Ethnomedicinal uses, Pharmacological and Phytochemical Studies of *Bambusa arundinacea* Retz (A Review)

SYED NAZREEN*

Department of Chemistry, Faculty of Science, Al Baha University, Al Baha, Kingdom of Saudi Arabia.
*Correponding author E-mail: syed.nazreen@gmail.com; syed.nazreen22885@gmail.com

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**ABSTRACT**

Medicinal plants are a source of different types of natural products which are used in different illness. *Bambusa arundinacea*, commonly known as Bamboo belongs to family Poaceae (Gramineae). In folk medicine, it has been utilized for various inflammatory disorder, strangury, wounds, piles, dislodgement of worms, cirrhosis, hard tumour and *Diabetes mellitus*. This plant possess antiinflammatory, antidiabetic, antimicrobial, antioxidant, anticancer, antiglycation, laxative, antifertility, antihelminthic, insecticidal, antiarthritic and neuroprotective activities. *B. arundinacea* extract has also been utilized in the synthesis of nanoparticles which have enhanced the biological activities such as anticancer, antidiabetic, antimicrobial and antiglycation. The phytochemical analysis of this plant has afforded important classes of natural products such as terpenoids, steroids, flavonoids, phenols and glycosides, etc. These natural products have been reported for various pharmacological activities which may be responsible for the different biological activities of this plant. Although, this plant has not been explored much scientifically, very few reports are available on this plant. However, this plant is gaining interest in nanomedicine field as the nanoparticles synthesized using this plant extract have shown enhancement in antidiabetic, anticancer and antimicrobial activities. The present review article will help the readers to explore more on this plant in various filed of nanotechnology, biotechnology and phytochemistry as it contains promising bioactive molecules. Moreover, some phytoconstituents especially flavonoids may be used for semisynthetic modification for development of lead molecules.

**Keywords:** *Bambusa arundinacea*, Pharmacology, Ethnomedicinal, Phytochemistry.

**INTRODUCTION**

*Bambusa arundinacea*, commonly known as Bamboo belongs to family Poaceae (Gramineae). It is known by various names as Bnah in Assamese, Spanish bamboo in English, Wans in Gujarati, Kanta bans in Hindi, Bansa in Urdu, Vansa in Sanskrit and Bilawar in Kashmiri. It is situated upto height of 1250 m on the hills of Andhra Pradesh, Tamil Nadu, Karnataka in India, Peru, China, Sri Lanka, Bangladesh, and Malaysia. The plant consists of hard stem with internode and solid node that gives strength to this plant. The nodes bears many buds from which branches evolve, this makes Bamboo different from other grass family. The plant stems are thorny tufted on a stout rootstock, with a height of 240-280 cm and diameter of 150-170 mm. It has elongated and lanceolate leaves and flowers are in the form of panicles.
**Bambusa arundinacea** has been reported to possess important pharmacological activities such as antiinflammatory, anti diabetic, antioxidant, antimicrobial, insecticidal, antihelminthic, anticancer, protective effect, antiarthritis, etc. Muniappan et al.,\(^5\) reported that the methanolic leaves extract exhibited promising antiinflammatory activity on carrageenan and immunologically induced paw edema in Albino wistar rats\(^{14}\). **B. arundinacea** has been found to possess antimicrobial activity against a number of bacterial and fungal strains hence it could be a possible source to obtain new and effective compound to treat bacterial and fungal infections. Zubair et al.,\(^{14}\) reported that n-hexane and chloroform extract displayed significant antimicrobial activity against the tested pathogens while acetone, methanol and butanol extract were found to be inactive. Thamizarasan et al.,\(^8\) reported that hexane, acetone and hydroethanolic extract of this plant seeds have significant antimicrobial effect against various microorganisms. Jayarambabu et al.,\(^9\) reported the antimicrobial activity of **Bambusa arundinacea** extract by Agar disc diffusion method against *S. aureus* and *B. subtilis*. The ethanolic extract of tender shoots of the plant possess antifertility effect as reported by Vanithakumari et al.,\(^{16}\).

