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Antimicrobial properties and preliminary phytochemical analysis of different fractions of *Achyranthes aspera* (whole plant)

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Abstract

Background: Different microorganisms that are resistant to multiple drugs and the emergence of pathogenic strains that are less susceptible to medicines are steadily rising. The careless use of wide-spectrum antibiotics has been blamed for this rise. Furthermore, synthetic medications are not only costly and ineffective in treating illnesses in developing nations, but also often have adverse effects on human health.

Method: In the present investigation, several solvent extracts of *Achyranthes aspera* (whole plant) screened for antibacterial potential against organisms such as *Staphylococcus aureus*, *Candida albicans* and *Pseudomonas aeruginosa* using the agar diffusion plate method. *Achyranthes aspera* (whole plant) was subjected to a qualitative phytochemical analysis utilising various solvent extracts.

Result: The ethanol extract of *Achyranthes aspera* (whole plant) fractions shown significant antibacterial activity in case of *Pseudomonas aeruginosa* (124 µg/ml), *Staphylococcus aureus* (141 µg/ml) and *Candida albicans* (130 µg/ml) at the minimum inhibitory concentration (MIC). Whole plant extracts of *Achyranthes aspera* (ethyl acetate and chloroform) exhibited little antibacterial activity against *Candida albicans*. *Achyranthes aspera* chloroform extract was the least effective antibacterial agent against *Pseudomonas aeruginosa* (387 µg/ml) and ethyl acetate extract (388 µg/ml). According to qualitative analysis, the majority of whole plant extracts include almost all phytochemicals.

Conclusion: The water and ethanol fraction of *Achyranthes aspera* demonstrated potent therapeutic antibacterial activity and presence of various phytochemicals.

Keywords: *Achyranthes aspera*, antimicrobial activity, Preliminary phytochemical analysis

Introduction

The search for substances with potent antibacterial properties is one of the fastest-growing areas of research aimed at lowering the risk of infectious diseases caused by dangerous microbes that damage humans. Plant extracts continue to be a source of most pharmaceutical substances, including antimicrobial drugs used to treat infectious diseases. The pharmaceutical industry has created a number of novel antibiotics in the last three decades: however, microorganisms have become increasingly resistant to these drugs (Aiyegrero & Okoh, 2010). In general, drugs employed as therapeutic treatments may be genetically transmitted by microbes and becomes resistant to them. The number of hospital patients with weakened immune systems and the rise of multidrug-resistant bacterial strains have led to this discovery. Consequently, hospitals can encounter novel diseases with a high death rate (Tebabal, 2021).

The use of bactericidal medications will continue to be controversial in the coming decades owing to the growing problem of microbial resistance. Therefore, efforts must be made to reduce this problem, including reducing the use of antibiotics, studying the genetic processes underlying resistance, and continuing research to develop new drugs, both natural and synthetic. The primary goal was to provide patients with appropriate and efficient antibacterial drugs (Al-Shahwany, 2014). Although research into natural medicines has grown dramatically over the last ten years, different medicinal plant parts always used as a essential source of therapeutic bioactive compounds for management of normal health. Traditionally use of various plant parts in the preparation of medications to cure several chronic diseases and this trend increasing significantly on a global scale. According to the World Health Organization (WHO), herbal treatments are the best source of a variety of drugs. In wealthy countries, almost 80% of the population uses traditional medications, including compounds made from medicinal plants. More studies on plants are necessary to understand their traits, efficacy, and safety of these plants (Ingle, 2017).

Materials and Methods:

Plant material:

Whole plant parts of *Achyranthes aspera* were collected from the Bhokar. Area of the District of Nanded, and the taxonomist from the Department of Botany, Yeshwant Mahavidyalaya, Nanded, Maharashtra, identified and verified the plant.

Preparation of Plant extracts:

All of *Achyranthes aspera*'s parts were collected and shade dried. The dried whole plant materials made powder using electrical grinder. A Soxhlet apparatus used for the extraction of plant material around 5-6 cycles per solvent. The different solvents used such as ethyl acetate, chloroform, ethanol, and water etc. Following extraction, the resulting concentrated extract has been used in a variety of studies.

Preliminary Phytochemical Analysis:

The primary phytochemicals in *Achyranthes aspera* (whole plant) extracts were examined using a systematic approach that included many solvent extracts (Shinde, 2024).

Test microorganisms:

The test organisms used in this study were *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Candida albicans*. They acquired it from the School of Life Sciences' Cultural Collection Facilities Centre at Swami Ramanand Teerth Marathwada University in Nanded. Subcultures of these microorganisms were used frequently to this investigation.

Antimicrobial activity:

The agar plate diffusion method was used to evaluate the effectiveness and antibacterial properties of a number of solvent extracts prepared from *Achyranthes aspera* whole plant. A subcultured microbial solution (100 µl) was prepared to disperse the agar medium. Antibacterial activity was evaluated using several different concentrated fractions (Wendakoon et al., 2012). To allow the extract to penetrate the plates, the sample was placed on the plates and left for an hour. The plates were incubated at 37°C for 24 h, during which measured the inhibitory zone in millimeters (mm). The antibacterial effects of extract were compared with traditional standard medications.

Results and Discussions:

A preliminary phytochemical examination of *Achyranthes aspera* (whole plant) extracts revealed that they all included coumarins, alkaloids, terpenoids, flavonoids, glycosides, phenols, tannins, and saponin. phytochemicals present in all parts of *Achyranthes aspera* whole plant extract, except for the absence of glycosides and coumarins from the water and chloroform extract. Table 1 summarizes the finding of the phytochemical analysis. Increased biological activity is correlated with high phytochemical content in plants.

