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ORIGINAL ARTICLE

Phytochemical Screening, Antioxidant and Antibacterial Studies of Various Extracts of *Maranta arundinacea* L. rhizomes

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ABSTRACT

Background: Due to widespread availability, low cost, safety, and little side effects, herbal medications are now more often used than ever before. Medicinal plants with various pharmacological effects may be found in a variety of places in nature. An herbaceous, perennial tropical plant known as *Maranta arundinacea* L. offers a number of built-in medical benefits, including efficacy as an antioxidant and an antibacterial.

Objective: This plant's rhizome extracts were tested for phytochemical analysis, antioxidant capacity and antibacterial efficacy against some Gram-negative bacteria.

Methodology: In the current work, phytochemical analysis of *M. arundinacea* rhizome's various extracts was done by standard methods and its free radicals scavenge activity was assessed by using the well-known (in-vitro) model of DPPH while antibacterial activity was estimated by the disc diffusion method.

Results: Phenols, flavonoids, saponins, tannins, alkaloids, glycosides and steroids were found in the *M. arundinacea* rhizome extracts after a preliminary phytochemical screening, which may be the source of the plant's antioxidant and antibacterial action. The percentage inhibition (DPPH) of its water extract (80.11±3.2%) was higher than methanol extract (70.20±2.5%) followed by chloroform (37.50±1.8%) and petroleum ether extract (20.40±1.4%) at concentration 1mg/ml. The minimum inhibition zone developed against *Enterobacter aerogene* was (16±0.01mm), *Salmonella typhimurium* (19±0.03mm), *Pseudomonas aeruginosa* (18±0.02mm) and *Escherichia coli* (24±0.04mm), in methanolic extract, while the inhibition zone developed against *E. aerogene* was (18.5±0.02mm), *S. typhimurium* (19.5±0.03mm), *P. aeruginosa* (20±0.03mm) and *E. coli* (29±0.05mm), in water extract and no inhibition zone was developed in petroleum ether and chloroform extract.

Conclusion: It was concluded that *M. arundinacea* rhizome water and methanol extracts posses a strong antioxidant and antibacterial activity due to its phytochemicals which may offer an option for the treatment of illnesses linked to oxidative stress and for pathogens that are resistant to a number of drugs.

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INTRODUCTION

The use of herbal medicine is growing because of the pharmacological qualities of herbs and the idea that using a green solution would not damage anyone that are the original source of medicine. Several quality control criteria

for herbs were established by the World Health Organization (WHO)[1]. The conformation of plant resources can be aided by the pharmacognostic assessment. The medicinal value of herbs is due to their various naturally derived biologically active components (phytochemicals) like flavonoids, alkaloids, phenols, tannins, saponins, and so on[2]. Hence, phytochemical screening is crucial to uncover a drug's beneficial various powerful components.

Our natural world has endowed a thriving herbal world with several varieties of plants in various geographic locations[3]. One of these is *Maranta arundinacea* L, which is cultivated extensively in warm countries including Pakistan, China, Sri Lanka and the Philippines. It is a member of the family *Marantaceae* and the order *Zingiberales* (Figure **1**). The plant yields arrowroot, an easily digested starch, from an edible rhizome and is still one of the most popular natural medicines in the world[4]. It is used as a nutritious meal for newborns, as a culinary component and a flavorless thickener, as well as a treatment for individuals who are unwell. With direct application to the afflicted area, medications made from this plant are used to relieve sore mouths and painful gums. It soothes inflammation of the digestive tract alleviates acidity, indigestion, many types of persistent stomach discomfort and heartburn symptoms, laxative, wound healing and has antimicrobial activity[5, 6]. According to Francis *et al*. (2020)[7], the plant root has anti-arthritis and cytotoxic properties.

Figure 1. *Maranta arundinac*ea herb and its rhizomes.

Moreover, the mashed rhizomes are used to septic wounds, black spider and scorpion bites and snake poisoning to extract the poison from the affected region and it is also recognized to treat athlete's foot skin infections and has also antimicrobial and antioxidant properties. Phytochemical analysis of *Maranta arundinacea* L. indicated the presence of phenolic and flavonoids contents, both of which are known to be powerful antioxidants[8]. Antioxidants have positive effects on health and consuming antioxidant-rich foods may reduce the risk of developing certain diseases by preventing the growth of rancidity, delaying the formation of harmful oxidation products, preserving nutritional value and extending the shelf life of food products[7]. Antioxidant, antibacterial, antimutagenic, anti-inflammatory, anticarcinogenic and other biological characteristics of phenolic compounds have been reported[9]. In the current research phytochemical, antioxidant and antibacterial activity of diverse extracts of the rhizome were analyzed against some (Gram negative bacterial isolate) *Enterobacter aerogene, Salmonella typhimurium, Pseudomonas aeruginosa* and *Escherichia coli*.