**B. arundinacea** is endowed with antihyperglycemic potential. Joshi et al.,\(^{17}\) reported the aqueous ethanolic extract of leaves of **B. arundinacea** to possess hypoglycemic activity, Nazreen et al.,\(^6\) reported the hypoglycemic effect of **B. arundinacea** leaves three fractions viz. ethanolic petroleum ether, chloroform in STZ induced diabetic rats. Kumar et al.,\(^23\) reported that roots ethanolic extract of this plant displayed lowering in the blood glucose level in normal and hyperglycemic rats in alloxan and OGTT methods. Macharla et al.,\(^{18}\) reported that the aqueous ethanolic stem extract (200 mg/kg) of **Bambusa arundinacea** showed decrease in glucose level in alloxan induced diabetic rats. Jayarambabu et al.,\(^{18}\) reported the antidiabetic effect of **Bambusa arundinacea** (BA) extract and its ZnO nanoparticles in normal and STZ induced rats. **B. arundinacea** has been reported to possess insecticidal\(^9\) and antihelminthic\(^{10}\) properties. **B. arundinacea** has been used for the treatment of rheumatoid arthritis. Anti-arthritic effect against complete Freund’s Adjuvant (CFA) induced arthritis in female rat were investigated by Rathod et al.\(^3\). **B. arundinacea** has been found to possess protecting properties as well as anti-plasmin activity in cortical neuron which were induced by N-methylaspartate and fibrinogen and fibrin degradation (FDPs) assay, respectively as reported by Hong et al.,\(^{12}\) **B. arundinacea** is a rich source of antioxidants. Chauhan et al.,\(^7\) reported that the methanolic extract and different fractions of young shoots of **Bambusa arundinacea** have prominent antioxidant property. **B. arundinacea** synthesized nanoparticles further enhanced the biological activities. For example, Kalaiarasi et al.,\(^{11}\) have synthesized the silver nanoparticles (AgNPs) using **B. arundinacea** leaf extract which showed enhanced cytotoxicity on PC-3 (lung cancer) and Vero normal cell lines. Jayarambabu et al.,\(^{15}\) prepared zinc oxide nanoparticles (ZnO NPs) of BA extract exhibited strong anticancer activity against MCF-7 cell line. Patel et al.,\(^{19}\) reported antiglycation potential of zinc oxide nanoparticles utilizing **B. arundinacea** leaf extract, inhibited the formation of AGEs, decreased the level of fructosamine and formation of glycosylated Hb.

**Ethnomedicinal uses**

**Bambusa arundinacea** are arboreous grasses known to mankind since a long time and is utilized as a food and shelter by native people\(^{20,21}\). It is used in various application such as making traditional and musical instruments, boat rafts, construction, utensils for cooking, and in management of waste water\(^{22}\).

In folk medicine, **Bambusa arundinacea** is used for the treatment of many inflammatory disorders\(^{23}\). The plant stem and leaves are acidic and used as a laxative, in blood diseases, kapha, inflammation, piles and bile disorders\(^{24}\). It is also used in constringent and kidney disorders in Ayurveda. The extract of leaves bud is used in menstrual discharge, leaves infusion for eye wash and used internally for bronchitis, gonorrhoea and fever\(^6\). The acrid seed are used for liver dysfunction and urinary discharges\(^5\). The root ointment is a remedy for liver cirrhosis and tumors\(^7\). The leaves are emmenagogue and used for sciatica, fibrositis, gastic and liver diseases, lung bronchitis, and gonorrhea whereas flower juices is used in deafness and ear pain. The bark is used as a cure for eruptions\(^{26}\). The manna is sweet, acrid, tonic which is used for blood
diseases, lung diseases such as asthma, bronchitis and tuberculosis. Besides this, it is also used for fever, haemoglobin deficient anaemia, hepatitis and leprosy. Tabasheer (dried bamboo sap) containing 97% silicon dioxide is used as a tonic for cough and asthma. The leaves of this plant are used by tribal women in Madras for abortion of a child by chewing it two times a day. In Kanyakumari Kani tribes, the seeds of this plant increase the fertility and therefore it is in large demands for the improvement of fertility in this area. The leaf juice is used for osteoarthritis, osteoporosis for making the cartilage and bones strong, for strengthening arterial walls, teeth and nails and reduces psoriasis and dermatitis. Traditional practitioner’s uses 2-3 cups of B. arundinacea Retz. leaf decoction three times a day for months to treat diabetes mellitus.

Pharmacology

*Bambusa arundinacea* has been reported to exhibit important pharmacological activities viz. antiinflammatory, antidiabetic, anticancer, antifertility, anthelmintic, insecticidal, antimicrobial, etc. (Fig. 1). These activities are discussed below.

