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PHYTOCHEMICAL ANALYSIS AND ANTIBACTERIAL ACTIVITY OF *Mangifera indica* L AND *Piper betle*

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ABSTRACT

The leaves of *Mangifera indica* and *Piper betle* are known for their antioxidant and antimicrobial properties. In the present study, the phytochemical constituents of the leaves of *Mangifera indica* and *Piper betle* were analyzed and their antibacterial properties were tested against bacteria isolated from dental caries. *Staphylococcus aureus* (ASDV5,6,7,12), *Staphylococcus epidermidis* (ASDV 4, 10), *Streptococcus mutans* (ASDV 2, 3, 9) were isolated on Mannitol salt agar and blood agar from caries tooth scum samples. All the isolates of *S. aureus*, *S. epidermidis* and *Streptococcus mutans* were sensitive to Ciprofloxacin, Azithromycin, Tetracycline and resistant to Clotrimazole, Methicillin. Leaf extracts of *Mangifera indica* and *Piper betle* were prepared using various solvents and tested against the bacterial isolates. The phytochemical analysis revealed the presence of tannins, flavonoids, alkaloids, terpenoids, glycosides, carbohydrates, saponins and resins. The antibacterial activity of the leaf extract of *M. indica* showed a zone of inhibition ranging from 10 to 20 mm at a concentration of 50, 100 µg whereas the antibacterial activity of the leaf extract of *P. betle* showed a zone of inhibition ranging from 10 to 25mm at the same concentration against *S. aureus*, *S. epidermidis* and *Streptococcus mutans*. The findings of the study indicate a propensity of these plants for drug development.

KEYWORDS: ***Mangifera indica, Piper betle,*** **Dental caries, Antibacterial activity, Drug Development**

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INTRODUCTION

Natural sources for developing drugs includes plants and their parts and these could be used in treatment of infectious diseases caused by pathogenic microbes.[1] Besides being a source of food, higher plants were utilised for their medicinal properties .[2,3] Medicinal properties of plants are due to the presence of bioactive compounds such as flavonoids, alkaloids, phenols, tannins, terpenoids, glycosides and essential oils.[4] Due to the development of antibiotic resistance and re-emerging infectious diseases, there is a need to discover new antimicrobial compounds which are affordable and accessible.[5] Plant derived drugs are sustainable source that may be employed in combating infections.[6] Mangifera indica L., (family Anacardiaceae) commonly known as mango has been an important tree in both Ayurveda and indigenous system. Mangiferin is the bioactive compound that has strong antioxidant, antidiabetic, wound healing activities.[7] Extracts from *M. indica* leaf and stem bark have been found to possess antimalarial, [8] antifungal, [9] antimicrobial, anti-inflammatory, antiviral [10,11] and anticancer activity.[12] The leaves are also used in treating skin disease, dental caries, bronchitis, diarrhea, pyogenic infections and internal hemorrhages.[13] Mango seeds are used in treatment of disorders of female reproductive organs namely vaginal leucorrhoea, vaginitis while mango bark juice is used to control menorrhagia.[14] *Piper betle* L., (family Piperaceae) commonly known as the betle vine is an important medicinal plant in Southeast Asian countries. Betle leaf is traditionally known to be useful as a post meal mouth freshener, for the treatment of diseases such as bad breath, boils and abscesses, conjunctivitis, constipation, headache, hysteria, itches, mastitis, mastoiditis, leucorrhoea, ringworm, swelling of gum, rheumatism and abrasion.[15,16] The leaves are warmed and applied to the chest to relieve cough and asthma.[17,18] They have antimicrobial activity against *Streptococcus viridans, Staphylococcus aureus* and *Streptococcus mutans*. [19]The present work was aimed to screen the phytochemical constituents of the organic solvent extracts of the leaves of *Mangifera indica* and *Piper betle* for their antibacterial efficacy against bacteria isolated from dental caries.

