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A FIELD STUDY ONANTIMICROBIAL AND ANTIBACTERIAL ACTIVITY OF INDIAN MEDICINAL PLANTS

Devender Sharma[1], Dr. Niraj Gupta[2]

[1]Research Scholar, OPJS University, Churu, Rajasthan
[2]Research Supervisor, OPJS University, Churu, Rajasthan

ABSTRACT

Phytochemicals are chemical molecules found naturally in plants that aren't essential for human nutrition but provide a variety of health benefits. Antimicrobial compounds used to combat human diseases may be derived from phytochemicals such carotenoids, flavonoids, and polyphenols. Aqueous and organic solvents were used to extract the phytochemical components of the dried powdered plant parts (acetone and ethanol). The paper disc diffusion technique was used to measure the diameter of the zone of inhibition produced by the concentrated extracts against gram-negative and gram-positive bacteria and fungi. Tannings, saponins, sesquiterpenes, alkaloids, and phlobatamins were found in the extracts, and these compounds were effective against gram-positive and gram-negative bacteria, as determined by the phytochemical analyses. The plant extracts' activity was unaffected by heat treatment at four distinct temperatures (4^o C, 30^o C, 60^o C, and 100^o C), although it was diminished in an alkaline pH environment. For example, research into the extracts' minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) found that they were most effective against Staphylococcus aureus and least effective against Salmonella paratyphi, Bacillus subtilis, and Salmonella typhi. In this study, we report on the physical and biological characteristics of the seed oil and fatty acids that contribute to their antibacterial action.

Keywords: Antibacterial, Phytochemical. Antimicrobial, alkaline

INTRODUCTION

The biodiversity of northeastern India is well-known. Phytochemicals are chemical molecules found naturally in plants that are not essential for human nutrition but which have a wide range of proactive qualities, including resistance against illness. It is well-documented that plants generate these compounds for self-defense. However, current studies show that they may also help keep people healthy. Certain ones of these plants have been used for millennia in traditional medicine. Most phytochemicals, such as flavonoids, carotenoids, and polyphones, have antibacterial action and may be used to combat disease-causing microorganisms. In this investigation, we focused on the following plant types: Oldenlandiacorymbosa, Ricinuscommunis, Lpomeaaquatica, Xanthium strumarium, and Menthapiperita.

From the beginning of humankind, people have sought relief from illness with the help of medicinal plants, and herbal preparations remain an integral element of every indigenous medical practice around the globe, especially in Asia, South America, and Africa. Nonetheless, western medicine branched out from herbal practice as its foundation. Seventy-five percent to ninety percent of the world's rural population reportedly still uses herbs as their primary form of healthcare. Therefore, in many village markets in Asia, Africa, and Latin America, medicinal herbs are sold separately alongside vegetables and other goods. The use of herbal medicine has been overlooked for some time in favor of synthetic pharmaceuticals, but this attitude is changing, even in the West. The growing prevalence of resistance to antibacterial medications has prompted the shift in strategy.

Because most medicinal plants are also known to metabolize human and animal dietary items, their constituents are thought to be safe and easily comprehended. In vitro testing confirmed the antibacterial activity of a number of plants traditionally utilizedfor the treatment of illness. In addition, the genus Tamarindusindica (tamarind) is classified as a member of the subfamily Caesalpiniceae of the leguminous plant family, Leguminosae. The fruits of the tamarind tree are the most prized because they have been reported as curative in various pharmacopeias. However, it has also been found that the leaves of the tamarind tree have a proven hap to protective activity due to the presence of polydroxylated compounds, many of which are of a flavonoid nature. Protein, fat, fiber, and vitamins including thiamine, riboflavin, niacin, ascorbic acid, and beta-carotene are all found in respectable quantities in leaves.

Tamarind, or Tamarindusindica Linn, is a member of the Fabaceae family and one of the oldest plants still cultivated today. The leaves, fruit, branches, particularly twigs, and roots of the tamarin tree are all edible and useful in some way or another, making it a really exceptional plant. Seeds are one of the most underutilized parts of fruits. Researchers from a variety of disciplines, including chemistry, biology, and pharmacology, have examined tamarind seeds. It has been stated that T. indica seed has been the subject of chemical component analysis, with particular focus on the oil content, properties, and polysaccharide composition.

Research shows that tamarind leaves have antibacterial efficacy against both gram-positive and -negative bacteria.