![Fig. 1. Biological activities exhibited by B. arundinacea](image)

**Antiinflammatory, analgesic and antiulcer activity**

*B. arundinacea* is reported for the treatment of many inflammatory conditions. It has been found that the methanolic leaves extract exhibited antiinflammatory activity on carrageenan and immunologically induced paw edema in Albino wistar rats. The effect was found to be significant, compared to positive control, phenylbutazone. However, amalgamation of extract and phenylbutazone when administered orally in Albino rats resulted in enhanced antiinflammatory activity experimentally without any ulcerogenic effect. Therefore, the amalgamation of extract of this plant with modern medication could produce antiinflammatory drugs that could be of advantage in treating inflammatory problems such as rheumatoid and osteoarthritis. *B. arundinacea* ethanolic and hydroalcoholic extract displayed *in vitro* anti-inflammatory activity with $IC_{50}$ of 700 and 212 μg/mL, respectively whereas ibuprofen displayed $IC_{50}$ of 118.33 μg/mL. Also, the ethanolic leaves extract at 100 mg/kg and 200 mg/kg exhibited promising analgesic and antipyretic effect in dose dependent manner. These results indicate that *B. arundinacea* has the potential to reduce inflammation with less side effects.

**Antimicrobial effect**

*B. arundinacea* could be a possible source to obtain new and effective compound to treat bacterial and fungal infections. *B. arundinacea* has been found to possess antimicrobial activity against a number of bacterial and fungal strains. 2,6 dimethoxy-p-benzoquinone isolated from bamboo extract inhibits the growth of *Candida albicans*, *Trichophyton interdigitale*, *Microsporum gypseum*, *Penicillium chrysogenum*, *Staphylococcus aureus*, *Bacillus subtilis*, and *P. aeruginosa*.

Zubair et al., reported that n-hexane and chloroform extract displayed significant antimicrobial activity against the tested pathogens while acetone, methanol and butanol extract were found to be inactive. Table 1 showed that n-hexane extract showed good inhibitory activity against *E. coli*, *P. multocida*, and *B. subtilis* with MIC 3.81 μg/mL, 5.28 μg/mL and 5.26 μg/mL, respectively whereas it was inactive on tested fungal strains. Chloroform extract displayed moderate inhibition on *S. aureus* and *B. subtilis* with MIC 15.5 μg/mL and 10.7 μg/mL, respectively while it was inactive against *E. coli*. Acetone extract was found to be active against *G. lucidum* with MIC = 4.00 μg/mL only while it did not show any inhibitory activity against A. alternata, *E. coli*, and *S. aureus*. 

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**Table 1. Antimicrobial activity of *B. arundinacea* extract**

| Extract Type | MIC (μg/mL) |
|--------------|-------------|
| n-Hexane     | 3.81        |
| Chloroform   | 15.5        |
| Acetone      |             |
Table 1: Antimicrobial activity in terms of inhibition zones and minimum inhibitory concentration of B. arundinaceae leaves against selected bacterial and fungal strains

| Tested microorganisms          | Different organic extracts | B. subtilis | P. multocida | S. aureus | E. coli | A. alternata | G. lucidum |
|--------------------------------|---------------------------|------------|-------------|----------|--------|-------------|-----------|
|                                | n-hexane                  | 17.0±0.81b| 19.0±0.70b  | 15.5±1.11 | 22.2±1.47 | n.d         | n.d       |
|                                | Chloroform                | 17.0±0.70b| 16.0±1.80b  | 19.0±0.70 | n.d    | 8.5±1.23    | 9.0±1.11  |
|                                | Ethyl acetate             | 22.7±2.27b| 18.0±0.70b  | n.d      | n.d    | n.d         | n.d       |
|                                | Acetone                   | 18.5±0.56  | 16.2±1.47   | n.d      | n.d    | n.d         | 24.2±5.26 |
|                                | n-butanol                 | n.d        | n.d         | 19.5±1.08 | 22.0±3.11 | 6.5±0.03    | 6.5±1.11  |
|                                | Absolute Methanol         | n.d        | n.d         | n.d      | n.d    | 11±1        | 8.5±0.02  |
|                                | (0.5:9.5) water: methanol | 17.7±0.82b| n.d         | 22.0±1.82 | n.d    | 7.75±1.47   | 8.5±1.11  |
|                                | (1:9) water: methanol     | n.d        | n.d         | n.d      | n.d    | 6.0±1.58    | n.d       |
|                                | Control                   | 29.0±1.08b | 34±1.08b    | 28.5±0.82 | 28.5±1.08 | 26±0.0 ± 5  | 7.1 ± 1   |