MATERIALS AND METHOD

Sample collection, isolation and identification of bacteria

The caries tooth scum samples were randomly collected aseptically in screw cap bottles with saline using sterile swabs from a dental clinic in Chennai, Tamil Nadu. The collected samples were brought to the laboratory on ice. Serial dilutions were made using sterile saline solution and plated on selective Mannitol salt agar, blood agar and incubated at 37º C for 24 hours. The plates were observed for growth of the bacterial colonies. Bacterial isolates were characterized by Grams staining, biochemical tests and identified by Bergey's Manual of Systematic Bacteriology.[20]

Antibiogram of the bacterial isolates[21]

In the present study, the bacterial isolates were tested for their susceptibility to several commonly used antibiotics (Hi-media, Mumbai) by disc diffusion method.[21] The antibiotic discs tested include Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin, Co-trimoxazole, Erythromycin, Ampicillin, Nalidixic acid, Clotrimazole, Penicillin-G and Methicillin. The 18 hrs cultures of the bacterial isolates were adjusted to McFarland standard and spread on Muller Hinton Agar. Antibiotic discs were placed on the agar surface. Zones of inhibition (in mm) against each bacterial isolate were measured after 24 hrs of incubation at 37ºC. According to NCCLS (National Committee for Clinical Laboratory Standard) an organism was interpreted as highly susceptible if the diameter of inhibition zone was more than 19 mm, intermediate if diameter was 15-18 mm and resistant if diameter was less than 13 mm.

Collection of the plant samples

Fresh leaves of *Mangifera indica* were collected from the College campus and fresh leaves of *Piper betle* (Vellaikodi variety) were collected from Tirunelveli, Tamilnadu. The plant samples were authenticated by Dr. N.K. Udayaprakash, Assistant Professor, Department of Biotechnology, Vels University, Chennai and deposited in the herbarium (MLHA 1032 and MLHA 1033) at Marina Labs.

Preparation of the Plant Extract

The freshly collected leaves were thoroughly washed thrice in distilled water, shade dried, powdered using a mechanical blender and subjected to extraction using solvents such as methanol, ethanol, ethyl acetate and chloroform separately using Soxhlet apparatus.

Test for Carbohydrates [22]

Molisch Test: To 2 ml extract few drops of α-naphtha (20% in ethyl alcohol) were added. Then 1 ml of conc. H_2SO_4 was added along the side of the test tube. Reddish violet ring at the junction of the two layers indicates the presence of carbohydrates.

Reduction of Fehling's Solution

10 ml of Fehling solution (copper sulphate in alkaline condition) was added to the concentrated extracts and heated on a steam bath. Brick-red precipitate indicates the presence of carbohydrate.

Test for Proteins [23]

Biuret Test: To 3 ml of extract was added 4% NaOH and few drops of 1% $CuSO_4$ solution. Violet or pink colour indicates the presence of proteins.

Ninhydrin Test

To 1 ml of extract 1% Ninhydrin reagent was added and heated on a steam bath. Violet colour indicates the presence of proteins.

Phytochemical Analysis of Leaf Extract

The leaf extracts obtained from methanol, ethanol, ethylacetate and chloroform were subjected to preliminary qualitative tests for the presence of carbohydrates, proteins, steroids, flavonoids, tannins, alkaloids.

Test for Glycosides [23]

Keller- Killani Test: 1 ml of glacial acetic acid containing traces of $FeCl_3$ and 1 ml of concentrated H_2SO_4 were

added to the extracts carefully. A reddish-brown colour is formed at the junction of two layers and the upper layer turns bluish green indicates the presence of glycosides.

Test for Tannins [24]
To 1 ml of extract, 2 ml of 5% $FeCl_3$ was added. A dark blue or green black colour indicates the presence of tannins.

Test for Alkaloids [24]
To 2 ml extract 2 ml Conc. HCl and few drops of Mayer's reagent was added. A green or white precipitate indicates the presence of alkaloids.

Test for Flavonoids [23]
To 2 ml extract 1 ml 2N NaOH was added. Appearance of yellow colour indicates the presence of flavonoids.

