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A comprehensive review of the ethnobotanical, phytochemical, and pharmacological properties of the genus *Bambusa*

Mohammad Amil Zulhilmi Benjamin, Fiffy Hanisdah Saikim, Shean Yeaw Ng, Nor Azizun Rusdi*
Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Jalan UMS, Kota Kinabalu, Sabah, Malaysia.

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ABSTRACT

Throughout Africa, China, India, and other parts of the world for ages, the genus *Bambusa* (Poaceae) has been utilized in folk medicine. Various studies have concentrated on the ethnobotany, phytochemistry, and pharmacology of *Bambusa* spp. in recent years. This scoping study employed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline to analyze articles published from 2003 to 2021 on *Bambusa* spp. The articles were also retrieved from the Scopus database. As a result, 97 articles were selected based on the criteria given: 50 articles for the ethnobotanical aspect, 11 articles for the phytochemical aspect, and 44 articles for the pharmacological aspects (including 8 similar articles from other aspects). A large variety of pharmacological activities, including antioxidant, anti-inflammatory, antibacterial, antifungal, antimalarial, anticancer, antidiabetic, abortifacient, and cytotoxicity activities, were found in the crude extracts and purified bioactive components of *Bambusa* spp. Alkaloids, flavonoids, phenolics, terpenoids, and other compounds have all been isolated and named from *Bambusa* spp. *Bambusa* spp. have a sizable worldwide marketplace due to their outstanding medicinal benefits and minimal toxicity, which has sparked increased attention from academics. Nevertheless, there is no available review article that has compiled all the information regarding the utilization and properties of *Bambusa* spp. Hence, this review aims to identify and reveal the widely used *Bambusa* spp. that have grown worldwide. The review mainly summarizes the phytoconstituents and their corresponding pharmacological properties, which are significant in providing a collective scientific evaluation of *Bambusa* spp. for the development and utilization of a potential novel ethnomedicine.

INTRODUCTION

Naturally occurring substances have been used as another option, instead of conventional treatments, for several ailments because of their respectable effectiveness and reduced toxicity (Ijaz *et al*., 2017). Biologically active compounds from natural resources have received exceptional interest among scientists working on different diseases (Krishnakumar *et al*., 2013). To date, several modern pharmaceutical products derived from plants or plant-based medicine have been utilized in treating various conditions (Antony *et al*., 2017; Gajalakshmi *et al*., 2012; Himaja and Neelufar Shama, 2015; Sanusi *et al*., 2017). Due to their extraordinary curative powers and fewer side effects, traditional medicines continue to be used as alternatives or supplemental therapies despite the increasing global acceptance of contemporary drugs (Divya *et al*., 2017; Monton *et al*., 2014).

One of the biggest genera of woody bamboos, with over 100 species, *Bambusa* Schreber is a member of the subtribe Bambusinae J. S. Presl, with its subfamily being known as Bambusoideae Kunth ex Ascherson and Graebner (Ohrnberger, 1999). *Bambusa* spp. can be identified by its dominant primary branch with several secondary branches, thick-walled culms, and erect triangular blades of the culm sheaths (Dransfield, 1992; Dransfield and Widjaja, 1995). They possess unique sheathing structures, a spreading architecture, petiolate foliage, a highly effective rhizome network, hollowed woody stems, and tree-like characteristics from a physiological perspective (Banik, 2015). This genus is located between southern Asia and the Pacific Rim

*Corresponding Author
Nor Azizun Rusdi, Institute for Tropical Biology and Conservation, Universiti Malaysia Sabah, Jalan UMS, Kota Kinabalu, Sabah, Malaysia.
E-mail: azizun @ ums.edu.my

in the tropics and subtropics, and many species are arboreal in Africa, India, China, and Brazil, with widespread utility and economic value (Bahru and Ding, 2021; Pereira and Beraldo, 2007; Tewari *et al*., 2019; Wu *et al*., 2009). Due to its several applications, this plant also plays a significant financial and socioeconomic part in the lives of the locals in some Asian nations including China, India, Japan, and the countries of Southeast Asia, especially in rural regions (Cho *et al*., 2011; Khairi *et al*., 2020; Ruiz-Sanchez *et al*., 2019). They are present in about 1,500 consumer products (Li and Kobayashi, 2004), that are used in a variety of contexts, including musical instruments, food profiles, and building supplies (Cho *et al*., 2011) to the production of paper pulp, fencing, basketry (Pearson *et al*., 1994), water pipes, utensils (Liu *et al*., 2008), bridges (Xiao *et al*., 2010), and low-rise housing (Chung and Yu, 2002).

Bamboos have drawn interest from all around the world and are essential to the drug and food industry sectors due to their nutritional and medicinal capabilities (Nirmala *et al*., 2018). Thus, *Bambusa* spp. harbor many pharmaceutical compounds, such as steroids, terpenoids, tannins, flavonoids, polyphenols, alkaloids, glycosides, phytosterols, ginsenosides, and fatty acids (Carey *et al*., 2009; Jawaid *et al*., 2015; Lodhi *et al*., 2016; Saducos, 2021; Thamizharasan *et al*., 2015; Yakubu and Bukoye, 2009; Zihad *et al*., 2018). For centuries, *Bambusa* spp. have been used in folk medicines for the treatment and prevention of various diseases (Esakkimuthu *et al*., 2016; Luo *et al*., 2020; Prabhu *et al*., 2021). Pharmacological properties of *Bambusa* spp. include anti-inflammatory (Carey *et al*., 2009; Lodhi *et al*., 2016; Muniappan and Sundararaj, 2003; Vanitha *et al*., 2016), antifungal (Abiala *et al*., 2015; Saducos, 2021; Tyagi *et al*., 2018), antibacterial (Badwaik *et al*., 2014; Jayarambabu *et al*., 2021), antimalarial (Esmaeili *et al*., 2015; Komlaga *et al*., 2016), antioxidant (Alok *et al*., 2017; Karnjanapratum *et al*., 2019; Kong *et al*., 2020; Sandhiya *et al*., 2013), anticancer (Jayarambabu *et al*., 2021; Kalaiarasi *et al*., 2015), antidiabetic (Dey *et al*., 2018; Goyal *et al*., 2017), abortifacient (Yakubu and Bukoye, 2009; Yakubu et al., 2009), and cytotoxicity (Komlaga *et al*., 2016; Valdés *et al*., 2010) activities. Resultantly, the bioactive compounds of *Bambusa* spp. can serve as a fundamental idea for drug development.

In order to promote future investigation into the widespread use and therapeutic application of this medicinal plant, this review presents the existing information on plant ethnobotany, phytochemistry, and the pharmacological activities of *Bambusa* spp.

MATERIALS AND METHODS

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher *et al*., 2009) were used to assist this research on the ethnobotanical, phytochemical, and pharmacological aspects of the genus *Bambusa* and scoping study methodology (Arksey and O'Malley, 2005) as a systematic approach. The methodological framework for the scoping review consisted of five stages: (1) establishing the research questions; (2) locating relevant studies; (3) study selection; (4) charting the data; (5) compiling, summarizing, and reporting the results. Figure 1 illustrates the PRISMA flow diagram for article selection.

Stage 1: establishing the research questions

The research questions were: (1) What are the beneficial health effects of ethnobotanical and pharmacological properties of *Bambusa* species? (2) What type of phytochemicals can be found in *Bambusa* species?

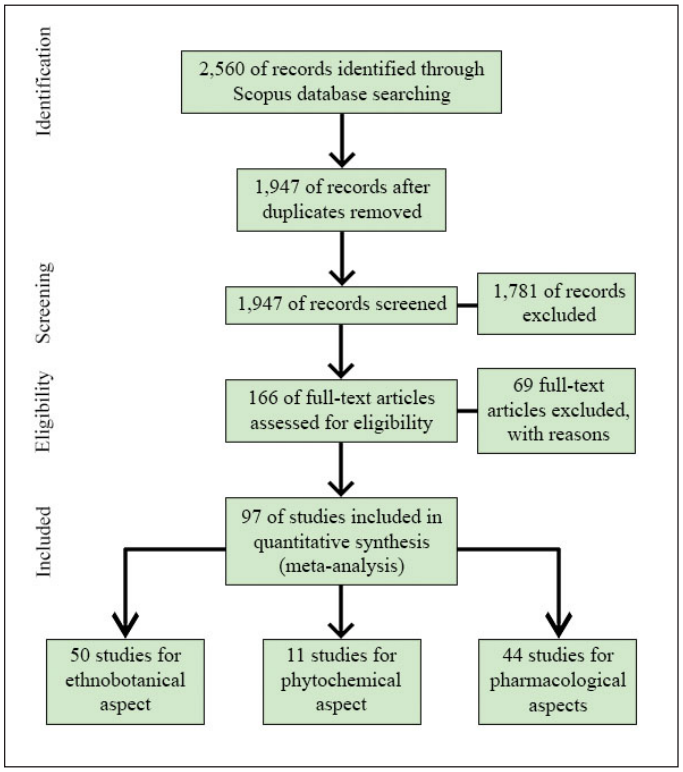

Figure 1. PRISMA flow diagram for article selection process.

Stage 2: locating relevant studies

The source of data was the Scopus database. Articles published between 2003 and 2021 were considered for the search process. The literature search was conducted using specific keywords, comprising "*Bambusa*/Poaceae ethnobotany" or "*Bambusa*/Poaceae traditional knowledge" and "*Bambusa*/Poaceae phytochemistry" and "*Bambusa*/Poaceae pharmacology" or "*Bambusa*/Poaceae medicine" or "*Bambusa*/Poaceae biological activities". A total of 2,560 total articles were retrieved from the literature search.

Stage 3: study selection

Studies were considered in regards to inclusion in this study if they satisfied the criteria which follow: (1) emphasizing all species names from the genus *Bambusa*; (2) reporting single or multiple data of the ethnobotany, phytochemistry, and pharmacology in *Bambusa* species; (3) showing bioactive compound with its figure and Chemical Abstracts Service Registry Number (CAS RN) that can be found in *Bambusa* species; (4) highlighting the beneficial health effects of the ethnobotany in *Bambusa* species; and (5) evaluating the mechanism of each pharmacological property in *Bambusa* species.

