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Antibacterial activity of six indigenous Indian plants: *Acacia nilotica* (Fabaceae), *Albizia saman* (Fabaceae), *Azadirachta indica* (Meliaceae), *Carica papaya* (Caricaceae), *Cymbopogon citratus* (Poaceae) and *Mangifera indica* (Anacardiaceae)

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Plants have been used as major source of active compounds with medicinal importance since human civilization. These naturally occurring pharmacologically active agents have least or no toxicity to the host. The antibacterial activity of extracts (water, acetone and methanol) from six indigenous Indian plants: *Acacia nilotica* (Fabaceae), *Albizia saman* (Fabaceae), *Azadirachta indica* (Meliaceae), *Carica papaya* (Caricaceae), *Cymbopogon citratus* (Poaceae) and *Mangifera indica* (Anacardiaceae) were determined against the pathogenic bacteria (*Staphylococcus aureus:* ATCC 25923; *Escherichia coli:* ATCC 25922 and *Klebsiella pneumonia:* ATCC 700603). The antimicrobial study was carried out by the gel diffusion method and the results show that as compared to aqueous extract, methanolic and acetone extracts were more effective. Of all the studied plants, the methanolic extract of *A. saman* leaves inhibited the growth of all the three test organisms.

Key words: Antibacterial activity, pathogenic bacteria, indigenous plants.

INTRODUCTION

According to World Health Organization, plants are the preferred source of a variety of drugs. About 80% of individuals from developed countries use traditional medicine, which has compounds acquired from plants (Selvamohan et al., 2012). Therefore, immense research is required for better understanding of properties, safety and efficiency of these plants. There is a huge variety of plants, rich in secondary metabolites [which may be potential sources of drugs] and essential oils of therapeutic importance (Dipankar et al., 2011). These products are known by their pharmacologically active agents, for example, the organic compounds which are

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part of the essential oils, as well as in tannin. In general, bacteria have the genetic ability to transmit and acquire resistance to various environmental factors viz. metals, drugs, which are utilized as therapeutic agents (Singh et al., 2015). The increasing prevalence of multidrug resistant strains of the bacteria and the recent appearance of strains with reduced susceptibility to antibiotics raises the spectre of untreatable bacterial infections and adds urgency to the search for new infection-fighting strategies.

Plants like *Acacia nilotica* (babool), *Albizia saman* (jungle jalebi), *Azadirachta indica* (neem), *Carica papaya* (papaya), *Cymbopogon citratus* (lemon grass), *Mangifera indica* (mango), etc. possess many medicinal properties. Apart from these, various other plants have been successfully used against several ailments. Studies have been conducted to isolate the medicinal ingredients from different parts of the plants which are effective against many diseases produced by various pathogenic and antibiotic resistant bacteria.

Therefore, researchers are increasingly turning their attention to traditional methods, looking for novel molecules to synthesize better drugs against microbial infections sources of drugs and essential oils of therapeutic importance. Despite the existence of potent antibiotic and antifungal compounds, resistant microorganisms are rapidly appearing (Byarugaba, 2005), posing immediate need for a permanent search and development of new drugs, which is safe, more dependable than costly drugs and which have no adverse side effects. The present study aimed to evaluate the antimicrobial activity of the above mentioned common plants against three pathogenic bacteria.