MATERIALS AND METHODS

Plant Material

The rhizomes of *M. arundinacea* L. were collected, identified, washed with fresh water and dried in a hot air oven at 50 °C. The dried rhizomes were ground into a fine powder using an electric blender.

Solvent Extraction

The powdered plant material (20g rhizome) was extracted in a soxhlet extractor using 200 ml of petroleum ether, chloroform, ethanol and water solvent. To get rid of any remaining solvent residues, all solvent extracts were evaporated.

Phytochemical Screening

Following the procedures of Harborne, (1984)[10], and Kokate *et al*., (1995)[11], phytochemical screening of various solvent extracts was done to check the existence of numerous kinds of chemicals such as alkaloids, flavonoids, tannins, phenolic compounds, sterols, saponins, glycosides, carbohydrates and proteins.

DPPH Radical Scavenging Activity

This test was measured as described by Brand-Williams, (1995)[12] with slight modification by Saeed *et al*., (2022)[13]. Briefly 2.9 ml of a DPPH solution (0.004% in methanol), 100 µl of the samples (1 mg/ml) were added. After 30 minutes of reaction time at room temperature, the absorbance of the solution was measured at 517 nm. Each solution's capacity to scavenge free radicals was assessed by comparing its absorbance to that of a control solution (no extract). The ability to scavenge the DPPH radical was calculated using the following equation:

DPPH scavenging activity (%) = $(A_0 – A_1) /A_0 \times 100$

Where A_0 is the control absorbance and A_1 is the sample absorbance.

Antimicrobial Study

By the agar disc diffusion technique, the antibacterial activity of the various extracts of *M. arundinacea* samples was examined against several bacterial pathogens[14]. Oxoid's standard culture medium was used throughout the experiment to maintain the cultures at the appropriate temperature, which was 37°C. The medium was prepared, autoclaved, and aseptically transferred to petri plates. Microbial colonies were established in test tube slants before being transferred to medium petri plates for the experiment. Sterile and dried 6mm disc (Dif co, USA) were impregnated with 20µl filtered (using sterilized 0.45mm Millipore filter) with samples with concentration 1mg/ml. The impregnated discs of these samples were dried in a laminar flow cabinet and positioned on newly seeded microbial lawns (4 discs per plate), with a control being 20µl of sterile water and positive control 1% streptomycin while negative control with no extract. Every experiment was carried out in triplicate. The petri plates were incubated at the precise temperature and the zones of inhibition were measured in millimetres (mm) using the zone technique[15]. The organisms used were *Enterobacter aerogene, Salmonella typhimurium, Pseudomonas aeruginosa and Escherichia coli* were obtained from the Microbial Lab of Food and Biotechnology Research Centre (FBRC), PCSIR, Lahore, Pakistan.

Statistical Analysis

The averages of at least three different experiments were provided in each outcome. Data was presented as averages and standard deviations and subjected to one-way ANOVA. The statistical analysis program SPSS (SPSS software for Windows release 17.5; SPSS Inc., Chicago IL, USA) was also used to analyze the data.

RESULTS AND DISCUSSION

Phytochemical Screening

Screening for phytochemicals of rhizome of *Maranta arundinacea* revealed the presence of phenols, glycosides and saponins were present in all the extracts. Alkaloids, flavonoids, steroids and tannins were present in methanol and water extract while absent in petroleum ether and chloroform extract and protein was only present in water extracts (Table **1**). Alkaloids have the ability to alleviate pain and temperature[16]. Saponins have anti-carcinogenic and antioxidant properties, while glycosides can be used to treat blood circulation and cough. It also contains anti-inflammatory properties and encourages weight reduction[17]. It has been discovered that tannins and flavonoids have anti-oxidant, anti-inflammatory, antibacterial, antimutagenic and anticarcinogenic properties[18, 19].

Table 1. Phytochemical investigation of various extracts of *Maranta arundinacea* rhizomes.