Stage 4: charting the data

The data were presented according to the following: (1) species, local names, diseases or ailments, parts used, preparation and administration, and references for ethnobotanical aspect; (2) compound names, CAS RN, species, pharmacological activities,

and references for phytochemical aspect; and (3) pharmacological properties, species, material basis, methods, results, and references for pharmacological aspects.

Stage 5: compiling, summarizing, and reporting the results

The findings of the genus *Bambusa* were presented systematically in the form of tables for ethnobotanical and pharmacological aspects, whereas both tables and figures were utilized for the phytochemical aspect.

ETHNOBOTANICAL ASPECT

Bambusa spp. (Fig. 2) have been used to cure a variety of diseases in folk medicine. For instance, the people of Subhartipuram in India prescribed the leaves of *B. vulgaris* for the treatment of rheumatism (Singh *et al*., 2020). Additionally, *B. vulgaris* is prescribed to cure malaria, heart problems, and clean-out dilation. Kani tribals consume the seeds of *B. arundinacea* as a paste to cure rheumatism (Ayyanar and Ignacimuthu, 2011). The paste of *B. bambos* seeds is used to treat rheumatism (Silambarasan and Ayyanar, 2015). Traditional healers in Kanyakumari apply a paste made from the entire plant, turmeric, and *Areca catechu* to cure bruising and reduce swelling (Sukumaran *et al*., 2014). The people of the Rakhain tribe used the leaves and roots of *B. multiplex* to cure fever and skin itches in Bangladesh (Hanif *et al*., 2009), whereas the root of *B. arundinacea* is used in treating joint pains (Sharkar *et al*., 2013).

Bambusa arundinacea and *B. vulgaris* are the two most utilized species in traditional medicine. Hence, the medical applications of *Bambusa* spp. are detailed in Table 1.

PHYTOCHEMICAL ASPECT

The phytochemical analyses of ethanol extract from *B. vulgaris* yielded positive results for carbohydrates, flavonoids, glycosides, proteins, tannins, and terpenoids. The extraction of aqueous and ethyl acetate fractions was found to be 1.82% *w*/*w* and 1.13% *w*/*w*, respectively (Lodhi *et al*., 2016). The phytochemical analysis of *B. arundinacea* leaves revealed the presence of amino acids, carbohydrates, flavonoids, proteins, and steroids in the crude extract (Jawaid *et al*., 2015). Furthermore, the presence of phytoconstituents such as alkaloids, flavonols, and phenolics in *B. arundinacea* was attributed to the laxative properties found in the shoot (Zihad *et al*., 2018). *Bambusa blumeana* (known as Kawayang Tinik) extracts of whole plants contain phytochemicals such as alkaloids, flavonoids, phenolics, sterols, and tannins. Hence, more research is crucial to discover the compounds responsible for the antifungal properties (Saducos, 2021). This study of *B. arundinacea* seed extracts showed the presence of flavonoids, phenolics, quinines, steroids, and tannins (Thamizharasan *et al*., 2015). Additionally, early phytochemical testing of a fluid extract of *B. vulgaris* foliage revealed the presence of alkaloids, anthraquinones, flavonoids, glycosides, phenolics, saponins, and tannins. However, terpenes, steroids, and chalcones were not identified. Alkaloids made up the majority of the *B. vulgaris* leaves' aqueous extract, whereas flavonoids made up the least amount of the phytochemicals (Yakubu and Bukoye, 2009). The early phytochemical screening of *B. vulgaris* methanol extract revealed the presence of alkaloids, carbohydrates, flavonoids, glycosides, and proteins (Carey *et al*., 2009).

Bambusa vulgaris

Bambusa multiplex

Bambusa tuldoides

Figure 2. Example of *Bambusa* spp.

The phytochemistry of *Bambusa* spp. including *B. balcooa*, *B. nutans*, and *B. textilis* has been investigated in detail and classified into certain chemical compounds (Table 2). In Figures 3–14, the structural properties of these compounds (**1-49**) are also depicted (Liu *et al*., 2016; Pande *et al*., 2018; Sarkar *et al*., 2020; Soumya *et al*., 2014).

PHARMACOLOGICAL ASPECTS

Table 3 shows a variety of pharmaceutical activities of *Bambusa* spp. that exhibit clinically relevant biological activities.

Antioxidant activity

The antioxidant activity of *Bambusa* spp. has been extensively investigated. The methanolic extract of *B. arundinacea*

Table 1. List of *Bambusa* spp. used as medicinal plant worldwide.

Species	Local names	Diseases or ailments	Parts used	Preparation and administration	References
Bambusa vulgaris	Kawayan	Allergy	Stems	Apply ash burned stems with coconut oil. Drink decoction.	Abe and Ohtani, 2013
Bambusa vulgaris	–	Typhoid	Leaves	Boiling (in water)	Ajaiyeoba *et al*., 2003
Bambusa vulgaris	Oparun	Sickle cell disease	Leaves	–	Amujoyegbe *et al*., 2016
Bambusa arundinacea	Moongil	Fractured bones	Young leaves; Terminal buds	Along with turmeric leaves. *Aloe vera* is ground and the paste is applied to the fractured bones for 2 weeks to join quickly.	Anbarashan *et al*., 2011
Bambusa vulgaris	Pamplo	Malaria	Leaves	Boil and drink decoction as desired until recovered.	Asase *et al*., 2010
Bambusa vulgaris	Pamporo	Malaria	Leaves	Boil leaves with leaves of *Alchornea cordifolia*, *Carica papaya*, and *Persea americana*. Drink decoction 3 times daily.	Asase and Asafo-Agyei, 2011; Komlaga *et al*., 2015
Bambusa sp.	Buluh	Postpartum diet	Young shoots	Boil and drink decoction.	Awang-Kanak *et al*., 2018
Bambusa arundinacea	Moongil	Rheumatism	Seed and seed oil	Paste; Oral	Ayyanar and Ignacimuthu, 2011
Bambusa arundinacea	Baans	Kidney stone	Roots	Root decoction taken orally releases kidney stone.	Bhatia *et al*., 2014
Bambusa vulgaris	Féfé	Typhoid fever	Leaves	–	Bolou *et al*., 2011
Bambusa spp.	Russey Srok/Russey Prey	Liver disorders	Woods	Decoction	Chassagne *et al*., 2017
Bambusa sp.	Bamboo	Erysipelas	Roots	–	de Albuquerque *et al*., 2007
Bambusa vulgaris	Oparun	Infantile dermatitis	Leaves	Decoction with pure water. Drinking (2-3 teaspoonfuls) 3 times daily, and for bath.	Erinoso *et al*., 2016
Bambusa vulgaris	–	Type 2 diabetes	–	–	Esakkimuthu *et al*., 2016
Bambusa vulgaris	Opaarun	Abortion	Leaves	Ingestion	Fred-Jaiyesimi and Ajibesin, 2012
Bambusa multiplex *Bambusa oldhamii*	Thirwa O-onna	Fever, formation of abscess or itches on body due to blood disorders	Leaves; Roots	Ten drops of leaf juice are to be taken on a full stomach for 3 days for fevers. Leaf and root paste are applied to abscess or area of itching as remedy.	Hanif *et al*., 2009
Bambusa vulgaris	Oparun	Measles	Leaves	Half stainless cup 3 times daily.	Idu *et al*., 2010
Bambusa vulgaris	Oparun	Malaria	Leaves	Decoction	Iyamah and Idu, 2015
Bambusa sp.	Bans	Cancer	Leaves; Barks; Seeds	Leaf juice and bark decoction internally; Seed with Shahad (honey)	Jain and Jain, 2010
Bambusa arundinacea	Mungil	Cough in children	Leaves	Equal proportion of leaf juice is mixed with honey.	Jeeva and Femila, 2012
Bambusa arundinacea	Mulmunkil	Skin diseases	Roots; Leaves	Decoction of roots; Infusion of leaves	Johnsy *et al*., 2012
Bambusa vulgaris	Mai Sang Kham	Kidney stones	Roots	The root is boiled with the root of Mak Feuang Phu.	Libman *et al*., 2006
Bambusa pervariabilis	Zhu Ru	Clearing heat, stopping bleeding	Shavings	–	Luo *et al*., 2020
Bambusa bambos	Bamboo	Pimple onto eyelid	Leaves	Rub the leaves onto the pimple.	Mahomoodally, 2014
Bambusa balcooa	–	–	–	–	Majumder *et al*., 2014
Bambusa bambos	–	Constipation Bilharzia	Leaves	Powder; Oral Bolus; Oral	Neamsuvan *et al*., 2016
Bambusa vulgaris	Bambu Kuning	Malaria	Stems	Decoction; Oral	Novaryatiin and Indah, 2019

Continued

Species	Local names	Diseases or ailments	Parts used	Preparation and administration	References
Bambusa vulgaris	Kawayan	Postpartum wash	Leaves	External application as wash or hot compress after boiling leaves.	Ong and Kim, 2015
Bambusa vulgaris	Haur Koneng	Liver disease, gonorrhea	Water inside the cavity bamboo	Oral	Partasasmita *et al*., 2017
Bambusa arundinacea	Moongil	Rheumatism	Seeds	–	Prabhu *et al*., 2021
Bambusa tulda	Bans	Cardiovascular disorders, weakness of heart	Soft inner core of stems	Decoction (with *Terminalia bellirica* sliced fruits, *Terminalia chebula* fruits, *Phyllanthus emblica* fruits, *Solanum violaceum* sliced leaves, and *Drynaia quercifolia* roots. The final weight should be 2 kg distributed evenly between the various plant parts. Five kilograms water is then added to the mixture and boiled in a pan until the weight of water is reduced to around 2 kg. The decoction is then cooled and strained through a piece of cloth. Three tablespoonfuls of the decoction is taken 3 times daily for 21 days.	Rahmatullah and Biswas, 2012
Bambusa vulgaris	Caña Brava	Malarial fevers	–	–	Rodríguez-Pérez *et al*., 2006
Bambusa bambos	Kanta Bans	Laxative, leukoderma, inflammation, strangury, cough, cold, consumption, asthma, emmenagogue, bleeding disorder	Stems; Leaves; Roots; Sprouts; Barks	–	Rudra *et al*., 2021
Bambusa arundinacea	Gora, Kewal, Kewe, Songough, Otosi	Stomach upset, antimalarial	Tender shoots	–	Saalu, 2016
Bambusa vulgaris	Bamboo, Golden Bamboo	Cough	Buds	Prepare an infusion of the buds. Drink 1 cup per day.	Samoisy and Mahomoodally, 2016
Bambusa vulgaris	Mughil	Reduced sperm count	Leaves	Leaves extract is taken orally.	Sathiyaraj *et al*., 2012
Bambusa arundinacea	Veduru	Asthma	Leaves	Decoction, 30–50 ml taken twice a day orally.	Savithramma *et al*., 2007
Bambusa vulgaris	Oparun	Cancer	Leaves	The seeds of *Acacia nilotica*, *Lagenaria breviflora*, leaves of *Momordica charantia*, *Tetracera alnifolia*, stem bark of *Khaya ivorensis*, *Tetrapleura tetraptera* and the root of *Securidaca longipedunculata* are cooked with water. Two cups to be taken three times daily for 3 weeks. Also bathe with the decoction once daily.	Segun *et al*., 2018
Bambusa vulgaris	Haur Koneng	Cancer	Buds	–	Setiawati *et al*., 2017
		Leukoderma	Stems		
Bambusa arundinacea	Bans	Cough, cold	Leaves	–	Sharkar *et al*., 2013
		Joint pains	Roots		
Bambusa tulda	Ejo	Tetanus infection	–	–	Sharma and Borthakur, 2008
Bambusa tulda	Bans	Piles, constipation	Whole plant	Decoction of roots is prepared and given 3 teaspoonfuls daily for 10 days.	Sharma *et al*., 2012
Bambusa bambos	Moongil	Rheumatism	Seeds	Paste; Topical	Silambarasan and Ayyanar, 2015