Minimum inhibitory concentration (MIC) mg/mL.

| Extracts                      | B. subtilis | P. multocida | S. aureus | E. coli | A. alternata | G. lucidum |
|-------------------------------|------------|--------------|----------|--------|-------------|-----------|
| n-hexane                      | 5.6±0.12   | 5.2±0.16     | 22.4±0.32| 3.8±0.5| n.d         | n.d       |
| Chloroform                    | 10.7±0.07  | 12.5±0.21    | 15.5±0.21| n.d    | 10.6±0.38   | 10.5±0.40 |
| Ethyl acetate                 | 3.0±0.25   | 6.4±0.29     | n.d      | n.d    | n.d         | n.d       |
| Acetone                       | 12.4±0.11  | 12.1±0.12    | n.d      | n.d    | n.d         | 4.0±0.36  |
| n-butanol                     | n.d        | n.d          | 15.8±0.22| 2.8±0.23| 18.4        | 15.0±0.04 |
| Absolute Methanol             | n.d        | n.d          | n.d      | n.d    | 7.4±0.40    | 11.4±0.04 |
| (0.5:9.5) water: methanol     | 10.4±0.17  | n.d          | 5.8±0.10 | n.d    | 11.8±0.07   | 11.4±0.46 |
| (1:9) water: methanol         | n.d        | n.d          | n.d      | n.d    | 18.4±0.36   | n.d       |
| Control                       | 2.0±0.32   | 2.0±0.32     | 2.1±0.32 | 2.0±0.32| 3.0±0.04    | 3.0±0.04  |

Data are expressed as the mean ± standard deviation; values having different letters differ significantly (p <0.05). n.d= not detected.

The hexane, acetone and hydroethanolic extract of this plant seeds have shown significant antimicrobial effect against various microorganisms. Jayarambabu et al., reported the antimicrobial activity of ZnO nanoparticles using Bambusa arundinacea extract by Agar disc diffusion method against S. aureus and B. subtilis. As observed from Fig. 2, the synthesized ZnO nanoparticles showed enhanced zone of inhibition of 14, 16, 17, 19 mm and 12, 14, 15, 17 mm against S. aureus and B. subtilis, respectively. The ZnO NPs interaction between S. aureus and B. Substilis was studied by SEM to observe the morphology changes of bacteria and under ZnO NPs treatment. The normal S. aureus and B. subtilis shows spherical and rod shape with smooth surface area, but ZnO NPs treated bacteria displayed irregular morphology and ruptured bacterial cell walls which indicate the interaction of bacteria and ZnO NPs, leading to demolition of bacterial cells.

Antifertility effect
The ethanolic extract of tender shoots of the plant exhibits antifertility effect. The administration of plant extract at 300 mg/kg in male rats for 7 days caused a fertility reduction in male rats and the reduction was 15% for control rats and 23% for tested rats after a seven day recovery period. The protein serum as well as effect of oxaloacetic and pyruvic transaminase was non toxic on the rats.
Antidiabetic effect

*B. arundinacea* is endowed with antihyperglycemic potential. The aqueous ethanolic extract of leaves of *B. arundinacea* have been found to possess hypoglycemic activity. Joshi *et al.*,\(^{17}\) reported that BA leaves aqueous extract at 1000 mg/kg produced a promising decrease in blood glucose level to 260 mg/dL at 3 h in STZ induced diabetic rats. Whereas in OGTT method, the extract increased blood glucose significantly at 30 min as shown Fig. 3.

![Blood glucose levels comparison](image1)

**Fig. 3.** OGTT in euclidean rats treated with *Bambusa arundinacea* extract

Nazreen *et al.*,\(^6\) reported the hypoglycemic effect of *B. arundinacea* leaves three fractions viz. ethanolic petroleum ether, chloroform in STZ induced diabetic rats showed that chloroform was the most potent in lowering the blood glucose at 150 mg/kg b.w., compared to glibenclamide, positive control. Also, this fraction did not cause any ulceration, decreased GSH level and increased LPO, AST and ALP enzymes Fig. 4.