LITERATURE AND REVIEW

Minakshi B, et al (2016) Phytochemicals are chemical molecules found naturally in plants that aren't essential for human nutrition but provide a variety of health benefits. Antimicrobial compounds used to combat human diseases may be derived from several phytochemicals, including carotenoids, flavonoids, and polyphenols. Here, we looked at the Phytochemicals and antimicrobial activity of five native Assamese plants: Oldenlandiacorymbosa, Ricinuscommunis, Lpomeaaquatica, Xanthium strumarium, and Menthapiperita. Saponins, tannins, flavonoids, terpenoids, glycosides, and reducing sugars are only some of the many Phytochemicals discovered in the extract of these five plant species, with phenol and flavonoids precipitating at a greater rate than the others. Extracts from these plants were examined for their antibacterial activity against Staphylococcus aureus and Escherichia coli, both of which are common human infections, using the well diffusion technique on Nutrient agar. In this research, plant extracts from Xanthium strumarium (leaves and roots) and Menthapiperita (stem) shown potent

antibacterial action against Staphylococcus aureus, while those from Ricinuscommunis (leaves, stems, and roots) and Lpomeaaquatica (stem) did the same for Escherichia coli. It was previously unknown if Oldenlandiacorymbosa has antibacterial action against Staphylococcus aureus and/or Escherichia coli. These results suggest that the selected plant extracts possess antimicrobial properties that could be used for biological control of bacterial cultures, and these bioactive compounds serve as a source of antimicrobia.

Abdallah MS et al (2018) Extracts of Tamarindusindica leaves and fruits were tested for their antibacterial activity and phytochemical composition against Escherichia coli and Shigella sp. isolated from the feces of pregnant women who had visited the prenatal clinic in Potiskum, Yobe State, Nigeria. The extracts' antibacterial activity was measured using the agar well diffusion technique, while the phytochemical analysis was performed in a laboratory. Alkaloids, glycosides, saponins, tannins, anthraquinones, steroids, reducing sugar flavonoids, terpenoids, and phenols were all found in the extracts during phytochemical analysis. The antibacterial activity of the extracts against the isolates showed that they were effective, with the methanol extract being more so than the aqueous extract (with an average zone of inhibition of 14.48mm) (12.52mm). The average zone of inhibition for the isolates demonstrated that Escherichia coli was more susceptible to the extracts than Shigella sp. The minimum inhibitory concentration (MIC) of the extracts demonstrated that aqueous and methanol extracts at values ranging from 3.125-25mg/ml limit the development of the isolates. According to statistical analysis, there is a p0.05 difference in the extracts' activity against the isolates tested. The results of this study provide credence to the therapeutic potential of Tamarindusindica leaf and fruit extracts.

Gupta, C. et al (2014) It is common practice in Indian cooking to utilize tamarind (Tamarindusindica) as a souring agent to get the necessary acidity in a variety of dishes. Because of modern worries about the safety of artificial food additives, natural preservation techniques and natural preservatives are in the spotlight. Ten bacterial strains (three Gram-positive and seven Gram-negative) and seven fungi known to cause food spoiling were examined for their susceptibility to tamarind extract (50% ethanol) using agar well diffusion tests. Both types of bacteria were inhibited by the aqueous-ethanolic extract, demonstrating its potent antimicrobial properties. All of the Gram-positive bacteria isolates tested were susceptible to tamarind extract, but it showed particularly strong results against Staphylococcus aureus, Staphylococcus epidermidis, Bacillus subtilis, and Listeria monocytogenes, with an inhibition zone of 18 mm, 19 mm, 16 mm, and 16 mm, respectively. All Gram-negative bacteria isolates had their growth inhibited as well, however only Pseudomonas aeruginosa, Pseudomonas sp., and Salmonella spp. had an inhibition zone larger than 15 mm. However, most of the test fungi showed no response to the extract. Only two mold species, Aspergillus and Penicillium, showed some degree of sensitivity to the extract. Tamarind extract included tannins, terpenoids, and citric acid, according to the phytochemical study. The results of this research demonstrate that tamarind extracts may be used as a safe alternative to synthetic preservatives in food.