Continued

Species	Local names	Diseases or ailments	Parts used	Preparation and administration	References
Bambusa tulda	Waa	Wound and injuries	Tender shoots	Tender shoot decoction paste is applied in wounds and injuries.	Singh *et al*., 2003
		Rheumatism, malaria	Young shoots	Cooked and eaten with rice.	
		Astringent, emmenagogue	Barks	–	
Bambusa vulgaris	–	Heart problems, malaria, fevers	Leaves	–	Singh *et al*., 2020
		Clean-out dilation and expulsion after parturition	–	The concentrated boiled leaves extract is used by women.	
				The leaves of *B. vulgaris* and *Caesalpinia bonduc* are soaked in hot water with the leaves of *Dioscorea rotundata* and then allowed to cool. Two tablespoonfuls of the extract are taken twice daily.	
Bambusa vulgaris	Oparun	Measles	Leaves	The leaves of *Peperomia pellucida*, *Elytraria marginata*, *B. vulgaris*, seeds of *Aframomum melegueta*, and the whole plant of *Corchorus olitorius* are washed and boiled with a little potash using plenty water. It is allowed to cool and a teacupful of extract is taken thrice daily after meal.	Sonibare *et al*., 2009
Bambusa bambos	Phai Pa	Leprosy, lipoma	Young stems	Decoction; Potion; Oral	Srisawat *et al*., 2016
		Dislodgement of worms, ulcers	Young shoots	Poultice of young shoots is used.	
		Discharge of menses	Leaf buds	Decoction	
Bambusa arundinacea	–	Indigestion	Tender shoots	Curry from tender shoots.	Sukumaran *et al*., 2014
		Contusion, swellings	Whole plant	Paste of whole plant with turmeric and *Areca catechu* is used.	
		–	Shoots	Shoot extract is applied and cured by a bandage for varmam.	
Bambusa bambos	Bidiru	All diseases	Grains	Rice prepared from the grains of Bamboo whose stem is infested by Sigare (*Dendrophthoe falcata*) is taken internally for relief from all diseases (believed as Sanjeevani).	Udayan *et al*., 2005

as one of the ingredients in the Ayurvedic formula of Drakshavaleha (DKV) had a maximum DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging activity of 68.24% at 100 µg/ml. Furthermore, at 100 µg/ml, the maximum DPPH radical scavenging activity of marketed DKV formulations (DKV-1, DKV-2, and DKV-3) was 67.90%, 68.35%, and 68.40%, respectively (Alok *et al*., 2017). The ethyl acetate and hexane extracts of fresh *B. balcooa* did not show instant radical scavenging capacity as the second oxidation wave was delayed (Boruah *et al*., 2012). DPPH radical scavenging activity was 8.57%, 14.31%, and 17.85% for biscuits merged with 5%, 10%, and 15% of *B. balcooa* levels, respectively. Meanwhile, the value for the control was 3.50%, depicting improved functional and nutraceutical properties for biscuit preparation and other food products (Choudhury *et al*., 2015). By absorbing hydrogen peroxide and DPPH radicals, both acetone and the aqueous extracts of *B. vulgaris* demonstrated their antioxidant properties in a manner dependent on dosage (Goyal *et al*., 2013).

The maximum scavenging of DPPH radicals was seen in the methanolic extract from *B. balcooa*, which was followed by the aqueous extract. However, the *B. balcooa* extract in acetonic form had the least amount of action. The maximum ferric reducing antioxidant power (FRAP) result was seen in the aqueous extract of *B. balcooa* (0.217), followed by the acetonic extract (0.027), and the methanolic extract (0.079) when compared to ascorbic acid (0.041) as a reference at a concentration of 200 µg/ml. Therefore, it can be inferred that aqueous extract contains *in vitro* antioxidant effect (Goyal *et al*., 2017). The fiber hydrolysate from *B. vulgaris* shoots displayed ABTS [2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonate)] radical scavenging activities, DPPH, FRAP, and oxygen radical absorbance capacity. *Bambusa vulgaris* can thus be successfully synthesized via enzymatic hydrolysis with

Table 2. Phytoconstituents isolated from *Bambusa* spp.

No.	Compound names	CAS RN	Species	Pharmacological Activities	References
Flavonoids					
1.	Apigenin	520-36-5	*Bambusa nutans*; *B. textilis*	Antioxidant, antidiabetic, and anti-obesity activities	Liu *et al*., 2016; Pande *et al*., 2018
2.	Luteolin	491-70-3			
3.	Orientin	28608-75-5			
4.	Isoorientin	4261-42-1			
5.	Tricin	520-32-1			
6.	Vitexin	3681-93-4			
7.	Isovitexin	38953-85-4			
8.	Quercitrin	522-12-3	*Bambusa nutans*	Antioxidant and antidiabetic activities	Pande *et al*., 2018
9.	Rutin	153-18-4			
Phenols and Phenylpropanoids					
10.	*p*-Coumaric acid	7400-08-0	*Bambusa balcooa*; *B. nutans*; *B. textilis*	Antioxidant, antidiabetic, and anti-obesity activities	Liu *et al*., 2016; Pande *et al*., 2018; Sarkar *et al*., 2020
11.	Caffeic acid	331-39-5	*Bambusa nutans*; *B. textilis*	Antioxidant, antidiabetic, and anti-obesity activities	Liu *et al*., 2016; Pande *et al*., 2018
12.	Chlorogenic acid	327-97-9			
13.	Gallic acid	149-91-7	*Bambusa textilis*	Antioxidant and anti-obesity activities	Liu *et al*., 2016
14.	*p*-Hydroxybenzoic acid	99-96-7			
15.	Vanillic acid	121-34-6			
16.	Coumaroylquinic acid	1899-30-5			
17.	Dihydroxybenzoic acid	27138-57-4	*Bambusa nutans*	Antioxidant and antidiabetic activities	Pande *et al*., 2018
18.	Ferulic acid	1135-24-6			
19.	Sinapic acid	530-59-6			
20.	*p*-Hydroxybenzaldehyde	123-08-0	*Bambusa balcooa*	Antioxidant and antithyroid activities	Sarkar *et al*., 2020
Alkaloids					
21.	Adenine	73-24-5	*Bambusa balcooa*	Antioxidant and antithyroid activities	Sarkar *et al*., 2020
22.	Betaine	107-43-7			
23.	Histamine	51-45-6			
24.	Hypoxanthine	68-94-0			
25.	Nornicotine	494-97-3			
26.	L-Phenylalanine	63-91-2			
27.	Piperidine	110-89-4			
28.	L-Proline	147-85-3			
29.	Tyramine	51-67-2			
Fatty acids					
30.	Palmitic acid	57-10-3	*Bambusa bambos*; *B. textilis*	Antioxidant, antimicrobial, and anti-obesity activities	Liu *et al*., 2016; Soumya *et al*., 2014
31.	α-Linolenic acid	463-40-1	*Bambusa textilis*	Antioxidant and anti-obesity activities	Liu *et al*., 2016
32.	Linoleic acid	60-33-3			
33.	Oleic acid	112-80-1			
34.	Stearic acid	57-11-4			
35.	cis-Aconitic acid	585-84-2	*Bambusa balcooa*	Antioxidant and antithyroid activities	Sarkar *et al*., 2020
36.	trans-Aconitic acid	4023-65-8			
37.	Citraconic acid	498-23-7			
38.	Citramalic acid	597-44-4			
39.	Ethylmalonic acid	601-75-2			
40.	Glutaric acid	110-94-1			
41.	Hexanoic acid	142-62-1			

Continued

No.	Compound names	CAS RN	Species	Pharmacological Activities	References
42.	Itaconic acid	97-65-4	*Bambusa balcooa*	Antioxidant and antithyroid activities	Sarkar *et al*., 2020
43.	Mesaconic acid	498-24-8			
44.	Methylsuccinic acid	498-21-5			
45.	Succinic acid	110-15-6			
46.	9-octadecenoic acid	2027-47-6	*Bambusa bambos*	Antioxidant and antimicrobial activities	Soumya *et al*., 2014
47.	9,12-Octadecadienoic acid	2197-37-7			
48.	Octanoic acid	124-07-2			
49.	Tetradecanoic acid	544-63-8			

Note: Its CAS number can be found at www.commonchemistry.cas.org.