Kumar *et al.*,\(^{31}\) reported that roots ethanolic extract of this plant displayed lowering in the blood glucose level in normal and hyperglycemic rats in alloxan and OGTT methods. Macharla *et al.*,\(^{18}\) reported that the aqueous ethanolic stem extract (200mg/kg) of *Bambusa arundinaceae* showed decrease in glucose level in alloxan induced diabetic rats. As observed from Fig. 5, Group II, III, IV, V and VII showed suppression of blood glucose level at 6 h significantly (p<0.01) compared to zero hour to its respective group.

![Lipid peroxidation levels comparison](image2)

**Fig. 4.** Effect of chloroform fractions and ethyl acetate fraction of *Bambusa* on blood glucose levels of diabetic rats (A). Effect of fractions on lipid peroxidation (B)

Jayarambabu *et al.*,\(^{15}\) reported the antidiabetic effect of *Bambusa arundinaceae* (BA) extract and its ZnO nanoparticles. As shown in Fig. 6, BA extract and ZnO-NPs did not produce reduction in
blood glucose levels in normal rats. Whereas in STZ induced diabetic rats, ZnO NPs significantly dropped the blood glucose levels at 200 mg/kg after 14 days of oral administration than BA extract. Moreover, the histopathology of liver after treatment with BA extract and ZnO-NPs displayed normal architecture, and the hepatocytes were observed Fig. 7.

contain 0.03% hydrogen cyanide, benzene carboxylic acid and cyanogenic glucosides viz. taxiphyllin which are reported to be fatal on mosquito larvae. Bamboo shoots can resist insects, laterites, pH and hemp thus they have antiseptic and antilarval properties.

**Antiarthritic activity**

*B. arundinacea* has been used for the treatment of rheumatoid arthritis. Anti-arthritic effect against complete Freund’s Adjuvant (CFA) induced arthritis in female rat were investigated. The methanolic plant extract at 100, 200 and 300 mg/kg b.w. for 21 days displayed dose dependent reduction in erosion of bone and enlargement of spleen, compared to control, But the reduction was not as significant as dexamethasone (5 mg/kg i.p.)

**Antihelminthic Activity**

*B. arundinacea* root ethanolic extract has been endowed with antihelminthic property. The anthelmintic activity of the extract has been investigated in *Pheretima posthuma*. It has been observed that the extract at 10, 20 and 50 mg/mL were found to be lethal for *Pheretima posthuma*. The antihelminthic effect was comparable to Albendazole, (10 mg/mL) and Piperazine citrate (15 mg/mL) positive control.

**Protective effects**

*B. arundinacea* has been found to possess protecting properties as well as anti-plasmin activity in cortical neuron which were induced by N-methyldaspartate and fibrinogen and fibrin degradation (FDPs) assay, respectively. It has been observed that *B. arundinacea* pyrolyzates treated neuronal cells increases the cell viability, compared to untreated cells. Furthermore, *B. arundinacea* pyrolyzates treated cortical neurons when stained by Hoechst 33342 showed decline in apoptosis following NMDA exposure. Besides this, pyrolyzates of *B. arundinacea* showed anti-plasmin activity. Pyrolyzate isolated from bamboo have antiapoptotic effect and it can be used for ischemic injury treatment as the amalgamation of NMDA receptor antagonists, GABAergic drugs, glucocorticosteroids, and heparin are used for delay in post ischemic injury.

**Antioxidant property**

Chauhan et al., reported that the methanolic extract and different fractions of young shoots of...
Bambusa arundinacea have prominent antioxidant property. Among the tested fractions (Table 2), n-butanol fraction contained highest phenolic (56.6±2.4 mg gallic acid equivalent (GAE)/g DW) and ethylacetate fraction contain highest flavanoid (47±2.6 mg Quercetin equivalent/g DW) content. From the DPPH scavenging activity as shown in Fig. 8, Ethylacetate fraction displayed highest scavenging with IC\textsubscript{50}=40.33±0.63 μM, compared to ascorbic acid (IC\textsubscript{50}=30.69±2.1 μM. Also, this fraction showed superior anti-lipid peroxidation (IC\textsubscript{50}= 61.89±0.44 μM and reducing power as shown in Fig. 8.