T Sravanthi et al (2017) The Fabaceae family includes the plant Tamarindusindica L., which is used in traditional medicine to cleanse the skin and cure a variety of medical conditions, including the common cold, fever, stomach disorders, diarrhea, and jaundice. Extracts from the seed coat were tested for their antibacterial efficacy against a panel of common gram-negative and gram-positive bacteria and fungus to assess the plant's scientific legitimacy. Additionally, the impact of temperature and pH on the plant's antibacterial activity was studied, as were the

plant's chemical contents. Aqueous and organic solvents were used to extract the phytochemical components of the dried powdered plant parts (acetone and ethanol). The paper disc diffusion technique was used to measure the size of the inhibition zones produced by the concentrated extracts against both gram-negative and gram-positive bacteria. The phytochemical analyses showed that the extracts were effective against both gram-positive and gram-negative bacteria, and that they included tannins, saponins, sesquiterpenes, alkaloids, and tri terpinoidalsaponins. There was an examination of the extracts for their potential application as a natural replacement for synthetic antimicrobials in food. Artificial antioxidants like BHT are used to prevent lipid oxidation in meals, hence the ethanolic extracts of the seed coat were evaluated for their antioxidant activity against BHT.

BiruteKarpavi˘cienet al. (2022) Traditional knowledge about plants and their applications may be lost due to shifts in people's reliance on the resources of the nearby natural environment and changes in the means in which information is transferred. A thorough ethnobotanical research was conducted in an underexplored ethnographic area with the goal of uncovering and preserving this knowledge. Information on medicinal plants was gathered via open-ended and semi-structured interviews in rural communities in southern Lithuania. Thirty-nine different plant species and one lichen were reported by a total of thirty different people. The study was conducted in a very limited region, yet up to five local names per species were reported. The most popular plants were chamomile (Matricaria), linden (Tiliacordata), wormwood (Artemisia absinthium), and dandelion (Plantago major). Disorders of the digestive system and the respiratory system were the most common targets for the use of medicinal plants. Seventy-one percent of all reports of usage indicated wild species, whereas a much greater percentage of cultivated plants were identified among the novel applications. The most popular methods of preparation were decoction and infusion, although numerous strange concoctions have also been documented. The variety of medicinal plant species has decreased during the last 20 years, according to studies, along with certain forms of traditional ethnobotanical knowledge.

METHODOLOGY

Medicinal plants from India, namely Tamarindusindica Linn, we gathered some stuff.

Preparation of Extracts

With a few tweaks, this was accomplished as planned. After collecting the stem bark and mature leaves, they were both cut into pieces and air dried in the shade for 5 days at room temperature (32-35o C). Each plant portion weighed 50 grams, and it was ground into a coarse powder using a mortar and pestle before being blended into a fine powder in an electric blender. We sealed the powder in airtight containers. The air-dried plant material was ground into a powder and then extracted using water, acetone, and ethanol. For each sample, 25 grams of powder were combined with 100 milliliters of deionized water or organic solvent in a conical flask, sealed, shaken at 120 revolutions per minute for 30 minutes, and then left to rest for 24 hours. After 24 hours, we filtered each extract fast through four layers of gauge and then more gently through Whatman no1 filter paper. The resultant filtrates were dried using lyophilization after being concentrated in a rotary evaporator. For the stem bark, powder yields of 51% were obtained from water extracts, 32% from acetone extracts, and 17% from ethanol extracts, whereas for the leaves, same percentages were 49%, 32%, and 19% (w/w), respectively.

Test Organisms

Various bacterial and fungal strains utilized in this study. Clinical isolates included gram-negative bacteria such as Escherichia coli, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella typhi, Salmonella paratyphi, and Shigellaflexnerri, and gram-positive bacteria such as Staphylococcus aureus, Bacillus subtilis, and Streptococcus pyogenes. Each bacterial strain was diluted in nutrient broth and left to ferment at 37 degrees Celsius for 48 hours. Specifically, antibacterial and antifungal activities were evaluated using Nutrient Agar (NA) and Potato Dextrose Agar (PDA), respectively.

Phytochemical analysis

Standard phytochemical studies were performed on the newly obtained extracts to determine the presence of phytoconstituents such tannins, saponins, sesquiterpenes, alkaloids, and phlobatamins.