Test for Terpenoids [25,26]
To 2ml of each extract 5ml of chloroform and few drops of concentrated H_2SO_4 were carefully added to form a layer. A reddish brown coloration formed in the interface indicates the presence of terpenoids.

Test for Saponins [25,26]
Foam test - The crude extract is mixed with 5ml of distilled water and shaken vigorously. The formation of stable foam indicates the presence of saponins. *Froth test* – 2 g of the powdered sample is boiled with 10 ml of distilled water and then filtered and mixed with 5 ml of distilled water and added with few drops of olive oil and mixed vigorously, then observed for the formation of emulsion.

Test for Resins [25,26]
1 ml of the extracts was treated with few drops of acetic anhydride followed by concentrated H_2SO_4. Colour ranging from orange to yellow was noticed.

Antibacterial activity [27]
In vitro antibacterial activities of the extracts were studied against isolated dental caries bacteria by the agar well diffusion method.[27] The extracts were dissolved in 5% (v/v) DMSO. 5% (v/v) DMSO was taken as the control. Muller Hinton agar was used as the bacteriological medium. Suspension of microorganisms were made in Nutrient broth and adjusted to 0.5 McFarland standards ($1X10^8$cfu/ml). Each plate was uniformly spread with 100 µl of test organism. A sterile cork borer of 5 mm diameter was used to make wells on the medium. 50µl of the extract corresponding to 50 µg and 100 µg were added into each well.[28,29] The plates were incubated at 37ºC for 24 hours. Antibacterial activity was determined by measuring the diameter of zones of inhibition (mm) after incubation.

RESULTS

The bacterial isolates were designated by ASDV (**A**runa **S**harmili **Div**yalashmi) followed by the isolate number. Bacteria isolated on Mannitol salt agar that turned the media yellow, indicated Mannitol fermentation were *Staphylococcus aureus* (ASDV5,6,7,12) and those isolates that did not change colour were *Staphylococcus epidermidis* (ASDV4,10) as Mannitol was not fermented. Bacterial isolates on blood agar that showed alpha haemolysis (ASDV 2, 3, 9) were *Streptococcus mutans.* Further biochemical characterization of the bacterial isolates obtained from Mannitol salt agar, Blood agar was also done to ascertain their identities. All the isolates of *Staphylococcus aureus* (ASDV 5, 6, 7, 12) were sensitive to Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin but resistant to Clotrimazole and Methicillin. ASDV 5, 7, 12 were sensitive to Co-trimoxazole. ASDV 7 was sensitive to Erythromycin and Nalidixic acid. ASDV 5 was sensitive to Ampicillin, Nalidixic acid and Penicillin-G. The two isolates of *Staphylococcus epidermidis* (ASDV 4, 10) were sensitive to Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin and resistant to Co-trimoxazole, Ampicillin, Penicillin-G and Methicillin. ASDV 4 was sensitive to Nalidixic acid and resistant to Erythromycin. ASDV 10 was sensitive to Erythromycin and resistant to Nalidixic acid. *Streptococcus mutans* (ASDV 2, 3, 9) was sensitive to Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin, Co-trimoxazole and resistant to Erythromycin, Ampicillin, Clotrimazole, Penicillin-G, Methicillin. ASDV 2 was sensitive to Nalidixic acid (Table 1) but the other two isolates (ASDV 3, 9) were resistant. In the present study, the methanolic and ethanolic extract of *Mangifera indica* revealed the presence of tannins, flavonoids, alkaloids, terpenoids and glycosides whereas saponins and resins were absent. The chloroform extract of *M. indica* showed the presence of tannins, flavonoids, terpenoids, glycosides, saponins and resins but alkaloids were absent. The ethylacetate extract of *M. indica* revealed the presence of flavonoids, terpenoids and glycosides but saponins, resins, alkaloids and tannins were absent (Table 2). Carbohydrates and proteins were absent in all the solvent extracts of *M. indica* In the current investigation, the ethanolic and methanolic extract of *Piper betle* showed the presence of tannins, flavonoids, alkaloids, terpenoids and glycosides but saponins and resins were absent. The chloroform extract of *P. betle* revealed the presence of flavonoids, terpenoids, glycosides, saponins, and resins whereas alkaloids and tannins were absent. The ethylacetate extract of *P. betle* showed the presence of flavonoids, terpenoids and glycosides but saponins, resins, alkaloids and tannins were absent (Table 2). Carbohydrates and proteins were absent in all the solvent extracts of *P. betle.* The methanol extract of *M. indica* leaves inhibited the growth of *S. aureus* (ASDV5, 6, 7, 12) at 50µg (13mm, 12mm, 16mm, 15mm) (Fig 1) and the growth of *Staphylococcus epidermidis* (ASDV4) at 100µg (10mm). The ethanolic extract of *M. indica* leaves inhibited *S.epidermidis* (DV4), *S.aureus* (ASDV5, 6, 7, 12) at 50µg (11mm, 15mm, 14mm, 12mm, 11mm) and the growth of *Streptococcus mutans* (ASDV3) at 100µg (12mm). The chloroform extract inhibited *S.aureus* (ASDV5) at 100µg (14mm). The ethylacetate extract of *M. indica* inhibited *Streptococcus mutans* (ASDV2, 9) (Fig 1), *S.epidermidis* (ASDV4,10), *S.aureus* (ASDV5, 6, 12) at 50µg (14mm,10mm, 12mm, 10mm, 16mm, 16mm, 16mm)whereas *Streptococcus mutans* (ASDV3) and *S.aureus* (ASDV7) showed no zone of inhibition (Table 3). The chloroform extracts no activity on any of the bacterial isolates. The methanol extract of *P. betle*