Table 2: Total Phenolic and Flavonoid content of different fractions of young shoots of Bambusa arundinacea by Chauhan et al.,

| Phenolic content | Flavonoid content |
|------------------|------------------|
| mg Gallic acid equivalent/g DW | mg Quercetin equivalent/g DW |
| n-hexane fraction | 3.5±1.4 | 9.5±1.1 |
| Chloroform fraction | 10.2±1.8 | 8.5±0.7 |
| Ethyl acetate fraction | 30.8±1.5 | 47±2.6 |
| n-butanol fraction | 56.6±2.4 | 20±1.6 |

Anticancer activity
Kalaiarasi et al., have synthesized the silver nanoparticles (AgNPs) using B. arundinacea leaf extract and screened for cytotoxicity on PC-3 (lung cancer) and Vero normal cell lines. The AgNPs were characterized by FTIR, TEM and SEM. The FTIR spectra of BaAgNPs showed intense peaks at 3396 cm\textsuperscript{-1}, 3211 cm\textsuperscript{-1}, 2286 cm\textsuperscript{-1}, 1402 cm\textsuperscript{-1} for NH stretching, S–H stretching, C=C stretching (alkenes) and C=C stretching Fig. 9.

The synthesized silver nanoparticles showed IC\textsubscript{50} values of the PC3 cells and Vero cells were 73.57 and 84.88 μg/mL and 93.58 and 96.41 μg/mL for BaAgNPs. The effect of NPs on the growth of normal cell lines (Vero) did not exhibit significant cytotoxicity at their lower concentrations (Fig. 11). The percentages of the apoptotic bodies by AO/EtBr staining were found to be 76% and 62% for BaAgNPs and BnAgNPs, respectively Fig. 12.
Jayarambabu et al.,\textsuperscript{19} prepared zinc oxide nanoparticles (ZnO NPs) of BA extract exhibited strong anticancer activity against MCF-7 cell line. As shown in Fig. 13 (a,b), SEM images of the obtained nanoparticles were agglomerated, and most of them are in spherical. From TEM Fig. 13 (c,d), the sizes of the particles were observed in the range of \(~7-20\) nm.

**Fig. 13.** FESEM images of the ZnO NPs biosynthesized with plant extract (a-b) low and high magnifications. (c-d) TEM images of ZnO NPs at different magnifications

**Anticancer activity of Bambusa arundinacea** mediated ZnO NPs against the MCF-7 cell lines is depicted in Fig. 14. It was observed that with an increase in ZnO NPs concentration the cell viability levels decreased. These results indicate that biosynthesized ZnO NPs exhibit good anticancer activity.

**Fig. 14.** Anticancer activity of Bambusa arundinacea mediated ZnO NPs

**Miscellaneous**

Zihad et al.,\textsuperscript{32} carried out the laxative activity of the ethanolic extract of shoot of B. arundinacea in mouse model. It was observed from Fig. 15 that the extract exhibited promising laxative potential by promoting watery faeces, increasing
gastrointestinal motility and the amount of intestinal content, when compared with a negative control. The maximum activity (47.92%) was observed at 2 h at the dose of 500 mg/kg b.w. Gastrointestinal transit at the dose of 250 and 500 mg/Kg was 67.18 and 60.03% respectively. This report supports the traditional use of shoot of *B. arundinacea* in constipation.

Patel *et al.*,19 reported that zinc oxide nanoparticles (ZnO NPs) utilizing *B. arundinacea* leaf extract inhibited the formation of AGEs, decreased the level of fructosamine and formation of glycosylated Hb. The antiglycation potential of zinc oxide nanoparticles, ZnO NPs which was prepared from zinc acetate using sodium hydroxide were investigated. The synthesized ZnO nanoparticles were characterized by FTIR, and TEM analysis as shown in Fig. 16. The FTIR spectra of ZnO NPs showed a sharp and intense peak at 681 cm⁻¹ for Zn–O stretching, 1430 cm⁻¹ for C-C stretching, 1600 to 1800 cm⁻¹ for C=O, and 2854 cm⁻¹ for O-H stretching of carboxylic acid. The result of TEM showed that ZnO NPs are spherical and some oval particles with an average size of 80 nm. The synthesized ZnO NPs were tested for degree of glycation of albumin by measuring fluorescence intensity. The increased fluorescent intensity in BSA/glucose reaction indicates the level of glycated BSA increased over a period of time. As observed from Fig. 17, ZnO-NPs showed significant inhibition on glycation reaction, compared to control. Also, ZnO NPs treated glycation of albumin and AG treated glycation of albumin showed significant inhibition of glycated albumin (43.41% and 55.19% respectively) when compared to the untreated glycated control. Moreover, these nanoparticles inhibit the glycosylation of hemoglobin significantly when compared to the control (Fig. 18). Table 3 illustrates the preventive effect of green synthesized ZnO NPs on the formation of hemoglobin glycosylation. The study suggests biologically synthesized zinc nanoparticles showed the strong antiglycation potential and considered as a potential source of therapeutic agents for AGEs related disorder.