Determination of antimicrobial activity

The paper disc diffusion technique was used to test the antibacterial activity of both the aqueous and organic extracts of the plant sample. In order to test its antibacterial properties, bacterial cultures were diluted to a 0.5 McFarland turbidity standard and injected onto plates of Nutrient agar (oxoid) (diameter: 15cm). All of the fungal isolates including Candida albicans were diluted to a concentration of 106 cfu/ml before their antimycotic activities were evaluated. To inoculate Sabroud Dextrose Agar plates, we first floated cultures of Candida albicans in sterile solution of 0.9% normal saline and spores of various filamentous fungi in Tanquay buffer. The plates were seeded with 0.5 McFarland and 106 cfu/ml bacterial and fungal cultures, and then sterile filter paper discs (diameter 6mm for bacteria and 13mm for fungi) impregnated with 100l of extract dilutions reconstituted in minimum amount of solvent at concentrations of 50 and 100mg/ml were placed over each. Then, the bacterial and Candida albicans cultures were kept at 37 degrees Celsius for 18 hours, while the other fungal cultures were kept at room temperature (30 to 32 degrees Celsius) for 48 hours. 20 l of a 10mg/ml solution of ciprofloxacin and cotrimoxazole (for bacteria) or nystatin and amphoteracin B (for fungus) was used to impregnate paper discs for use as a conventional antibacterial. Measurement of the zone of inhibition surrounding each paper disc served as an indicator of antimicrobial activity; three independent tests were performed on each extract and organism.

Determination of MIC and MBC

For each of the species tested, the MIC of the extracts was calculated using a triplicate set. Extraction concentrations of 20.0, 18.0, 15.0, 10.0, 8.0, 5.0, 1.0, 0.5, 0.05, and 0.005mg/ml were added to 0.5ml of nutrient broth, and then a loopful of the test organism was introduced into the tubes after being diluted to 0.5 McFarland turbidity standard for (bacterial isolates) and 10^6cfu/ml for (fungal isolates). Standard antibiotics were used to perform the operation again on the test organisms (ciprofloxacin and cotrimoxazole for bacteria and nystatin and amphoteric in B for fungal isolates). As a control, the test organisms were planted into a tube with nutritional broth alone. The bacterial cultures were kept at 37 degrees Celsius for 24 hours, while the fungal spore cultures were kept at room temperature for 48 hours (30 – 32^o C). After incubation,

microbial growth was checked by inspecting the tubes for turbidity. A loopful of broth was taken from the non-growing test tubes in each set to inoculate sterile nutritional agar (for bacteria) and saboraud dextrose agar (for fungus) for the MBC determination. Streaks of the test organisms were produced on both nutrient agar and saboraud agar, although the latter was used as a control. The bacterial plates were incubated at 37o C for 24 hours, while the fungal plates were kept at room temperature (30 - 32^{o} C) for 48 hours. The smallest dose at which no growth was seen during incubation was identified as the bactericidal threshold.

Effect of Temperature and pH on antimicrobial activity of extracts

The antibacterial efficacy of acetone extracts was evaluated after five milliliters of 100mg/ml solutions were formed in test tubes and heated at 4, 30, 60, and 100o C in a water bath for 30 minutes. Acetone extracts were subjected to 30 minutes of treatment with 1N HCl and 1N NaOH solutions in a series of test tubes, covering a pH range of 2.5 to 10, to investigate the impact of pH. After 30 minutes of treatment, 1N HCl or 1N NaOH was used to neutralize the extracts to pH 7 before testing them for antibacterial activity.

Antibacterial activity assay

T. indica seed oil and fatty acids were tested for their antimicrobial properties using a diffusion assay. Bacteria (E. coli and S. aureus) were first injected into nutrient agar plates after being standardized with 0.5 McFarland reagents. Second, a standard (ampicillin and n-hexane) and a test solution (5 mg/mL) have been coated on paper discs. Bacterial cultures were grown on nutrient agar plates, and the discs of paper were then placed on top. Each paper disc's antibacterial efficacy was calculated by gauging the size of the "inhibition zone" surrounding it. If the inhibition zone of a sample was larger than 6 mm, we determined that it was active.

RESULTS

Tannins, saponins, sesquiterpenes, alkaloids, and phlobatamins were all found in the plant extract. Table 1 displays the results of the tests performed on the antibacterial activity of the plant extracts. In other words, the results demonstrate that the plant extracts were efficient against both gram-positive and gram-negative bacteria. Extracts of stem bark in acetone showed the greatest activity (diameter of zone of inhibition, 27 mm) against Proteus mirabilis, while extracts in water showed the least activity (diameter of zone of inhibition, 2 mm) against Staphylococcus aureus. In contrast to the stem bark extracts, the leaf extracts were often less effective against the test organisms. Result of the influence of temperature and pH on the plant extracts indicated that different temperature ranges of 4, 30, 60 and 100o C had no effect on the antibacterial activity of the extracts, but the activity marginally enhanced at acidic pH (2 to 6). (2 to 6). While plant extract activity decreased at alkaline pH.we can see the outcomes of the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) tests. Staphylococcus aureus had the greatest MIC (18 mg/ml) and MBC (17.5 mg/ml), whereas Salmonella paratyphi and Bacillus subtilis had the lowest MICs, at 8 mg/ml. Salmonella typhi showed MIC and MBC values of 10 mg/ml for the stem bark extracts. For most of the test organisms, leaf extracts had lower MIC and MBC values compared to stem bark extracts.

