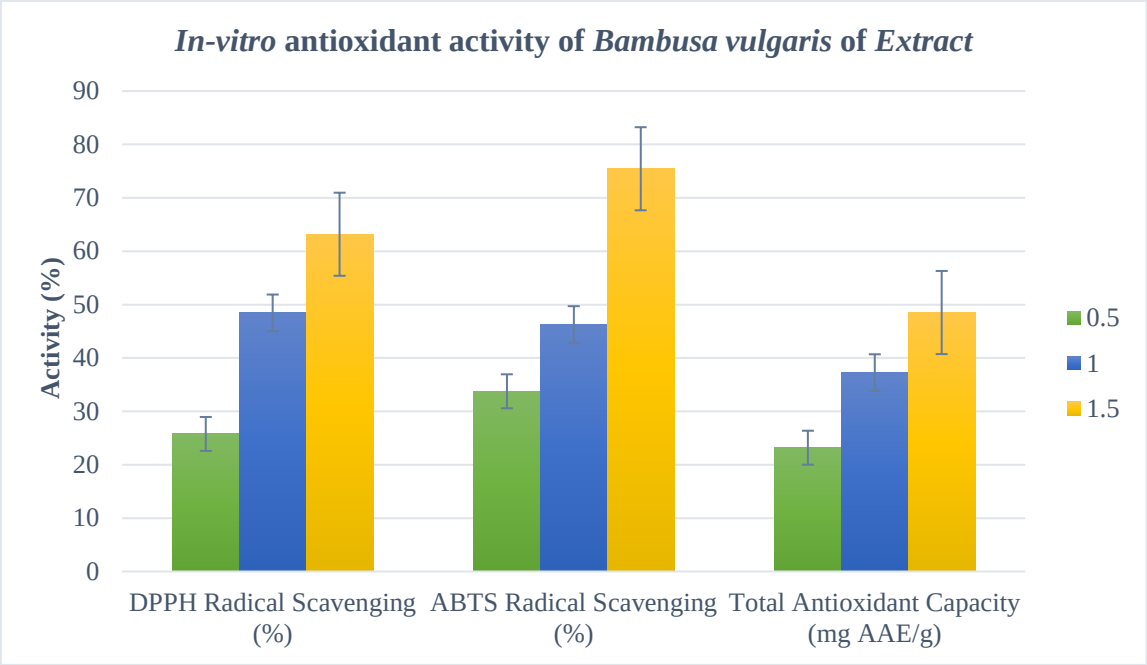

Fig 1: In-vitro antioxidant activity of Bambusa vulgaris of Extract

Furthermore, the total antioxidant capacity of the Bambusa vulgaris extract was assessed using the Trolox equivalent antioxidant capacity (TEAC) method. The results revealed a significant antioxidant capacity, with values ranging from 23.19 mg AAE/g at 0.5 mg/mL concentration to 48.52 mg AAE/g at 1.5 mg/mL concentration. This indicates the extract's ability to inhibit the oxidation of a standard antioxidant compound (Trolox) equivalent to a certain amount of ascorbic acid per gram of extract.

Overall, the in-vitro antioxidant activity of Bambusa vulgaris extract exhibited concentration-dependent efficacy in scavenging free radicals and exerting antioxidant effects. These findings suggest the potential therapeutic application of B. vulgaris extract as a natural antioxidant agent, which could contribute to its utilization in the development of functional foods, dietary supplements, or pharmaceutical formulations aimed at combating oxidative stress-related disorders. However, further studies are warranted to elucidate the underlying mechanisms of action and to evaluate its efficacy in in-vivo models.

Conclusion:

The comprehensive evaluation of Bambusa vulgaris undertaken in this study unveils its significant therapeutic potential. Through rigorous pharmacognostic assessment, we established the botanical identity and quality of B. vulgaris, ensuring a solid foundation for further exploration. Moreover, phytochemical analysis employing advanced techniques revealed a rich array of bioactive constituents within B. vulgaris, including alkaloids, glycosides, tannins, flavonoids, and steroids, among others. Furthermore, the in vitro antioxidant assays demonstrated the remarkable ability of B. vulgaris extract to scavenge free radicals and exhibit substantial total antioxidant capacity. These findings highlight the promising antioxidant properties of B. vulgaris, positioning it as a valuable natural resource in combating oxidative stress-related disorders. In conclusion, Bambusa vulgaris emerges as a promising candidate for pharmaceutical and medicinal applications owing to its diverse pharmacognostic attributes, rich phytochemical composition, and potent antioxidant activity. Further research endeavors should focus on elucidating the underlying mechanisms of action, conducting in vivo studies to validate its therapeutic efficacy, and exploring its potential in the development of novel therapeutic agents and functional food products. The insights gained from this study pave the way for harnessing the therapeutic potential of B. vulgaris to address contemporary health challenges and contribute to the advancement of natural medicine and healthcare.

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