leaves had no activity on any of the bacterial isolates. The ethanolic extract inhibited the growth of *Streptococcus mutans* (ASDV2), *Staphylococcus aureus* (ASDV5) at 50µg and that of *Staphylococcus epidermidis* (ASDV4) at 100µg (11mm). The growth of *S.aureus* (ASDV6, 7) (Fig 2) and *S. epidermidis* (ASDV10) were inhibited at 100µg (16mm, 12mm respectively). The chloroform extract inhibited *S.aureus* (ASDV6) at 100µg (12mm). The ethylacetate extract of *P. betle* leaves inhibited the growth of *Streptococcus mutans* (ASDV2, 3,9), *S.epidermidis* (ASDV4), and *S.aureus* (ASDV12) (Fig 2) at 50µg.The growth of *S.aureus* (ASDV5, 6) and *S.epidermidis* (ASDV10)was inhibited at 100µg (16mm, 25mm, 20mm) (Table 3).

Table 1
Antibiotic susceptibility pattern of the bacterial isolates

S.NO	Antibiotic Disc	zone of inhibition diameter (mm)								
		ASDV 5	ASDV 6	ASDV 7	ASDV 12	ASDV 4	ASDV10	ASDV 2	ASDV 3	ASDV 9
		S.aureus				*S. epidermidis*		*S.mutans*		
1	CIPROFLOXACIN (5 mcg/disc)	S (33)	S (32)	S (34)	S (35)	S (34)	S (26)	S (33)	S (30)	S (35)
2	AZITHROMYCIN (15 mcg/disc)	S (29)	S (24)	S (28)	S (23)	S (30)	S (22)	S (25)	S (23)	S (25)
3	TETRACYCLINE (30 mcg/disc)	S (30)	S (20)	S (33)	S (27)	S (27)	S (25)	S (21)	S (24)	S (25)
4	NORFLOXACIN (10 mcg/disc)	S (21)	S (27)	S (28)	S (28)	S (28)	S (22)	S (25)	S (21)	S (27)
5	CO -TRIMOXAZOLE (25 mcg/disc)	S (28)	R (9)	S (21)	S (21)	R (3)	R (9)	S (22)	S (23)	S (25)
6	ERYTHROMYCIN (15 mcg/disc)	S (27)	R (11)	S (24)	R (13)	R (9)	S (22)	R (10)	R (13)	R (12)
7	AMPICILLIN (10 mcg/disc)	S (40)	R (15)	R (14)	R (12)	R (8)	R	R (10)	R (9)	R (9)
8	NALIDIXIC ACID (30 mcg/disc)	S (21)	R (7)	S (23)	R (8)	S (22)	R (7)	S (20)	R (9)	R (9)
9	CLOTRIMAZOLE (10 mcg/disc)	R (13)	R (10)	R (9)	R (9)	R (2)	R (8)	R	R	R
10	PENICILLIN-G (10 mcg/disc)	S (36)	R (11)	R (10)	R	R	R	R	R	R
11	METHICILLIN (5 mcg/disc)	R	R (8)	R	R	R	R	R	R	R