![Fig. 15. Laxative activity of *Bambusa arundinacea* in mice](image)

![Fig. 16. (A) FT-IR spectrum of biologically synthesized ZnO NPs; (B) TEM images of ZnO NPs](image)

![Fig. 17. Degree of glycation of albumin formed at different time interval measured relative by measuring fluorescence intensity by using spectrofluorometry](image)
Fig. 18. Inhibitory effect of biosynthesized ZnO-NPs from bioactive fraction F3 obtained from crude Bambusa arundinacea leaf extract on glycosylated Hb

Table 3: Inhibitory effect of biologically synthesized ZnO NPs on the formation of glycosylated Hemoglobin expressed in percentage

| No | Absorbance | Percentage of Inhibition |
|----|------------|--------------------------|
| Control (Hb + glucose) | 0.723 ± 0.051 | 0 |
| In presence of ZnO NPs with Hb + glucose | 0.448 ± 0.082 | 39.73% |

Phytochemistry

Phytochemical investigation of B. arundinacea Retz has afforded different type of chemical constituents (Fig. 19). Tabasheer (dried bamboo sap) is white, crystalline and sweet siliceous matter near the shoots joint\(^{33,34}\). Shoot of the plant contain various substances such as ethanedioic acid, hydrogen cyanide, waxes, and benzene carboxylic acid\(^{35}\), fiferuloyl arabinose hexasaccharide and taxiphyllin\(^{1}\)\(^{36}\). The seed of the plant contains various amino acids and other essential organic molecules such as phenylalanine, thiamine, lysine, leucine, histidine, arginine, cysteine, isoleucine, lysine, valine, methionine, tyrosine, riboflavin, niacin and thiamine. The leaves of the plant contains mainly gluteline, betain, methionine, cholin, lysine, nuclease, urease and proteolytic enzymes.\(^{37}\)

Tanaka et al.,\(^{38}\) have reported isoorientin\((2)\), tricin glucoside\((3)\), p-hydroxy cinnamic acid\((4)\), lyoniresinol 3-\(\alpha\)-O-\(\beta\)-D-glucopyranoside\((5)\), 3, 4, 5-trimethoxyphenol-\(\beta\)-D-glucopyranoside\((6)\), koaburaside\((7)\), 2, 6 dimethoxy-p-benzoquinone\((8)\) and sinapic aldehyde\((9)\) from the leaves of the plant. The plant also contains 3′,3,6,7-tetramethoxy-4′,5,8-trihydroxy flavones\((10)\), p-anisidic acid\((11)\), 4′-hydroxy 3-hydroxy flavane\((12)\) and hemicelluloses\(^{39,40}\). Nazreen et al., isolated 17, 20, 20-tri demethyl-\(\alpha\)-isopranyl oleanane\((13)\), eicosanyl dicarboxylic acid\((14)\) stigmasterol\((15)\), Stigmastrol glucopyranoside\((16)\), \(\alpha\)-amyrin acetic acid\((17)\) and ursolic glucopyranoside\((18)\) from the chloroform fraction of this plant\(^{41}\).

Fig. 19. Compounds isolated from B. arundinacea
CONCLUSION

*Bambusa arundinacea* is endowed with important pharmacological activities such as antiinflammatory, antidiabetic, antioxidant, antimicrobial, insecticidal, antihelmintic, and anticancer. It is also rich in phenolic and flavonoid bioactive molecules. Moreover, the nanoparticles using this plant extract have shown remarkable enhancement in various biological activities. Although, this plant has not been explored much scientifically, very few reports are available on this plant. The present review article will help the readers to explore more on this plant in various field of nanotechnology, biotechnology and phytochemistry as it contains promising bioactive molecules.

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Conflicts of Interest

No conflict of interest

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