MATERIALS AND METHODS

Preparation of plant extracts

Fresh leaves were collected from six common indigenous plants, namely *A. nilotica* (Babool), *A. saman* (Jungle jalebi), *A. indica* (Neem), *C. papaya* (Papaya), *C. citratus* (Lemon grass) and *M. indica* (Mango) from the Amity University gardens and its surroundings. These were washed thoroughly, first with tap water (two to three times) and then with distilled water to remove the dust particles and mid-ribs of the leaves were removed. These were wiped by means of a tissue paper, kept in dark till they were completely dry and crushed into very fine powder using a pestle-mortar. Five grams powder of each plant was equally divided into three parts, each of which was kept in tarson tubes having acetone, distilled water and methanol, separately (10-12 ml). These tarson tubes were kept in a dark and hygienic place for 24 h and then in a water bath for 1 h at 60°C. This helped the powder to get dissolved in the solvent. Sterile 90 mm Petri dishes (Tarsons) were taken, weighed on the electric balance and labeled accordingly- plant names with their respective solvents. Then, the extract in the tarson tube was filtered using filter papers into these empty Petri plates, separately. The liquid in these plates was kept for air drying. When completely dried, the plates were taken out and weighed on the balance again. The weight of the empty Petri plates was subtracted from the weight of Petri plates with extracts. Extracts were dissolved in dimethyl sulfoxide (DMSO; 4 times the amount of extract). These tubes were kept in the freezer for future use.

Test organisms

Three organisms: *Staphylococcus aureus* (ATCC 25923), *Escherichia coli* (ATCC 25922), *Klebsiella pneumoniae* (ATCC 700603) were included in the study. The organisms were made as stock by mixing 100 µl of suspension in 10 ml of sterile nutrient broth and grown overnight. The organisms were maintained by subculturing them on nutrient agar at regular intervals and used throughout the study.

Antimicrobial activity assay

The microbial susceptibility test was done by using gel diffusion method. Nutrient agar media was prepared as per the supplier's instruction and sterilized by autoclaving at 121°C for 15 min. After preparing nutrient agar plates, four wells of 0.5 mm width and 0.5 mm depth were made at equal distance on each plate aseptically. Separate plates were inoculated with 50 µl of *E. coli, S. aureus* and *K. pneumonia*. For each bacteria, 50 µl of each extract prepared from same plant part, were loaded in the wells and plates were incubated at 37°C for 24 and 48 h. Antibacterial activity of each extract was expressed in terms of zone of inhibition (mm). Each experiment was repeated three times and average of all values was taken.

RESULTS AND DISCUSSION

Six locally available plants were selected randomly and the antimicrobial study was carried out. In this work, the objective was to discover an efficient alternative against the pathogenic bacteria which was free of the disadvantages of antibiotics. Extracts of six different plants viz. *A. nilotica* (babool), *A. saman* (jungle jalebi), *A. indica* (neem), *C. papaya* (papaya), *C. citratus* (lemon grass) and *M. indica* (mango) were made in three different solvents (acetone, distilled water and methanol) and tested for antimicrobial activity against *E. coli, S. aureus* and *K. pneumoniae.* Figure 1 shows zone of inhibition obtained against *E. coli* in the different extracts of plants. *A. saman* (in methanol), *M. indica* (acetone and methanol extracts) and *A. nilotica* (in acetone and methanol) showed good inhibition against *E. coli,* with methanolic extract of *A. saman* giving maximum zone of inhibition. Figure 2 represents the activity pattern of extracts against *K. pneumonia*, with *A. saman* having maximum inhibitory zones with all solvents in which *A. indica* showed least activity. The activity pattern for *S. aureus* is given in Figure 3. It shows maximum zone of inhibition with *A. saman*. Of all the studied plants, extracts of *A. indica*, *C. citratus* and *A. saman* were found to be most active against all test organisms, whereas *C. papaya* was effective only on Gram positive tested strains, that is, *S. aureus.*

Although antibiotics have been greatly of help in conquering a large number of microbial pathogens, these benefits have reduced significantly over the last couple of years since antibiotics have become less efficient against