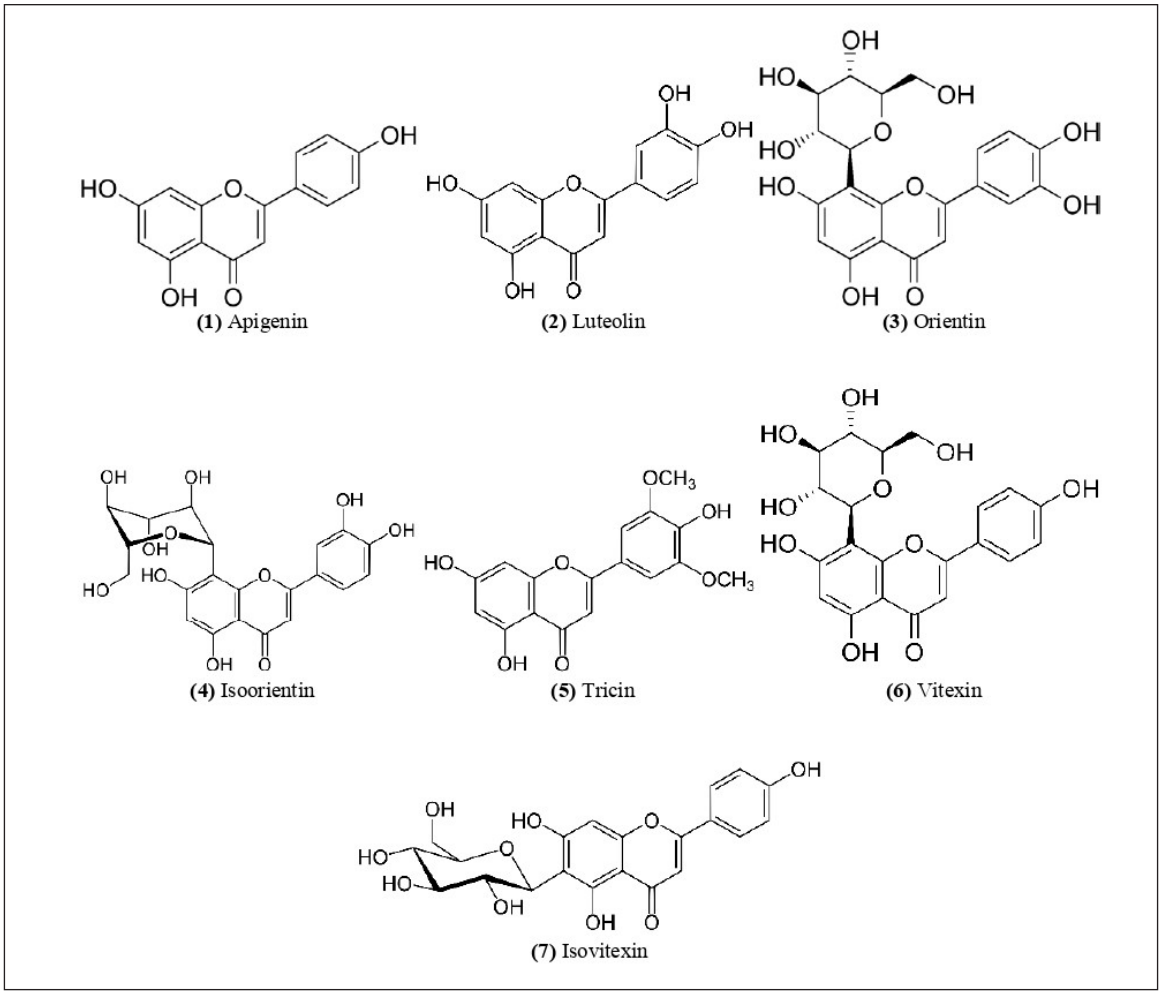

Figure 3. Chemical structures (**1-7**) isolated from *B. nutans* and *B. textilis*.

antioxidant activity and is appropriate for application in fortified fiber products (Karnjanapratum *et al*., 2019).

Anti-inflammatory activity

All experimental models, including acetic acid-induced vascular permeability, carrageenan-induced peritonitis, cotton pellet granuloma, formaldehyde-induced paw edema, and estimation of plasma malondialdehyde (MDA), were significantly and dose-dependently inhibited ($p < 0.01$) by *B. vulgaris* (100 mg/kg, 200 mg/kg, and 400 mg/kg, p.o.). The results indicated that *B. vulgaris* significantly contains anti-inflammatory properties, which are reflected in the use of this traditional plant for treating painful and inflammatory conditions (Carey *et al*., 2009). The inhibitory activities of paw edema were significantly decreased by increasing the amounts of ethyl acetate and aqueous fractions from *B. vulgaris*, which contains anti-inflammatory properties (Lodhi *et al*., 2016). When compared to the usual medications recognized as ulcerogenic, the methanolic extract of *B. arundinacea* leaves

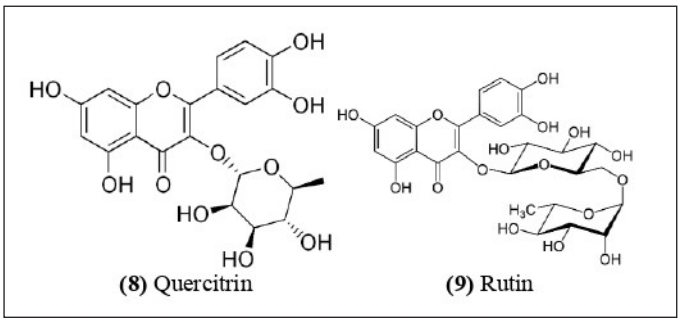

Figure 4. Chemical structures (**8-9**) isolated from *B. nutans*.

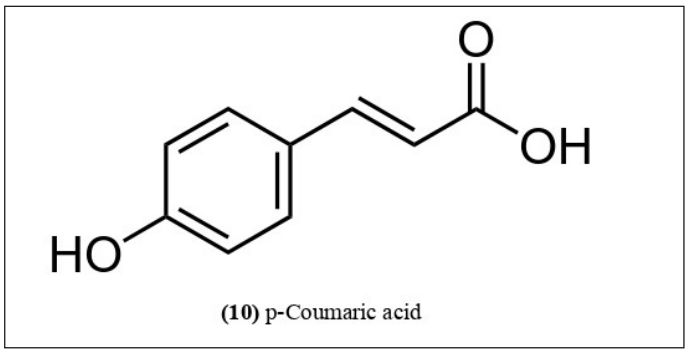

Figure 5. Chemical structure (**10**) isolated from *B. balcooa*, *B. nutans*, and *B. textilis*.

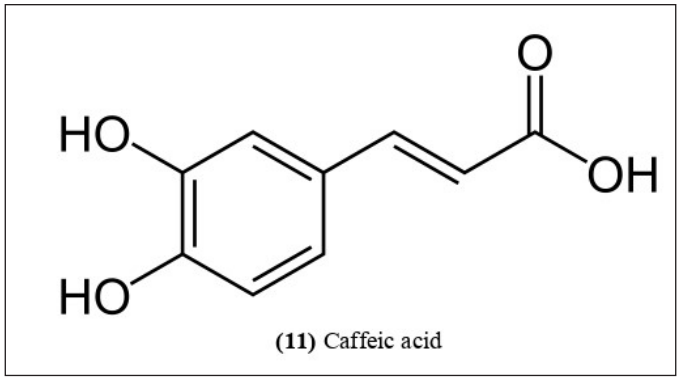

Figure 6. Chemical structure (**11**) isolated from *B. nutans* and *B. textilis*.

against immunologically generated paw edema and carrageenan-induced edema was shown to be better (Muniappan and Sundararaj, 2003). Additionally, by stabilizing the membrane of human red blood cells (HRBC) and using the protein denaturation technique, the hydroalcoholic extract of *B. arundinacea* shows potent anti-inflammatory properties (Vanitha *et al*., 2016).

Antibacterial activity

At doses ranging from 2.5 mg/ml to > 80 mg/ml, both aqueous and ethanolic extracts of *B. vulgaris* demonstrated bactericidal action against at least one of the test pathogens, as analyzed by Minimum Bactericidal Concentration and Minimum Inhibitory Concentration (MIC) (Bolou *et al*., 2011). In contrast to the ethanolic leaf extract, which lacked antibacterial activity against *Salmonella typhi* and *Streptococcus faecalis*, fresh leaf extracts of *B. tuldoides* from sorghum liquors and fermented maize at a concentration of 20 g/100 ml demonstrated antibacterial activity against all of the bacteria tested. Higher concentrations (20 g/40 ml) of both fresh and dried extracts of *B. tuldoides* demonstrated greater antibacterial activity than sorghum liquors and fermented maize (Oluwahenyinmi *et al*., 2014). For increasing concentrations (25, 50, 100, and 150 µl) of ethanolic extract of *B. arundinacea,* the inhibition zone for *Staphylococcus aureus* was 14, 16, 17, and 19 mm, whereas that of *Bacillus subtilis* was 12, 14, 15, and 17 mm, respectively (Jayarambabu *et al*., 2021). Following the use of the agar well diffusion method, *B. vulgaris* extracts may include compounds with antibacterial activities that can be incorporated into novel antimicrobial medicines (Sandhiya *et al*., 2013).

Antifungal activity

The extracts (sequentially ethanol, ethyl acetate, hexane, and water) acquired from *B. vulgaris* boiled shoots exhibited a higher antifungal effect (MIC: 0.01–2.50 mg/ml) compared to antibacterial effect (MIC: 0.31–2.50 mg/ml) (Kong *et al*., 2020). Class III chitinase cDNA (BoChi3-1) was cloned from suspension-cultured bamboo (*B. oldhamii*) cells and then produced in yeast by using a cDNA library (*Pichia pastoris* X-33). Both recombinant BoChi3-1 isoforms inhibited *Scolecobasidium longiphorum* growth (Kuo *et al*., 2008). At a concentration of 1 mg/ml, all Kawayang Tinik (*B. blumeana*) extracts showed a statistically equivalent zone of inhibition (ZOI) against *Aspergillus niger*, whereas ethanolic leaf and root extracts produced a wider ZOI against *Penicillium chrysogenum* than other *B. blumeana* extracts. In addition, antifungal assay findings demonstrated that *B. blumeana* extracts have a comparable antifungal effect to fluconazole, a pharmaceutically approved antifungal agent at 1 mg/ml concentration (Saducos, 2021).

Antimalarial activity

Plasmodium berghei was evaluated for *in vivo* antimalarial efficacy against *B. arundinacea* methanolic extract, and it demonstrated 26.0%, showing excellent antimalarial potential (Esmaeili *et al*., 2015). The organic solvent fractions of *B. vulgaris* exhibited antimalarial activity with ethyl acetate and petroleum ether fractions, displaying an IC_{50} below 1 µg/ml against the *Plasmodium falciparum* 3D7 strain (Komlaga *et al*., 2016). *Bambusa vulgaris* hydroalcoholic extract also demonstrated the most specific and potent antimalarial property (IC_{50} = 4.7 µg/ml, SI = 28.9) (Valdés *et al*., 2010).

