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ANTIBACTERIAL AND ANTIOXIDANT ACTIVITIES OF PIMENTA RACEMOSA LEAF EXTRACTS

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ABSTRACT

The current work uses solvents with varying polarity (methanol, acetone, chloroform, and distilled water) to examine the antibacterial and antioxidant qualities of *Pimenta racemosa* leaf extracts. The disc diffusion method was used to measure the antibacterial activity against *Salmonella typhi*, *Bacillus subtilis*, *Streptococcus species*, *Escherichia coli*, and *Klebsiella pneumoniae*. With the largest inhibition zone (1.8 cm) against *Bacillus subtilis*, methanol extract demonstrated the most potent antibacterial activity. Extracts of distilled water and acetone also shown modest action, whereas extracts of chloroform showed little to no inhibition. The Fe2+ reducing power assay was used to measure antioxidant activity, and the results indicated a dose-dependent rise in activity. Methanol extract showed the least amount of antioxidant activity, whereas distilled water extract showed the most. These results imply that *P. racemosa* leaves contain bioactive substances that may find use in pharmaceutical and nutraceutical products.

KEYWORDS: *Pimenta racemosa*, antibacterial activity, antioxidant activity, disc diffusion, medicinal plants.

INTRODUCTION

Natural health products and drug discovery heavily rely on medicinal plants as essential sources of bioactive chemicals with antioxidant and antibacterial qualities.[1,2] The need to find alternative therapeutic agents from plant sources has arisen due to the increase in antibiotic resistance.[3,4] Because of its antiseptic, analgesic, and antibacterial qualities, one of these plants, *Pimenta racemosa* (family Myrtaceae), also referred to as the bay rum tree or West Indian bay, has long been utilized in traditional medicine.[5–7] Secondary metabolites such phenolics, flavonoids, alkaloids, and terpenoids

are frequently responsible for the antibacterial properties of plant extracts.[8–10] Likewise, plant-based antioxidant molecules help prevent disorders linked to oxidative stress.[11,12] According to earlier research, *P. racemosa* includes flavonoids, tannins, and essential oils that have antioxidant and antibacterial qualities.[13–15] This study evaluates the antibacterial activity of methanol, acetone, chloroform, and aqueous extracts of *P. racemosa* leaves against selected pathogenic bacteria, along with their antioxidant potential using the Fe^{3+} reducing power assay.

MATERIALS AND METHODS

Plant Material

Fresh leaves of *Pimenta racemosa* were collected, shade-dried, and powdered. Extracts were prepared using methanol, acetone, chloroform, and distilled water as solvents.

Preparation of Extracts

About 10 g of powdered leaves was subjected to Soxhlet extraction in different solvents. Extracts were filtered and concentrated under reduced pressure.

Antibacterial Assay

The disc diffusion method was used to assess the antibacterial activity.[16] On nutrient agar plates seeded with the test species *E. coli, B. subtilis, Streptococcus spp., S. typhi, and K. pneumoniae*, sterile discs impregnated with extracts were positioned. Following a 24-hour incubation period at 37 °C, zones of inhibition were measured in centimeters.

Antioxidant Activity

Antioxidant activity was assessed using the Fe^{3+} reducing power assay.[17] Ascorbic acid was used as a standard to compare extracts at concentrations ranging from 100 to 500 µL. At 700 nm, absorbance was measured.

RESULTS AND DISCUSSION

Antibacterial Activity

Pimenta racemosa leaf extracts' antibacterial activity varied significantly based on the extraction solvent system, indicating the polarity and solubility of the bioactive phytoconstituents. Methanol extract continuously showed the most antibacterial potential among the studied solvents, generating inhibitory zones against every bacterial strain. *Bacillus subtilis* showed the largest zone of inhibition (1.8 cm), followed by *Salmonella typhi* (1.3 cm) and *Klebsiella pneumoniae* (1.1 cm) with significant activity (Table 1). Methanol is effective in extracting polar chemicals like phenolics, flavonoids, and tannins, which are known to damage bacterial cell membranes and obstruct protein synthesis, as evidenced by its significant activity against *B. subtilis*.[20] The ability of acetone extract to solubilize moderately polar molecules like terpenoids and alkaloids was demonstrated by its notable antibacterial action, especially against *B. subtilis* (1.7 cm) and *S. typhi* (1.0 cm). With inhibition zones ranging from 0.7 to 1.2 cm, the distilled water extract had moderate inhibitory activity, indicating the presence of hydrophilic bioactive compounds such as tannins, glycosides, or saponins.[21–23] The lowest antibacterial potential, on the other hand, was shown by chloroform extract, which showed no discernible activity against *E. coli*, *Streptococcus*, or *S. typhi* and only modest inhibition against *B. subtilis* (0.7 cm) and *K. pneumoniae* (0.6 cm) (Table 1). The reason for this decreased activity is probably that chloroform extracts contain a large number of non-polar components that are not very effective at penetrating bacterial cell walls and exerting inhibitory effects.[19,20] Gram-negative bacteria like *E. coli* and *K. pneumoniae* demonstrated moderate resistance, which is consistent with their thicker cell wall structure and outer