Note: R=Resistant; S=Sensitive ASDV = Aruna Sharmili¸ Divyalashmi.

Table 2
Phytochemical constituents of Mangifera indica and Piper betle

Phytochemical Tests	*Mangifera indica*				*Piper betle*			
	M	E	C	EA	M	E	C	EA
Tannin	+	+	+	-	+	+	-	-
Flavanoid	+	+	+	+	+	+	+	+
Alkaloid	+	+	-	-	+	+	-	-
Terpenoid	+	+	+	+	+	+	+	+
Glycoside	+	+	+	+	+	+	+	+
Saponine	-	-	+	-	-	-	+	-
Resin	-	-	+	-	-	-	+	-
Carbohydrate	+	+	+	+	+	+	+	+
Protein	-	-	-	-	-	-	-	-

Note: M= Methanol; E= Ethanol; C= Chloroform; EA= Ethylacetate; ASDV = Aruna Sharmili¸ Divyalashmi.

Table 3
Antibacterial activity of Mangifera indica and Piper betle

Bacterial Isolates	*Mangifera indica*								*Piper betle*							
	M		E		C		EA		M		E		C		EA	
	50 µg	100µg	50 µg	100 µg	50 µg	100 µg	50 µg	100 µg	50 µg	100µg	50 µg	100 µg	50 µg	100 µg	50 µg	100 µg
S. aureus (ASDV5)	13	14	15	17	-	14	16	18	-	-	11	15	-	-	-	16
S. aureus (ASDV6)	12	14	14	18	-	-	16	20	-	-	-	16	-	12	-	25
S. aureus (ASDV7)	16	18	12	14	-	-	-	-	-	-	-	16	-	-	-	-
S. aureus (ASDV12)	15	18	11	15	-	-	16	20	-	-	-	-	-	-	10	13
S.epidermidis (ASDV4)	-	10	11	14	-	-	12	14	-	-	-	11	-	-	14	21
S.epidermidis (ASDV10)	-	-	-	-	-	-	10	14	-	-	-	12	-	-	-	20

S. mutans (ASDV2)	-	-	-	-	-	-	14	15	-	-	15	20	-	-	18	25
S. mutans (ASDV3)	-	-	-	12	-	-	-	-	-	-	-	-	-	-	16	18
S. mutans (ASDV9)	-	-	-	-	-	-	10	12	-	-	-	-	-	-	10	12

Note: M= Methanol; E= Ethanol;C= Chloroform ;EA= Ethylacetate; ASDV = Aruna Sharmili, Divyalashmi