Table1. Results of antimicrobial activities of extracts of Tamarindusindica

S/No.	Organism	Zone of inhibition (mm)									
		Stem bark extracts			Leave extracts			Antibiotics			
		WE	AE	EE	WE	AE	EE	Cp	Ct	Am	Nys
1.	*Escherichia coli*	23	26	24	6	10	8	32	18	NA	NA
2.	*Proteus mirabilis*	24	27	24	4	7	5	30	20	NA	NA
3.	*Pseudomonas aerugenosa*	22	24	23	4	8	6	29	21	NA	NA
4.	*Salmonella typhi*	23	25	24	4	10	8	29	11	NA	NA
5.	*Salmonella paratyphi*	24	25	20	6	11	9	30	13	NA	NA
6.	*Shigella flexnerri*	18	20	17	3	10	7	31	14	NA	NA
7.	*Staphylococcus aureus*	23	25	22	2	11	9	27	5	NA	NA
8.	*Bacillus subtilis*	25	26	23	4	9	8	35	25	NA	NA
9.	*Streptococcus pyogenes*	17	22	21	7	13	10	32	9	NA	NA
10.	*Aspergillus flavus*	-	-	-	-	-	-	NA	NA	29	32
11.	*A. fumigatus*	-	-	-	-	-	-	NA	NA	26	28
12.	*A. niger*	-	-	-	-	-	-	NA	NA	25	30
13.	*Candida albicans*	-	-	-	-	-	-	NA	NA	29	26

Table2. Results of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) of ethanolic extracts of Tamarindusindica

S/No.	Organism	Stem bark extracts		Leaf extracts
		MIC (mg/ml)	MBC mg/ml)	MIC (mg/ml) MBC mg/ml)
1.	*Escherichia coli*	15.5	15	18 18
2.	*Proteus mirabilis*	15	18	20 20
3.	*Pseudomonas aerugenosa*	14	14	18 20
4.	*Salmonella typhi*	10	10	15 15
5.	*Salmonella paratyphi*	8	8	15 15
6.	*Shigella flexnerri*	8	8	10 10
7.	*Staphylococcus aureus*	8	20	20 20
8.	*Bacillus subtilis*	8	8	18 18
9.	*Streptococcus pyogenes*	10.5	12.5	15 15
10.	*Aspergillus flavus*	-	-	- -
11.	*A. fumigatus*	-	-	- -
12.	*A. niger*	-	-	- -
13.	*Candida albicans*	-	-	- -

The tamarind seed oil has a synergistic blend of these fatty acids. Furthermore, the antibacterial efficacy of these fatty acids was compared to that of tamarind seed oil. Evaluation of tamarind seed oil and its fatty acids for antibacterial activity against Escherichia coli and Staphylococcus aureus.

Table 3. Results of antibacterial assay of tamarind seed oil and its fatty acids against E. coli and S. aureus

Substances	Inhibition Zone (mm)									
	E. coli (gram-negative)					*S. aureus* (gram-positive)				
	I	II	III	IV	Ã	I	II	III	IV	Ã
Tamarind oil	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00
Fatty acids	6.95	7.10	8.75	7.50	7.58	7.75	6.75	8.25	6.50	7.31
Ampicillin (+ control)	18.35	16.35	17.85	*NA*	17.52	17.15	17.15	17.15	*NA*	17.15
Hexane	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00

Note: Ã is average from four times treatment. Zone of inhibition 6.00 mm indicates non-active or not potential as antibacterial activity.

Fatty acids were shown to be active against E. coli and S. aureus, whereas tamarind oil was inactive. Fatty acids have a stronger antibacterial action against E. coli than they do against S. aureus, although they are still not as effective as ampicillin. Extracts of T. indica's stem bark, fruit pulp, and leaves also showed antibacterial action against both gram-positive and gram-negative bacteria. The tamarind's 6-mm-wide inhibitory zone has been shown to be effective against S. aureus and E. coli (undetected inhibition).