Antidiabetic activity

Treatment of streptozotocin-induced diabetic rats with Qurs Tabasheer (including *B. arundinacea*) for 28 days significantly reduced serum glucose, cholesterol, fructose-1,6-bisphosphatase, glucose-6-phosphatase, and triglycerides, whereas the magnitude of hexokinase and high-density lipoprotein cholesterol was amplified (Ahmed *et al*., 2013). Compared to diabetic animals, the animals given *B. tulda* leaves showed a gain in body weight. Hence, hydromethanolic extract proved that *B. tulda* leaves possess antidiabetic activity. Although the effect was significant, *B. tulda* leaves could be utilized in managing diabetic levels (Dey *et al*., 2018). While plasma insulin levels were raised relative to diabetic control, the aqueous extract of *B. balcooa* at 100 mg/kg and 200

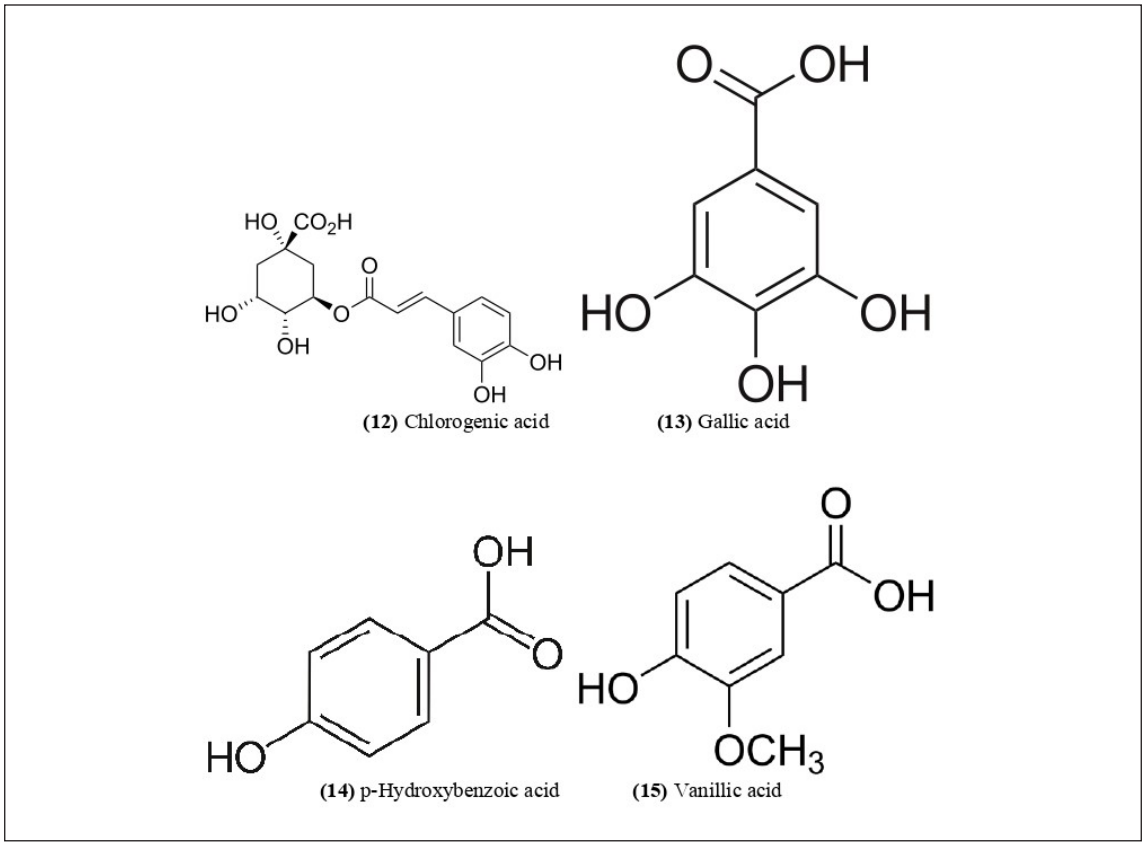

Figure 7. Chemical structures (**12-15**) isolated from *B. textilis*.

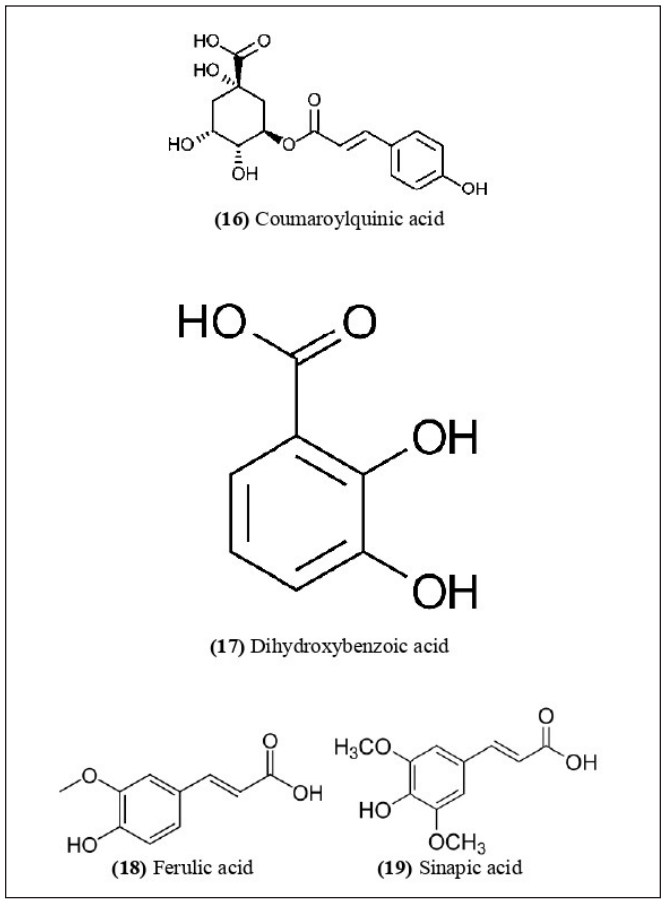

Figure 8. Chemical structures (**16-19**) isolated from *B. nutans*.

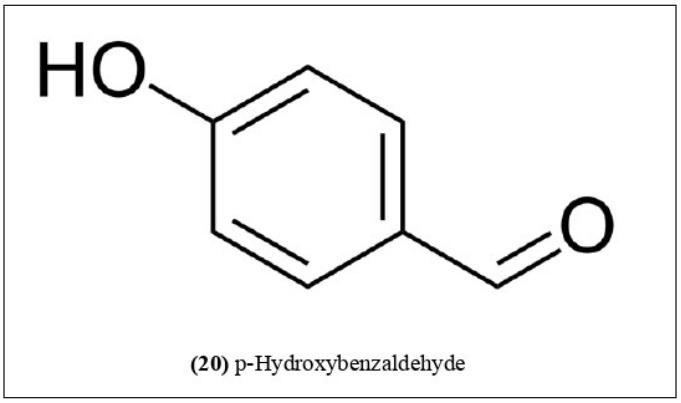

Figure 9. Chemical structure (**20**) isolated from *B. balcooa*.

mg/kg effectively reduced fasting blood glucose and glycated hemoglobin in alloxan-induced diabetic rats. Both dosages of glibenclamide (standard antidiabetic agent) were efficient against diabetic rats (Goyal *et al*., 2017). The hypoglycemic effect of *B. arundinacea* aqueous extract was statistically significant and equivalent to that of glibenclamide at 0.9 mg/kg in euglycemic rats at 30 minutes and 1,000 mg/kg in hyperglycemic rats at 3 hours with an oral dose of 500 mg/kg (Joshi *et al*., 2009).

Anticancer activity

Bambusa arundinacea-derived zinc oxide nanoparticles (ZnO NPs) demonstrated anticancer activity against MCF-7 cell lines. These results indicate that biosynthesized ZnO NPs may have therapeutic properties (Jayarambabu *et al*., 2021). Kalaiarasi *et al*.

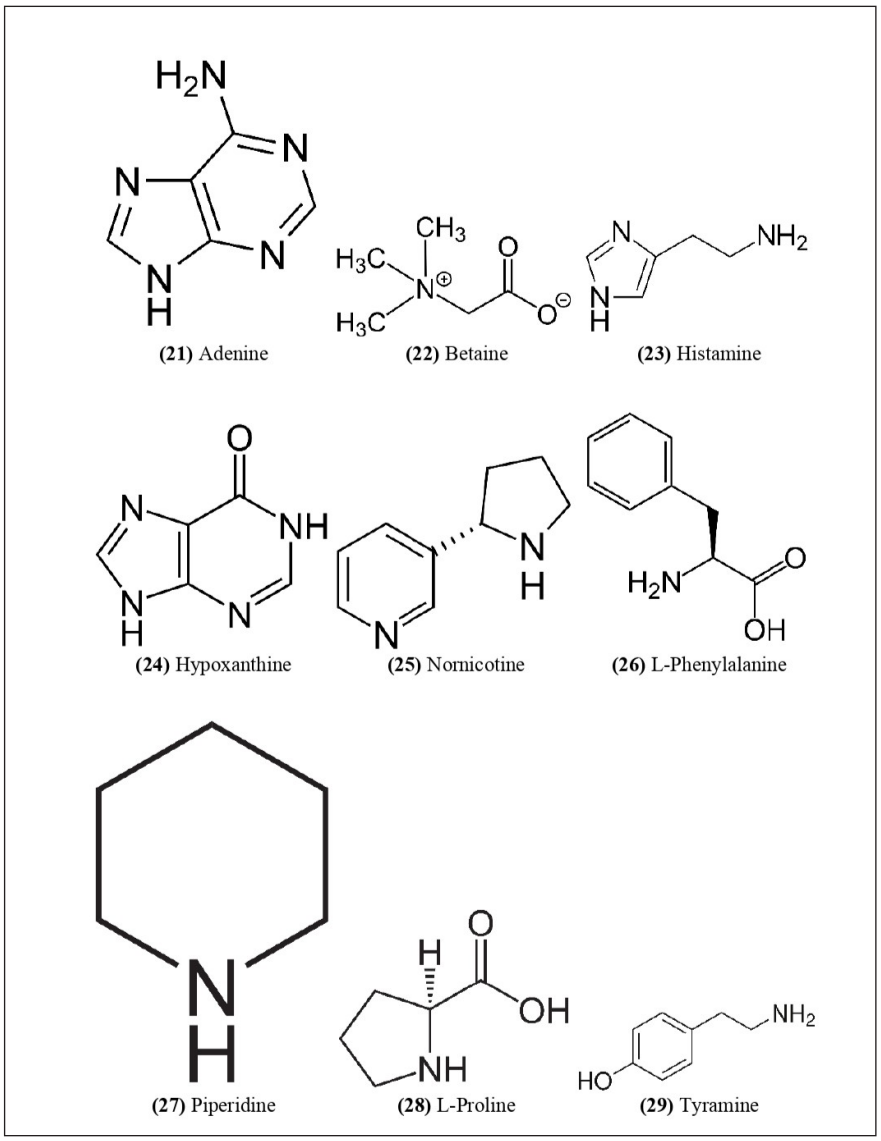

Figure 10. Chemical structures (**21-29**) isolated from *B. balcooa*.