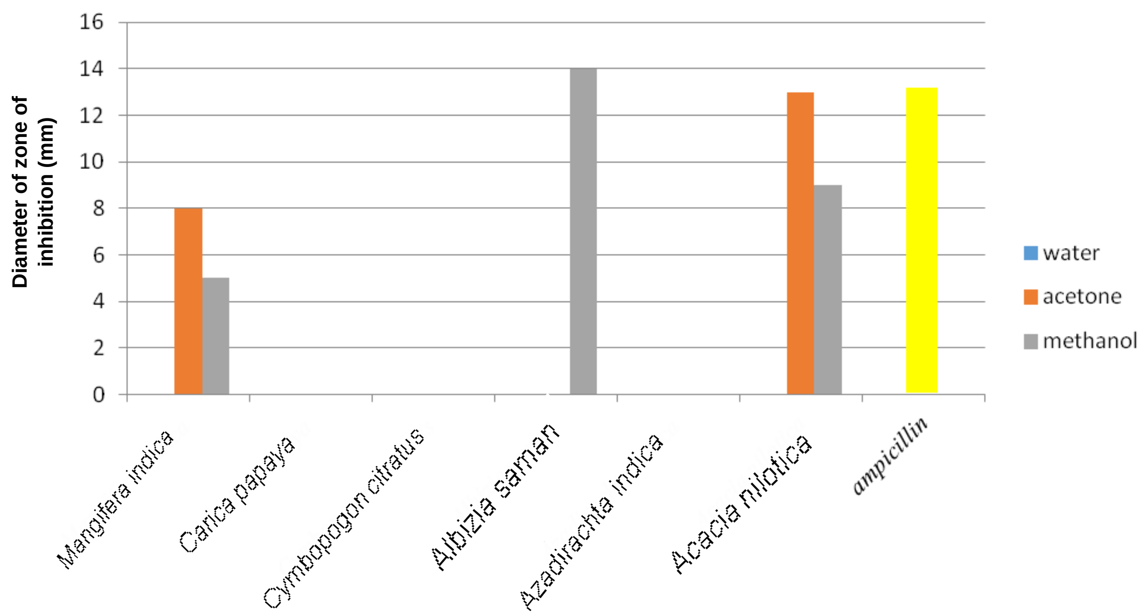

Figure 1. Antimicrobial activity of leaf extracts of test plants measured for *E. coli.*

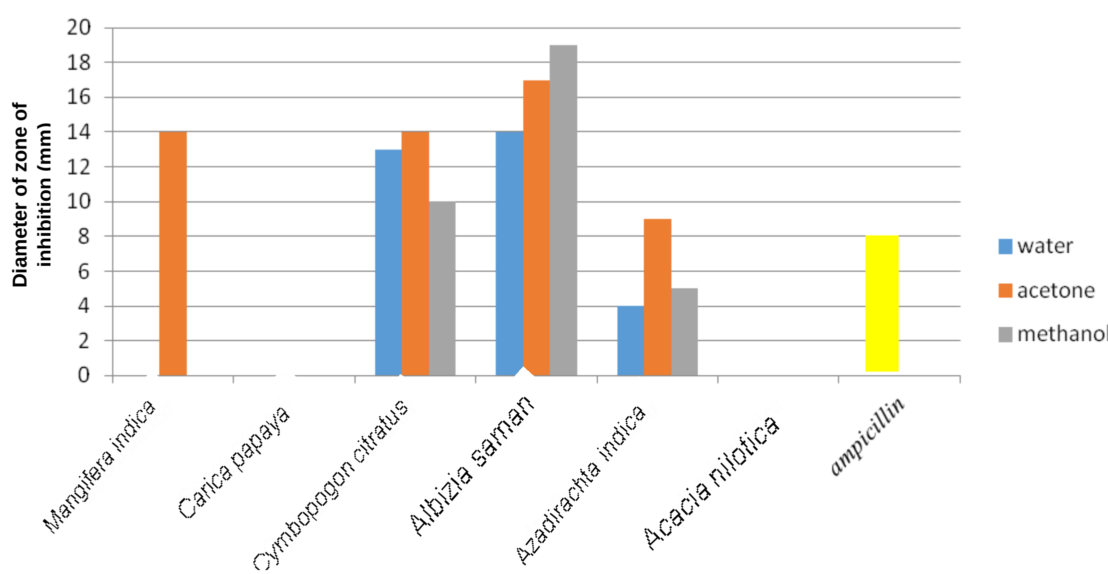

Figure 2. Antimicrobial activity of leaf extracts of test plants measured for *K. pneumoniae*.

various pathogenic bacteria. The main reason for this is the development of disease-resistant bacterial strains. Bacteria possess the ability to acquire as well as transmit resistance against antibiotics which are prepared synthetically. This is a genetic quality of bacteria- they recognize a therapeutic agent and develop resistance against it with time. Another reason which is contributing to the downfall of antibiotics is that some of them cause adverse effects to human health, the most common being unhealthy and deteriorating effects on some organs (Towers et al., 2001).