Phytochemicals	Test Methods	Result & Observation	Pet. Ether Extract	$CHCl_3$ Extract	MeOH Extract	Water Extract
Flavonoids	Lead acetate test	A orange color	-	-	++	++
Alkaloids	Mayer's test	A white precipitate	-	-	+	+
Tannins	Ferric chloride test	A greenish blue color	-	-	+	+
Saponins	Forth test	Persistent foam	+	+	+	++
Steroids	Liebermann-Burchard	A bluish green color	-	-	+	+
Phenols	$FeCl_3$ test	A purple color	+	+	++	++
Glycosides	Keller Killani test	Formation of two layers. Lower reddish brown & upper acetic acid layer which turns bluish green	+	+	+	+
Proteins	Biuret Test	Formation of pink color	-	-	-	+

'++' vastly presence '+' Presence '-' Absent

A previous study examined the phytochemical composition of various *M. arundinacea* extracts that contained alkaloids, flavonoids, saponins, tannins and phenol[20]. Comparable research was conducted on the *M. arundinacea* rhizomes by Nishaa *et al* (2013)[21] and Sutoyo *et al* (2021)[22], they reported the presence of these phytochemicals. In addition, Ieamkheng *et al*. (2022)[23] investigated the potential use of *M. arundinacea* and examined the concentrations of total phenolic, flavonoids and tannin compounds. Due to the presence of these phytochemicals, this plant was reported to have a variety of biological functions.

DPPH Radical Scavenging Activity

There is growing evidence that indigenous antioxidants can help reduce the negative effects of oxidative stress, and there is growing interest in the beneficial biochemical properties of natural antioxidants found in herbs and medicinal plants[24]. The reactivity of several *M. arundinacea* extracts with DPPH, a stable free radical, was investigated in this work. The absorbance diminishes when DPPH takes up one electron in the presence of a free radical scavenger, and the ensuing discolouration is stechiometrically linked to the number of electrons obtained[25]. Figure **2** depicts how several extracts of the *Maranta arundinacea* rhizome affected the DPPH radical. All extracts demonstrated radical scavenging action in a concentration-dependent manner when tested using the DPPH technique. At 1mg/mL concentration *M. arundinacea* water extract exhibited percentage inhibition 80.11±3.2% and methanol extract possess 70.20±2.5% followed by chloroform 37.50±1.8 % and petroleum ether extract 20.40±1.4 % scavenging activity on DPPH assay. Our findings are consistent with those of Agnel and Mohan (2013)[26], who found that the methanol extract's percentage inhibition (DPPH) 70.11% at the same concentration (1mg/ml) and Kusbandari and Susanti (2017)[27] also studies of antioxidant activity of *M. arundinacea* using DPPH method also demonstrated that its methanol extract was most effective. Similarly Nishaa *et al*., (2012)[28] determined the antioxidant activity of ethanol extract of *M. arundinacea* and narrated that its antioxidant activity was comparable with that of the standard butylated hydroxyl toluene (BHT). Their redox characteristics, which can be useful in absorbing and neutralizing free radicals, quenching singlet and triplet oxygen or dissolving peroxides are primarily responsible for the antioxidant activity[29]. Antioxidants are compounds that can inhibit reactive oxygen and nitrogen species, as well as free radicals and they have the ability to stop immune deficiency disorders, ageing, cataracts, atherosclerosis, diabetes, arthritis, cancer, and other oxidative cell damage-related diseases[30].

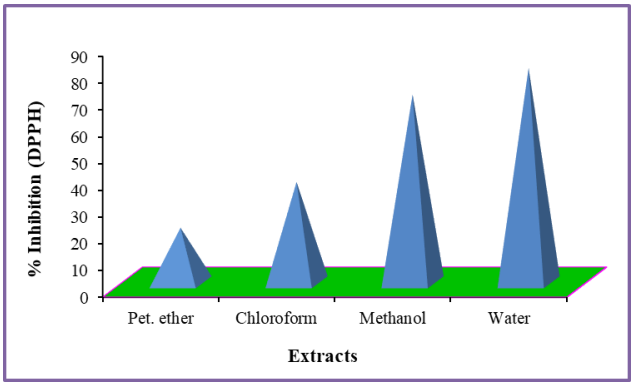

Figure 2. Percentage inhibition (DPPH) of various extract of *M. arundinacea* rhizomes.