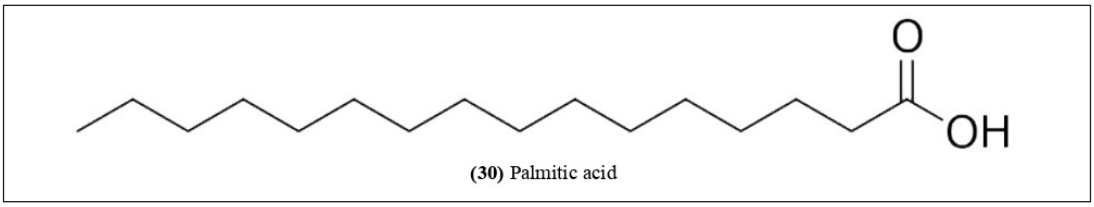

Figure 11. Chemical structure (**30**) isolated from *B. bambos* and *B. textilis*.

(2015) examined the antitumor effectiveness of *in vitro*-grown *B. arundinacea* (Ba) and *B. nutans* (Bn) leaf samples for the formation of metallic silver nanoparticles (AgNPs) from silver ions against human prostate cancer cell lines (PC-3). BaAgNPs and BnAgNPs had IC_{50} values for PC3 cancer cells of 73.57 µg/ml and 84.88 µg/ml, respectively, while Vero cells had IC_{50} values of 93.58 µg/ml and 96.41 µg/ml, respectively. For BaAgNPs and BnAgNPs, the percentages of apoptotic bodies as measured by acridine orange/ethidium bromide staining were 76% and 62%, respectively. The observations clearly suggest that synthesized BaAgNPs may have anticancer activity against human PC-3 cell lines in contrast to BnAgNPs.

Abortifacient activity

Aqueous extracts of *B. vulgaris* leaves were tested for their toxicity at 250 mg/kg and 500 mg/kg body weight in a pregnant Dutch rabbit test. The extract increased kidney gamma-glutamyl transferase (GGT) at a dose of 250 mg/kg. Contrarily,

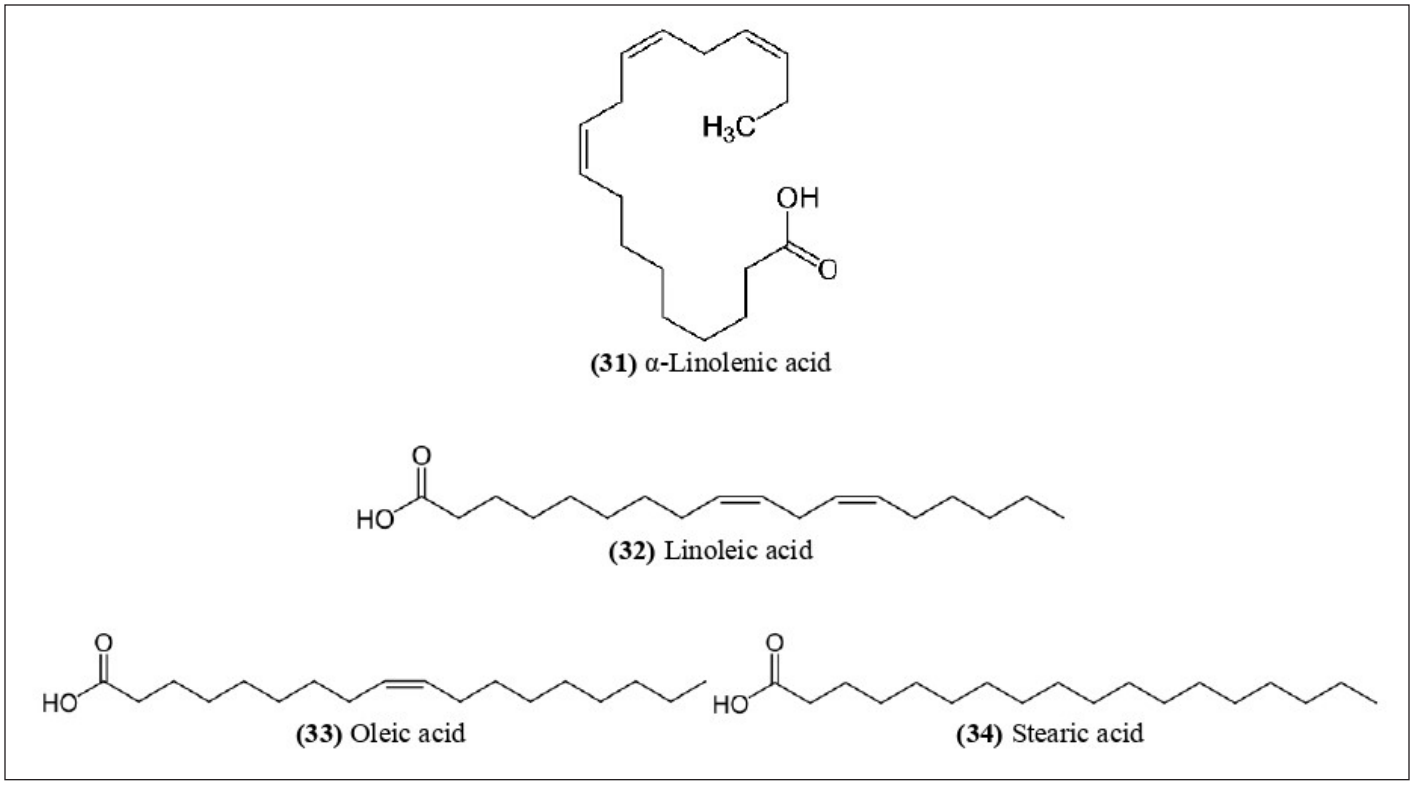

Figure 12. Chemical structures (**31-34**) isolated from *B. textilis*.

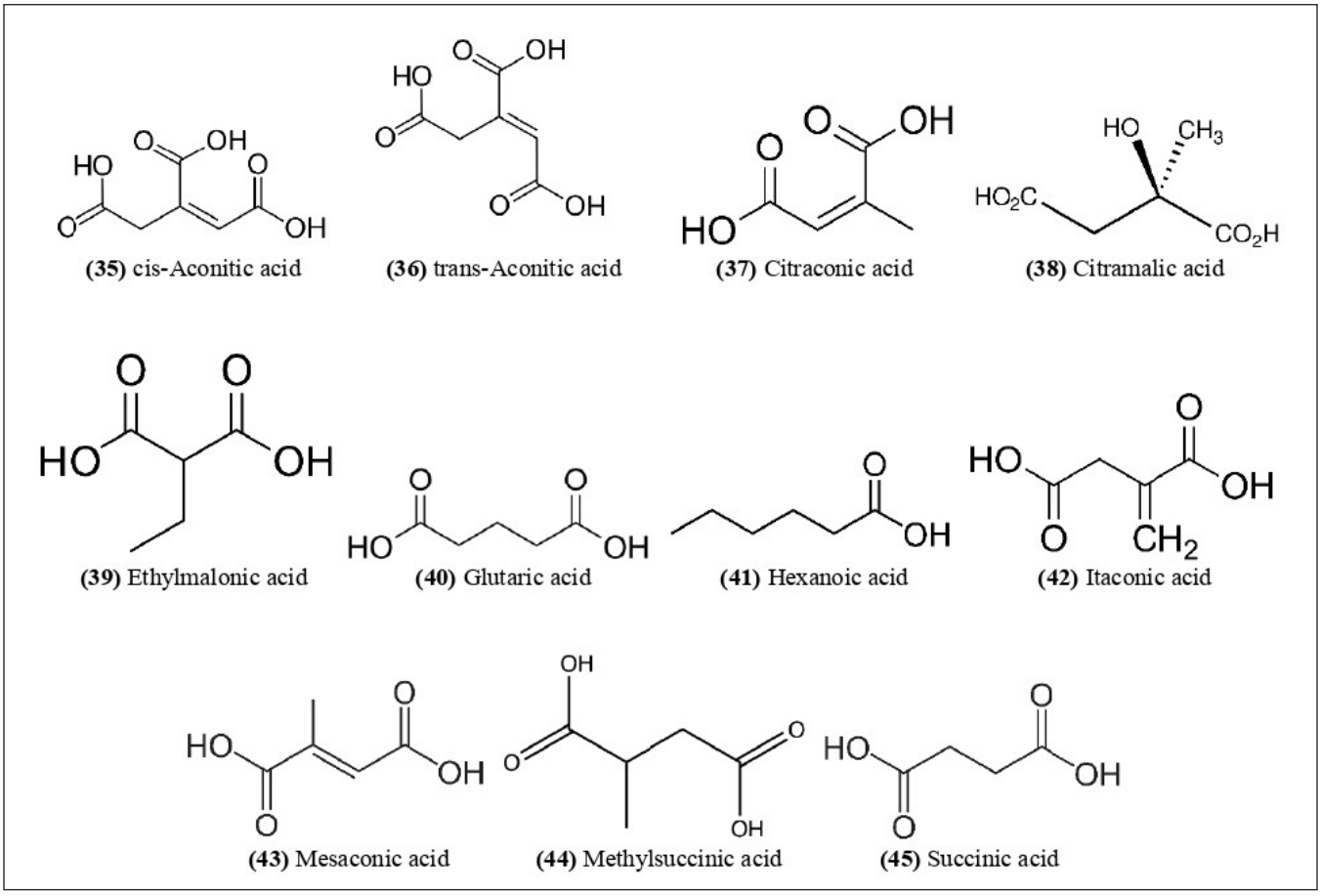

Figure 13. Chemical structures (**35-45**) isolated from *B. balcooa*.