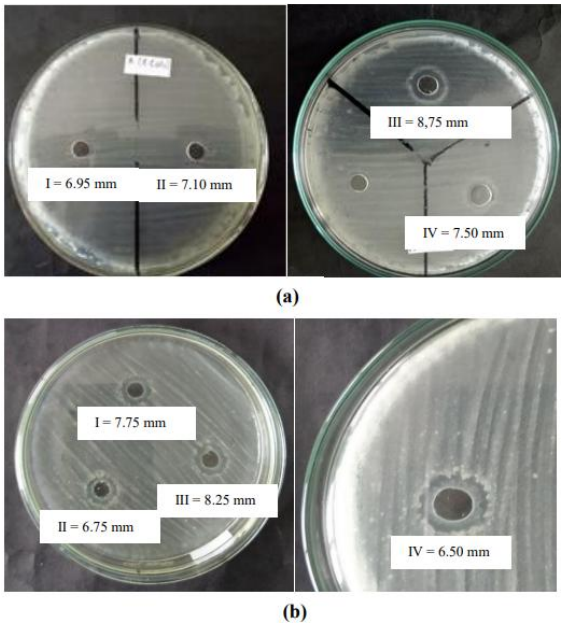

Figure 1.Antibacterial assay of fatty acids against (a) Escherichia coli, (b) Staphylococcus aureus.

Fatty acids have a wide range of antibacterial action, including against gram-positive and gram-negative bacteria. Saturated fatty acids often have less bactericidal action than unsaturated fatty acids. Antibacterial activity may be seen in long-chain unsaturated fatty acids such arachidonic acid, oleic acid, linoleic acid, linolenic acid, and palmitoleic acid.

DISCUSSION

Plants use secondary metabolites called phytochemicals to ward off several types of predators, including microbes, insects, and herbivores5, 6. Some examples of phytochemicals include tannins, flavonoids, alkaloids, and numerous other fragrant compounds. The antibacterial action shown in Tamarindusindica leaf and stem bark extracts may be due to this. Broad-spectrum antibiotic compounds may be present if antibacterial activity is shown against both gram-positive and gram-negative bacteria. This will be very helpful in the battle against antibiotic-resistant bacteria. This study's findings also demonstrated that extracts from the stem bark were superior than those from the leaves. The stem bark may include less of the pigments and other phenolics that have been shown to inhibit the antibacterial action of the extracts since it is more fully

grown and mature than the leaves. The extracts made using acetone were the most effective against the test organisms out of the three solvents employed (the others being ethanol and water). It has been observed that different solvents may extract various phytoconstituents based on the solubility or polarity of the phytoconstituents in question. In this research, acetone extracts may have had the maximum antibacterial activity because they were more soluble for more phytoconstituents. In traditional medicine, most decoctions are produced using water, therefore the demonstration of antibacterial activity by water extracts offers the scientific foundation for the use of these plants. Despite its common usage in skin-cleansing decoctions, none of the plant extracts tested showed antimycotic action against any of the fungus at the quantities employed in the experiments. Possible combination with other plant components and other metabolites accounts for their cleaning effect.

The ability to survive higher temperatures may be an indicator that the phytoconstituents are hardy. This explains why certain plant components have traditionally been boiled at high temperatures for extended periods of time. At a more acidic pH, the extracts showed a small improvement in their antibacterial activity. Previous research has shown that Phyto components are more active in an acidic medium. Potash, a powerful basic salt, is often added to the treatment area after these plants have been applied topically. The fact that the activity of the extracts decreased at alkaline pH in this study may explain why the plant concoction must be consumed for a greater length of time before any curative effect is noticed. Staphylococcus aureus's high MIC and MBC values suggest that the plant extracts are less effective against some gram-positive bacteria or that the organism has the potential to develop antibiotic resistance, while the low MIC and MBC values for other bacteria indicate the efficacy of the plant extracts.

CONCLUSION

This research used an assay for antimicrobial and antibacterial activity to determine that the Indian medicinal plant Tamarindusindica had beneficial properties. The Indian medicinal plant Tamarindusindica has shown to have broad-spectrum antibacterial action, which might lead to the identification of novel chemical families of antibiotic compounds that could be used as selective agents in the treatment and control of infectious diseases. The results of this study pave the way for further research into the use of this plant in the creation of drugs for human consumption, perhaps for the treatment of gastrointestinal, urinary tract, and wound infections as well as typhoid fever. However, further research into the plant's purity and its impact on more harmful microbes is required. Tamarind oil's fatty acids are effective against S. aureus and E. coli, but the oil itself is ineffective. In contrast to the gold standard ampicillin, its efficacy is lower.

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