Many of these plant-extracts showed significant results. Prominent zones of inhibition show that these plants have a lot of potential to serve as effective antimicrobial drug alternatives against many antibiotics. These plants not only possess antimicrobial properties but are also 'human friendly', that is, they do not cause any harmful effects on the body (Trivedi et al., 2013). However, further studies are required for efficient evaluation of the potential effects of the plant-extracts as antimicrobial agents (Farnsworth, 1993). The results of this study and those of the previous researches (Mathur et al., 2013) will form the base for the

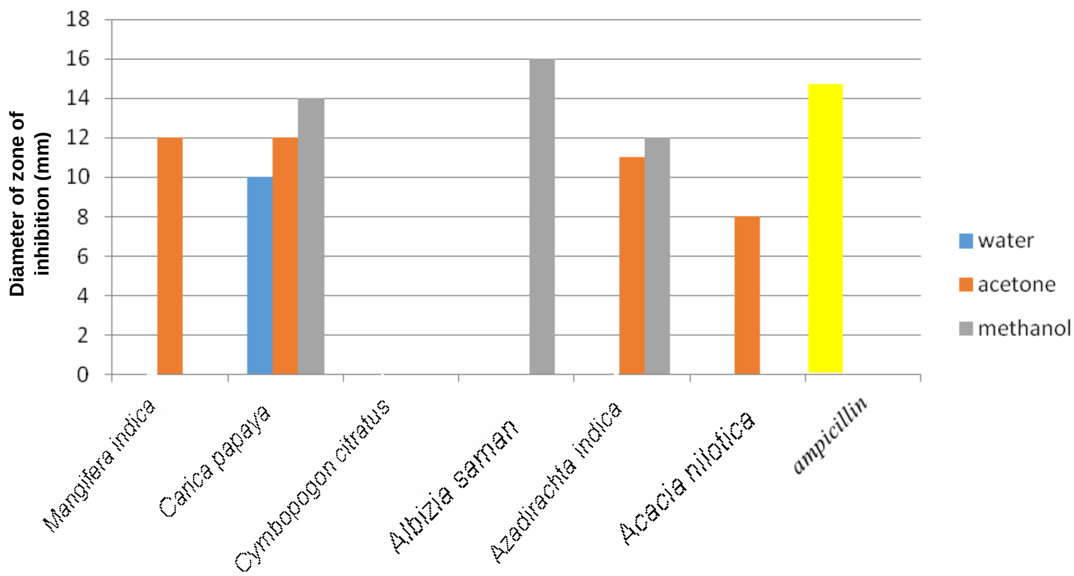

Figure 3. Antimicrobial activity of leaf extracts of test plants measured for *S. aureus.*

selection of other plants for investigations to be carried out in the future. This investigation will prove to be a milestone in this field of discovering new compounds having antimicrobial activities (Lam, 2007). This is a very promising and beneficial field; a lot of researches should be initiated for the betterment of mankind.

Conclusion

With this serious problem of antibiotic resistance in bacteria, there is a need to look for alternative antimicrobial agents other than synthetic antibiotics (Parmar and Rawat, 2012). Plants have valuable resources of secondary metabolites within them (Hada and Sharma, 2014). Various plant extracts have been known to have medicinal applications. Studies have been conducted all over the world to establish that plant extracts are indeed highly efficient against many pathogenic bacteria (Chowdhury et al., 2013). Therefore, the results justify that antibiotics from plants extracts are promising agents in treating these pathogenic strains.

Conflict of Interests

The authors have not declared any conflict of interests.

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