The summary of antibacterial activities of different solvent whole plant fractions of *Achyranthes aspera* are exhibited in Table 2.

The ethanol extract made from *Achyranthes aspera* whole plant had the highest MIC values (124 µg/ml) in case of *Pseudomonas aeruginosa*, (141 µg/ml) in case of *Staphylococcus aureus*, and (130 µg/ml) in case of *Candida albicans*. When tested against *Candida albicans*, the different extracts of *Achyranthes aspera* (whole plant) showed notable minimum inhibitory concentrations (MIC values) in the water extract (222 µg/ml). The results were compared to those of the reference substances, which were conventional fluconazole with a MIC of 59 µg/ml. When tested against *Pseudomonas aeruginosa*, the various *Achyranthes aspera* whole plant extracts showed notable minimum inhibitory concentrations (MIC) in the ethanol extract (124 µg/ml). The outcomes were compared with those of cephalosporins at an MIC of (48 µg/ml). When evaluated in case of microorganism *Staphylococcus aureus*, ethyl acetate extract (274 µg/ml), water extract (222 µg/ml), and chloroform extract (355 µg/ml), of *Achyranthes aspera* whole plant showed remarkable minimum inhibitory concentrations (MICs). The typical medication used gentamycin was (42 µg/ml).

Medicinal plants may be used in lieu of or as complements to modern treatment system of medications. Medicinal plants have huge diversity of biological and structural bioactive components to cure variety of diseases. These phytochemicals considerably reduce the spread of diseases (Umer et al., 2013). One major barrier to global healthcare, particularly in developing countries, is the need for novel, effective, and affordable drugs to treat microbiological infections. In addition to genera and bacteria belonging to the Enterobacteriaceae family, some strains of Streptococcus and Staphylococcus are linked to the pathophysiology of wound infections, urogenital and gastrointestinal disorders, and skin and lung infections. However, traditional antibiotics are ineffective against these bacteria (Karunyadevi et al., 2009). To promote the use of herbal treatments, it is crucial to evaluate their therapeutic potential. Much research has been conducted to improve traditional medicine (Belay, 2021).

Using phytochemical testing, several types of secondary metabolites have been identified, including alkaloids, polyphenols, flavonoids, coumarins, saponins, tannins, triterpenes, and steroids. Many phytochemicals have active effects on pathogenic microorganisms. The presence of bioactive components in medicinal plant fractions may exhibits antimicrobial properties. The extracts' antibacterial properties of extracts were found to varied (Mahady, 2005). The chemical composition and methods of action of the active ingredients may differ. Although secondary chemicals are prevalent in all extracts, their amount and possible interactions with other components also affect the plant extracts are (Valgas et al., 2007). Since proteins make up bacterial cell walls, it is believed that tannins' ability to react with proteins to produce stable, water-insoluble components gives them antibacterial properties. The alkaloids may affect or interfere with cell dividing capability and intercalate to the genetic material

of Gram positive and Gram negative microorganisms, alkaloids have antibacterial properties (Savithramma, 2011). Future antimicrobial drug use remain unclear, and the problem of germ resistance is only becoming worsens over time (Babayemi, 2012). To solve this problem and to include medicinal herbs with antibacterial properties, action must be performed. Medicinal plant derived medications used for prevention and management of various illnesses caused by pathogenic organisms. Herbal medicine is commonly preferred in various societies for treatment of chronic diseases and without much affecting severs detrimental effect on health. When used in excess, plant-based medications have fewer negative effects than commercial antibiotics. Researchers are using plant-based remedies instead of traditional antibiotics to prevent deadly infections caused by different microbes.

Conclusion:

According to the results, the water and ethanol extract possesses potential; it may contains the greatest concentration of various types of bioactive phytochemicals which have bactericidal properties. To discover and purify the bioactive compounds that might be used as natural cures instead of commercially synthesized medications, further study on *Achyranthes aspera* (whole plant) extract is needed.

Conflict of interest: The authors declare that they have no conflicts of interest.

Author's contributions: The author Dhole N. A. designed and concept of the research experiments. Plant extraction in different solvents, evaporation, antimicrobial activity and phytochemical analysis were performed. All obtained data were analyzed, manuscript drafting and revised it critically.

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Ethical Compliance: Protocols and handling of microorganisms were authorized by the Institutional Ethical Committee.

Table1.

Screening of phytochemical tests of different extract of *Achyranthes aspera*

Sr. No.	Test	Various extracts of <i>Achyranthes aspera</i>			
		Water fraction	Ethanol fraction	chloroform fraction	Ethyl acetate fraction
1	Phenols	+	+	+	+
2	Saponins	+	+	+	+
3	Flavonoids	+	+	+	+
4	Glycosides	-	+	-	+
5	Alkaloids	+	+	+	+
6	Tannins	+	+	+	+
7	Terpenoids	+	+	+	+
8	Coumarins	-	+	-	+

Table2.

Antibacterial activities of *Achyranthes aspera* (whole plant) extracts

Sr. No.	Microorganism	Minimum inhibitory concentration (MIC)						
		leaf extracts of <i>Achyranthes aspera</i> (µg/ml)						
		Water fraction	Ethanol fraction	Chloroform fraction	Ethyl acetate fraction	Gentamicin (µg/ml)	Cephalosporins (µg/ml)	Fluconazole (µg/ml)
1	<i>Candida albicans</i>	222	130	355	274	ND	ND	59
2	<i>Pseudomonas aeruginosa</i>	190	124	387	388	ND	48	ND
3	<i>Staphylococcus aureus</i>	224	141	327	470	42	ND	ND

The results showed are the mean values of three parallel tests. ND - Not determined

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Conflicts of interest

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