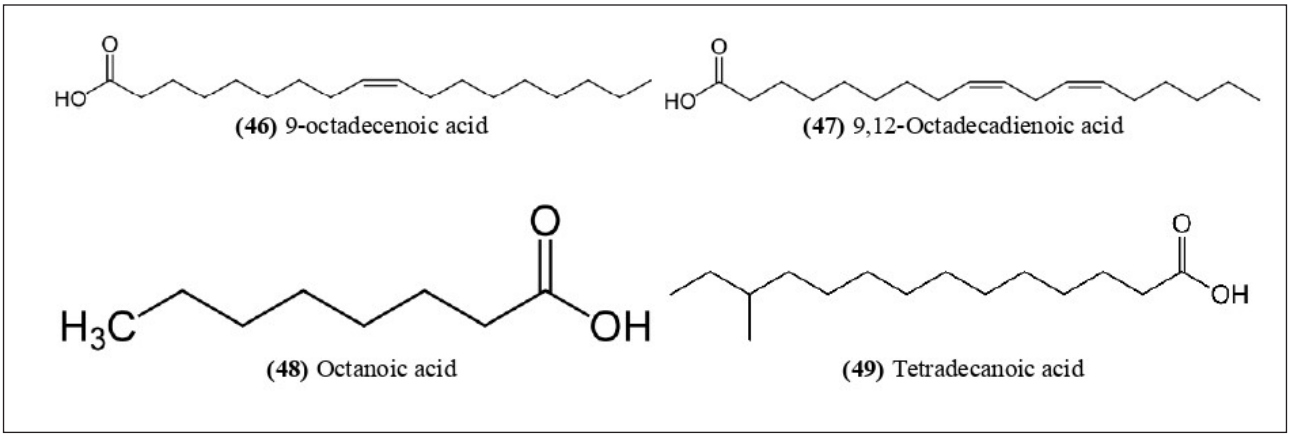

Figure 14. Chemical structures (**46-49**) isolated from *B. bambos*.

Table 3. Pharmacological properties of *Bambusa* spp.

Pharmacological properties	Species	Material basis	Methods	Results	References
Antioxidant activity	*Bambusa arundinacea*	Methanol extract	DPPH assay	IC_{50}: 63.27; 63.13; 62.82; 62.91 µg/ml	Alok *et al*., 2017
	Bambusa balcooa	Hexane extract; Ethyl acetate extract; Methanol extract	Cyclic voltammetry	In the presence of herbal extracts either the oxidation(s) is delayed and/or the radical cation is scavenged as soon as it is formed.	Boruah *et al*., 2012
	Bambusa balcooa	Hot water extract	DPPH assay	72.36 ± 1.19 %	Choudhury *et al*., 2015
	Bambusa vulgaris	Aqueous extract; Acetone extract	DPPH assay; Reducing power assay; H_2O_2 assay	Both the acetone and aqueous extracts displayed their antioxidant activity in a dose-dependent manner by DPPH and H_2O_2 assays.	Goyal *et al*., 2013
	Bambusa balcooa	Aqueous extract; Methanol extract; Acetone extract	DPPH assay; FRAP assay; H_2O_2 assay; Lipid peroxidation assay	The aqueous extract showed higher yield in DPPH and FRAP assays compared to the other extracts.	Goyal *et al*., 2017
	Bambusa vulgaris	Hot water extract	DPPH assay; ABTS assay; FRAP assay; ORAC assay	16.40 ± 1.55; 25.40 ± 0.01; 6.24 ± 0.32; 3.39 ± 0.04 mmol TE/g solid	Karnjanapratum *et al*., 2019
	Bambusa vulgaris	Aqueous extract; Ethanol extract; Ethyl acetate extract; Hexane extract	DPPH assay; FRAP assay; CAA assay	All extracts from *B. vulgaris* showed high DPPH assays and FRAP assays.	Kong *et al*., 2020
	Bambusa bambos	Aqueous extract	NO assay; FRAP assay; TAC; Metal chelating activity	7.60 ± 0.12; 3.28 ± 0.78; 3.28 ± 0.12; 5.72 ± 0.24 mg/g	Krishnaveni *et al*., 2014
	Bambusa tulda	Clear extract	TAC; FRAP assay; NO assay; H_2O_2 assay; Metal chelating activity	4.53 ± 2.02; 3.61 ± 1.52; 2.43 ± 0.02; 4.96 ± 1.09; 7.21 ± 3.55 mg/g	Krishnaveni *et al*., 2015
	Bambusa vulgaris	Boiling in 1% NaCl solution; Steaming	DPPH assay	IC_{50}: 347.48; 831.57; 497.25; 872.17 µg/ml	Kumalasari *et al*., 2019
	Bambusa textilis	Methanol extract	DPPH assay; FRAP assay; Inhibition of β-carotene bleaching assay	Significant antioxidant effect in DPPH, FRAP, and inhibition of β-carotene bleaching assays *in vitro*.	Liu *et al*., 2016

Continued

Pharmacological properties	Species	Material basis	Methods	Results	References
Antioxidant activity	*Bambusa vulgaris*	Ethyl acetate extract	SOD assay; CAT assay; GSH assay	*Bambusa vulgaris* exhibits antioxidant effects by its ability to increase antioxidant level.	Lodhi *et al*., 2016
	Bambusa nutans	Hot methanol: water (4:1) extract	DPPH assay; FRAP assay; OH assay; Metal chelating assay	A significant correlation between phenolics and antioxidant capacity as well as within the various antioxidant assay methods.	Pande *et al*., 2018
	Bambusa bambos	Lignin extraction	DPPH assay	61.75 ± 0.70 %	Ramakoti *et al*., 2019
	Bambusa arundinacea	Hexane extract; Hydroalcohol extract; Ethyl acetate extract; Ethanol extract	DPPH assay	DPPH assay has showed a maximum of 51.41% of percentage inhibition at 100 µg/ml concentration.	Sandhiya *et al*., 2013
	Bambusa balcooa	Aqueous extract	H_2O_2 assay	The activities of the studied enzymes decreased with increasing H_2O_2 dose and time.	Sarkar *et al*., 2020
	Bambusa balcooa	Acetone extract; Benzene extract; Chloroform extract; Methanol extract	ABTS assay; DPPH assay; FRAP assay	The plant extracts had a high capacity for free radical scavenging.	Seal and Chaudhuri, 2016
	Bambusa vulgaris	Ethanol extract	DPPH assay	IC_{50}: 31.421; 39.425; 25.373; 32.835 µg/ml	Soesanto, 2016
	Bambusa bambos	Ethanol extract	DPPH assay; ABTS assay; NO assay; Alkaline DMSO method	Bamboo seed oil showed good antioxidant.	Soumya *et al*., 2014
	Bambusa arundinacea	Ethanol extract; Hydroalcohol extract	DPPH assay; TAC; H_2O_2 assay; SOD assay; LPO assay	Hydroalcohol extract of bamboo shoot has strong antioxidant.	Vanitha *et al*., 2016
	Bambusa cacharensis; *B. manipureana*; *B. nutans*; *B. tulda*; *B. oliveriana*; *B.* sp.; *B.* sp.; *B. tuldoides*	Hot water extract	DPPH assay	IC_{50}: 0.58; 0.46; 1.83; 0.30; 0.57; 0.24; 0.25; 0.45 mg l^{-1}	Waikhom *et al*., 2013
	Bambusa oldhamii	Protein extract	SOD assay	5 genes and 7 isozymes of CuZnSOD; 4 genes and 1 isozyme of MnSOD	Wu *et al*., 2011
Anti-inflammatory activity	*Bambusa vulgaris*	Methanol extract	Acetic acid-induced vascular permeability; Cotton pellet granuloma; Estimation of plasma MDA; Carrageenan-induced peritonitis; Formaldehyde-induced rat paw edema	The anti-inflammatory activity of *B. vulgaris* supports its traditional use in some painful and inflammatory conditions.	Carey *et al*., 2009
	Bambusa vulgaris	Aqueous extract; Ethyl acetate extract	Paw edema in carrageenan-induced inflammation in rats	By increasing the concentration of both fractions, the percent inhibition of paw edema was significantly reduced.	Lodhi *et al*., 2016