lipopolysaccharide membrane that restrict the entry of antimicrobial compounds, whereas Gram-positive *B. subtilis* was the most sensitive strain overall.[3,8] The discovered antibacterial activities support *P. racemosa's* potential as a natural antibacterial agent, especially when extracted in methanol, and are consistent with earlier research showing broad-spectrum action of the plant against pathogenic microbes.[18,19]

Table 1: Antibacterial activity of P. racemosa leaf extracts against selected pathogens.

Sl. No	Test organism	Methanol	Acetone	Chloroform	Distilled water
1	*Escherichia coli*	0.9	0.6	-	0.7
2	*Bacillus*	1.8	1.7	0.7	1.2
3	*Streptococcus*	0.9	0.7	-	-
4	*Salmonella typhi*	1.3	1.0	-	1.2
5	*Klebsiella*	1.1	-	0.6	1

Antioxidant Activity

The Fe^{3+} reducing power assay, which measures the antioxidant ability of *P. racemosa* extracts, showed a clear solvent-dependent variation, with activity rising in a concentration-dependent manner across all treatments (Table 2). With an absorbance of 2.40 at 500 µL, distilled water outperformed the normal ascorbic acid value of 1.54 at the same concentration, demonstrating the highest reducing power among the extracts. This high activity points to the presence of hydrophilic antioxidants like flavonoids, polyphenols, and tannins, which can donate electrons or hydrogen atoms to neutralize free radicals and convert Fe^{3+} to Fe^{2+}.[21,23] High antioxidant activity was also demonstrated by chloroform extract, as evidenced by absorbance values that increased gradually from 0.80 at 100 µL to 2.37 at 500 µL. This suggests that lipophilic substances such terpenes and volatile oils may help reduce power.[15,28] Although its absorbance values varied with concentration, acetone extract exhibited modest antioxidant activity. At lower dosages, its activity was abnormally high (2.30 at 100 µL), followed by a fall at middle concentrations and a slight recovery at higher doses. This erratic pattern might result from interactions between test reagents and solvent-extracted chemicals that alter the latter's capacity to donate electrons.[17,22] Remarkably, the absorbance values remained consistently low (0.08–0.14) at all doses, indicating that methanol extract exhibited the weakest antioxidant activity (Table 2). This implies that *P. racemosa's* important antioxidant components were either damaged during extraction and storage or were not effectively extracted in methanol. In contrast to previous research, which found that methanol extracts typically exhibited robust antioxidant activity, this study emphasizes how ambient factors, solvent polarity, and extraction techniques can all have a substantial impact on plant phytochemistry.[15] The findings generally support the notion that *P. racemosa* leaves are a rich source of antioxidant chemicals, with the most promising aqueous and chloroform extracts for use in therapeutic and nutraceutical applications to fight oxidative stress and the illnesses it causes.[11,12,28]

Table 2: Antioxidant activity of P. racemosa leaf extracts against selected pathogens.

Sample extract	T1 100 µL	T2 200 µL	T3 300 µL	T4 400 µL	T5 500 µL
Standard	0.31	0.63	0.78	1.30	1.54
Methanol	0.14	0.12	0.08	0.09	0.13
Acetone	2.30	1.68	2.18	1.92	1.83
Chloroform	0.80	0.99	1.39	2.19	2.37
Distilled water	1.65	1.24	1.76	1.87	2.40

CONCLUSION

The study shows that leaf extracts from *Pimenta racemosa* have strong antioxidant and antibacterial properties. While distilled water extract demonstrated the best antioxidant capacity, methanol extract demonstrated substantial

antibacterial activity, especially against *B. subtilis*. These findings demonstrate *P. racemosa's* potential as a natural source of antioxidant and antibacterial compounds. It is advised to do additional phytochemical study in order to separate and describe the active ingredients.

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