Antibacterial Study

The most dangerous infections are those caused by microbes. To overcome microbial resistance to antibiotics, new antibiotics must be discovered. Numerous studies have shown that plant extracts function as natural antibacterial agents against the germs that cause food poisoning[31-33]. In this study it was revealed that the methanolic extract of *M. arundinacea* rhizome showed inhibition zone in diameter values of 16±0.01 mm, 19±0.03 mm, 18±0.02 mm and 25±0.04 mm respectively against *E. aerogene*, *S. typhimurium*, *P. aeruginosa and E. coli*. Whereas the inhibitory zone in its water extract had diameters of 18.5±0.02 mm, 19.5±0.03 mm, 20±0.03 mm and 29±0.05 mm respectively. The aqueous extract of *M. arundinacea* rhizome showed the strong antibacterial action against *E. coli* which demonstrated inhibition zone of 29 mm against strains which was higher than standard i.e. 1% streptomycin (Figure **3**). These findings may be beneficial for applying these rhizomes against pathogen bacteria. The lack of phytochemicals such alkaloids, flavonoids, and tannins, which may be responsible for antibacterial activity[34], may explain why the tested bacterial strain did not demonstrate a clear zone of inhibition in petroleum ether or chloroform extract. Amabye and Tadesse (2016)[35] also mention that tannins have the potential to exert antiviral, antibacterial and antiparasitic

properties which are found in the water and methanol extract but not be present in petroleum ether or chloroform extract. Antibacterial study showed that all extracts exhibited antibacterial efficacy against reference strains of human pathogenic bacteria and multidrug-resistant bacteria. While they prevented the development of the tested bacterial isolates with a zone of inhibition, *M. arundinacea* water and methanol extracts demonstrated the largest range of activity having a zone of inhibition of 16–29 mm in diameter (Table **2**).

The antimicrobial effect of *M. arundinacea* was discovered in vitro by Syahputra *et al*., (2020)[36] who measured its Minimum inhibitory concentration and Minimum bacterial concentration against Methicillin-Resistant Staphylococcus aureus (MRSA) and the inhibitory zone diameter was found to be 100% with a mean inhibitory zone diameter of 15.5mm. According to Dholaria and Desai (2018)[37], the medicinal plants posses the flavonoids, phenolics, alkaloids, steroids, tannins and glycosides that may have an antioxidant, bactericidal, bacteriostatic or fungicidal impact against a specific set of human infections. Some authors suggested that the successive inhibition of the metabolic process, suppression of protein production and crumbling of the outer membrane are what cause the secondary metabolites' inhibitory effect[38]. Consequently, according to many studies, medicinal plants offer a variety of secondary metabolites that work to counteract well-known illnesses brought on by infectious organisms like bacteria and fungus[39-41]. Because of *M. arundinacea* excellent therapeutic qualities towards the pathogenic organisms, the antibacterial activity was examined and it demonstrated effective antibacterial activity against a number of pathogens, including *Escherichia coli, Salmonella typhimurium, Pseudomonas aeruginosa,* and *Enterobacter aerogene*.

Table 2. Antibacterial activity (zone of inhibition) of different extracts of *M. arundinacea* rhizome against tested pathogenic bacteria.

Tested Microorganisms	Culture Media	Zone of Inhibition (mm)				
		Pet. Ether (A)	Chloroform (B)	Methanol (C)	Water (W)	Standard (S)
Enterobacter aerogene	CMF	ND	ND	16±0.01	18.5±0.02	25±0.04
Salmonella typhimurium	CM 201	ND	ND	19±0.03	19.5±0.03	27.5±0.05
Pseudomonas aeruginosa	CM 579	ND	ND	18±0.02	20±0.03	25±0.04
Escherichia coli.	CM 69	ND	ND	25±0.04	29±0.05	22±0.03

(A-pet. ether; B-chloroform; C-methanol; W-water and S-standard 1% streptomycin

Figure 3. Antibacterial effect of *M. arundinacea* rhizome against some bacterial isolates.

CONCLUSION

According to the study's findings, *M. arundinacea's* varied extracts contain secondary metabolites such as alkaloids, flavonoids, saponins, tannins, phenols and glycosides. Additionally, its extracts are a great source of natural antioxidants and both the methanol and water extracts show promise antibacterial activity, making them helpful in the treatment of a illnesses. Future research will, however, need to focus on the phytochemical characterization and the identification of these extracts of the bioactive chemicals that are responsible for their biological activity.

CONFLICT OF INTEREST

No conflict of interest.

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None

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None

LIST OF ABBREVIATION

None

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