Continued

Pharmacological properties	Species	Material basis	Methods	Results	References
Anti-inflammatory activity	*Bambusa arundinacea*	Methanol extract	Carrageenin-induced edema; Immunologically induced paw edema in albino rats	Combination of extract with with nonsteroidal anti-inflammatory agents will produce the best anti-inflammatory drug.	Muniappan and Sundararaj, 2003
	Bambusa arundinacea	Ethanol extract; Hydroalcohol extract	Protein denaturation; HRBC membrane stabilization	Hydroalcohol extract of bamboo shoot has high anti-inflammatory.	Vanitha *et al*., 2016
Antifungal activity	*Bambusa vulgaris*	Aqueous extract	Determination of inhibitory activity of *Botryodiplodia theobromae*, *Fusarium oxysporum*, *Fusarium solani*, *Fusarium verticillioides*, and *Macrophomina phaseolina*	*Bambusa vulgaris* were observed to be less effective against the fungal pathogens.	Abiala *et al*., 2015
	Bambusa vulgaris	Aqueous extract; Ethanol extract; Ethyl acetate extract; Hexane extract	Determination of inhibitory activity of *Candida albicans*, *Candida parapsilosis*, *Cryptococcus neoformans*, *Aspergillus fumigatus*, *Trichophyton interdigitale*, and *Trichophyton rubrum*	The extracts (sequentially: hexane, ethyl acetate, ethanol, and water) obtained from *B. vulgaris* of both species showed stronger antifungal activity (MIC: 0.01–2.50 mg/ml).	Kong *et al*., 2020
	Bambusa oldhamii	–	Determination of inhibitory of *Scolecobasidium longiphorum*	*Bambusa oldhamii* showed antifungal activity against *S. longiphorum*.	Kuo *et al*., 2008
	Bambusa blumeana	Aqueous extract; Ethanol extract	Determination of inhibitory of *Aspergillus niger* and *Penicillium chrysogenum*	Pharmaceutically approved antifungal drug at 1 mg/ml concentration.	Saducos, 2021
	Bambusa balcooa	Ethanol extract	Determination of inhibitory of *Fusarium equiseti*	Antimicrobial supplement at concentration of 500 µl/l was more effective in removing fungus contamination and had no negative effect on shoot growth parameters.	Tyagi *et al*., 2018
Antibacterial activity	*Bambusa balcooa*	Alginate and starch with added carboxymethyl cellulose	Determination of inhibitory of *Escherichia coli*, *Staphylococcus aureus*, and *Bacillus cereus*	The film successfully inhibited surface microbial load.	Badwaik *et al*., 2014
	Bambusa vulgaris	Aqueous extract; Ethanol extract	Determination of inhibitory of *Salmonella typhimurium*, *Salmonella typhi*, and *Pseudomonas aeruginosa*	MIC: 40.0 ± 4.2; 40.0 ± 4.3; 40.0 ± 4.8 mg/ml	Bolou *et al*., 2011
	Bambusa vulgaris	Aqueous extract; Methanol extract	Determination of inhibitory of *E. coli*, *Salmonella* sp., and *Shigella sonnei*	*Shigella sonnei* and *E. coli* were the most susceptible pathogens to the extracts of the medicinal plants.	Fagbohun Emmanuel *et al*., 2010

Continued

Pharmacological properties	Species	Material basis	Methods	Results	References
	Bambusa arundinacea	Ethanol extract	Determination of inhibitory of *Bacillus subtilis* and *Staphylococcus aureus*	The findings suggested that bacteria and ZnO NPs interact, resulting in the demolition of bacterial cells.	Jayarambabu *et al*., 2021
	Bambusa arundinacea	Aqueous extract	Biosynthesis process of AgNPs	AgNPs were successfully synthesized from $AgNO_3$ using the latex of *B. arundinacea* leaves as a reducing and capping agent in a simple green route.	Kataria *et al*., 2017
	Bambusa vulgaris	Aqueous extract; Ethanol extract; Ethyl acetate extract; Hexane extract	Determination of inhibitory of *Bacillus cereus*, *Staphylococcus aureus*, *Acinetobacter baumannii*, *E. coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*	None of the extracts were bactericidal against *A. baumannii* or *E. coli*.	Kong *et al*., 2020
Antibacterial activity	*Bambusa tuldoides*	Aqueous extract; Ethanol extract	Determination of inhibitory of *Staphylococcus aureus*, *Salmonella typhi*, *Streptococcus faecalis*, and *E. coli*	Higher concentrations (20 g/ 40 ml) resulted in higher antibacterial activity in all of the sorghum liquor and fermented maize leaf extracts.	Oluwahenyinmi *et al*., 2014
	Bambusa arundinacea	Ethanol extract; Ethyl acetate extract; Hexane extract; Hydroalcohol extract	Determination of inhibitory of *E. coli*, *Bacillus subtilis*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*	Hydroalcohol and ethanol extracts were active against all bacterial strains screened.	Sandhiya *et al*., 2013
	Bambusa bambos	Formation of nanobiocomposites in film and ointment forms	Determination of inhibitory of *Bacillus subtilis*, *Citrobacter freundii*, *E. coli*, *Pseudomonas aeruginosa*, *Staphylococcus epidermidis*, and *Micrococcus luteus*	Nanobiocomposites with high water absorption and antibacterial activity had a synergistic effect on *in vivo* skin wound healing, resulting in faster and more significant wound closure in treated mice.	Singla *et al*., 2017
Anticancer activity	*Bambusa arundinacea*	Ethanol extract	MTT assay	Cell viability levels were found to decrease as ZnO NPs concentration increased.	Jayarambabu *et al*., 2021
	Bambusa arundinacea; *B. nutans*	Hot water extract	MTT assay	IC_{50}: 73.57; 84.88 µg/ml	Kalaiarasi *et al*., 2015
Antimalarial activity	*Bambusa arundinacea*	Methanol extract	Peters' 4-day suppressive test against *Plasmodium berghei* infection in mice	26.0% suppression	Esmaeili *et al*., 2015

Continued

Pharmacological properties	Species	Material basis	Methods	Results	References
Antimalarial activity	*Bambusa vulgaris*	Aqueous extract; Ethyl acetate extract; Petroleum ether extract	*Plasmodium falciparum* chloroquine-sensitive 3D7 and chloroquine-resistant W2 strains	IC_{50}: 7.50 ± 1.08; 0.49 ± 0.06; 0.75 ± 0.21 µg/ml	Komlaga *et al*., 2016
	Bambusa vulgaris	Ethanol extract	*Plasmodium falciparum* chloroquine-susceptible Ghana strain	IC_{50}: 4.7 µg/ml	Valdés *et al*., 2010
Antidiabetic activity	*Bambusa arundinacea*	–	STZ-induced diabetic wistar rat model	Therapy with Qurs Tabasheer for 28 days significantly reduces the level of serum glucose.	Ahmed *et al*., 2013
	Bambusa tulda	Hydromethanol extract	Alloxan-induced diabetic rat model	A reduction pattern in blood glucose level was noticed up to 6th week in experimental animals receiving the high dose (100 mg/kg/ml).	Dey *et al*., 2018
	Bambusa balcooa	Acetone extract; Aqueous extract; Methanol extract	Alloxan-induced wistar albino rat model	In alloxan-induced diabetic rats, administration of aqueous *B. balcooa* at 100 and 200 mg/kg resulted in a significant reduction in fasting blood glucose and glycated hemoglobin while plasma insulin level was elevated compared to diabetic control.	Goyal *et al*., 2017
	Bambusa arundinacea	Ethanol extract	STZ-induced diabetic wistar rat model	Oral administration of ZnO nanoparticles for 14 days resulted in a significant decrease in blood glucose levels.	Jayarambabu *et al*., 2021
	Bambusa arundinacea	Aqueous extract	STZ-induced diabetic wistar rat model	The extract had a statistically significant hypoglycemic effect with an oral dose of 500 mg/kg in euglycemic rats after 30 min and 1,000 mg/kg in hyperglycemic rats after 3 hours.	Joshi *et al*., 2009
Abortifacient activity	*Bambusa vulgaris*	Aqueous extract	Pregnant Dutch rabbits	The 250 and 500 mg/kg body weight of the extract reduced the survival rate of the fetus to 29% and 0%, whereas the same doses produced abortion at the rate of 60% and 100%, respectively.	Yakubu and Bukoye, 2009

Continued

Pharmacological properties	Species	Material basis	Methods	Results	References
Abortifacient activity	*Bambusa vulgaris*	Aqueous extract	Pregnant Dutch rabbits	The extract did not significantly alter ($p > 0.05$) the serum follicle stimulating hormone and total protein content of the pregnant rabbits throughout the exposure period.	Yakubu *et al*., 2009
Cytotoxic activity	*Bambusa arundinacea*	Methanol extract	MTT assay	No significant	Esmaeili *et al*., 2015
	Bambusa vulgaris	Aqueous extract	MTT assay	CC_{50}: > 100 µg/ml	Komlaga *et al*., 2016
	Bambusa vulgaris	Ethanol extract	MTT assay	CC_{50}: 136.7 µg/ml	Valdés *et al*., 2010

kidney GGT activity decreased at 500 mg/kg while the 250 mg/kg dose did not affect the liver and serum GGT. Furthermore, the extract increased the levels of total and conjugated bilirubin, bicarbonate ions, creatinine, potassium, sodium, and uric acid in the blood. The alteration of biochemical markers by the aqueous extract of *B. vulgaris* leaves suggests a negative impact on the excretory, secretory, synthetic, and reabsorptive functions of the liver and kidney in animals (Yakubu *et al*., 2009). Yakubu and Bukoye (2009) also showed *B. vulgaris* aqueous extract to be an abortifacient. The dosage of the extract at 250 mg/kg and 500 mg/kg decreased the fetus survival rate to 29% and 0%, correspondingly, while the same levels resulted in 60% and 100% more abortions, accordingly. The implantation index and preimplantation loss were evaluated in relation to the control. Both dosages resulted in an increase in the post-implantation loss and resorption index. The extract also decreased serum progesterone, luteinizing hormone, and follicle-stimulating hormone levels. These results verified the abortifacient properties of the aqueous extract of *B. vulgaris* leaves.

Cytotoxic effect

Methanolic extract of *B. arundinacea* was screened for cytotoxicity effect on Madin-Darby bovine kidney cells and showed no IC_{50} (Esmaeili *et al*., 2015). Nevertheless, the aqueous extract of *B. vulgaris* showed CC_{50} > 100 µg/ml when tested for cytotoxicity against human umbilical vein endothelial cells, supporting its classical usage in Ghana as a malaria therapy (Komlaga *et al*., 2016). A hydroalcoholic extract of *B. vulgaris* over human cell line MRC-5 to examine cytotoxicity showed CC_{50} of 136.7 µg/ml, thereby reflecting that the extract could possess cytotoxicity activity (Valdés *et al*., 2010).

SUMMARY AND OUTLOOK

This review has elucidated the significance of *Bambusa* spp. as a medicinal plant with diverse pharmacological spectra. *Bambusa* spp. contain a variety of phytochemical constituents that are responsible for their diverse ethnomedicinal and pharmacological properties. Developing novel clinical therapeutics from *Bambusa* spp. requires additional investigation of the current data. Given that this review compiled vital information on various aspects of this medicinal plant, it provides an excellent opportunity for future research.

ACKNOWLEDGMENTS

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AUTHOR CONTRIBUTIONS

All authors made substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; took part in drafting the article or revising it critically for important intellectual content; agreed to submit to the current journal; gave final approval of the version to be published; and agree to be accountable for all aspects of the work. All the authors are eligible to be an author as per the international committee of medical journal editors (ICMJE) requirements/guidelines.

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The authors report no financial or any other conflicts of interest in this work.

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This study does not involve experiments on animals or human subjects.

DATA AVAILABILITY

All data generated and analyzed are included in this research article.

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