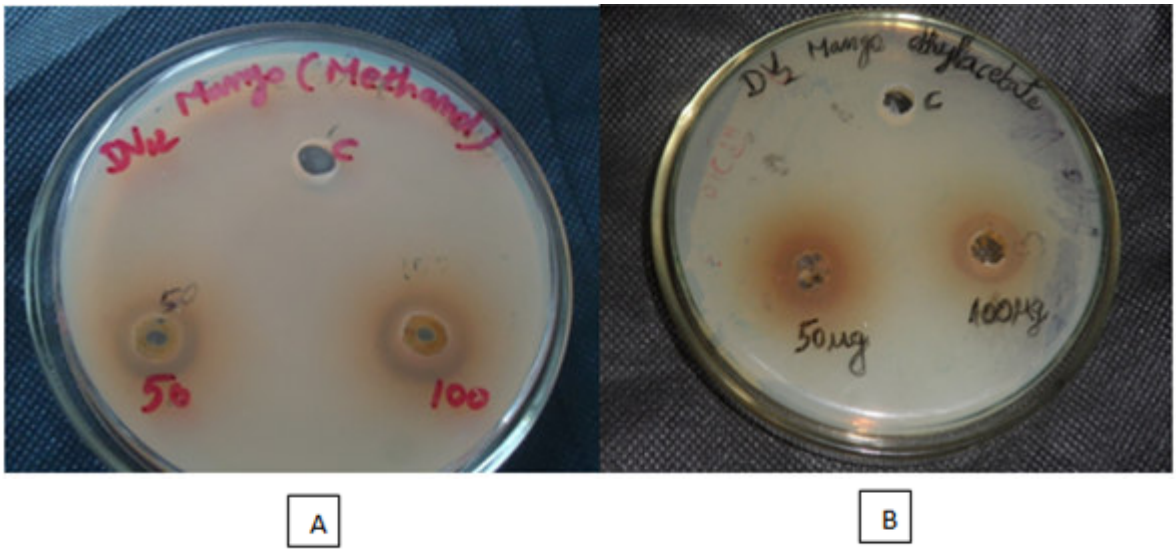

Figure1
Antibacterial activity of leaf extract of Mangifera indica against S. aureus (A) and S. mutans (B)

Figure 2
Antibacterial activity of leaf extract of Piper betle against S. aureus (C) and S. mutans (D)

DISCUSSION

In the present study isolates of *Staphylococcus aureus, Staphylococcus epidermidis* and *Streptococcus mutans* were isolated from the dental caries samples. Similarly Daniyan and Abalaka, [30] have isolated *Streptococcus mutans, Staphylococcus aureus* and *Lactobacillus spp* from 40 patients with dental caries at the Minna General Hospital. Mohapatra *et al*.,[31] have also reported the presence of S*taphylococci* (10 isolates), S*treptococci* (30 isolates), *Lactobacillus* (4 isolates) in the study of microbial association of dental caries. In the present study all the isolates of *Staphylococcus aureus* were sensitive to Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin and resistant to Clotrimazole, Methicillin. Kitara *et al*., [32] have reported that Ampicillin showed the highest overall resistance followed by Cotrimoxazole, Tetracycline, Chloramphenicol and Erythromycin, Ciprofloxacin and Methicillin against *Staphylococcus aureus*. In the current investigation, all the isolates of *Staphylococcus epidermidis* were sensitive to Ciprofloxacin, Azithromycin, Tetracycline and resistant to Co-trimoxazole, Ampicillin, Penicillin-G and Methicillin similar to the reports of Haque *et al*., [33] who have reported multidrug resistance of *S. epidermidis* to Penicillin, Oxacillin, Gentamycin and Erythromycin. *Streptococcus mutans* (ASDV 2, 3, 9) was sensitive to Ciprofloxacin, Azithromycin, Tetracycline, Norfloxacin, Co-trimoxazole and resistant to Erythromycin, Ampicillin, Clotrimazole, Penicillin-G,

Methicillin. Salman and Senthil, [34] have reported sensitivity of *S. mutans* to Ampicillin, Penicillin, Chloramphenicol, Cephalothin, Cefazolin, Cefotaxime, Erythromycin, and resistance to Methicillin. In the present study, the methanolic extract of *M. indica* revealed the presence of tannins, flavonoids, alkaloids, terpenoids, glycosides and carbohydrates similar to the findings of Joona *et al*.,[35], Teodora *et al*.,[36], Kaur *et al*.,[37] who have reported the presence of tannins, flavonoids, glycosides, saponins. In the current investigation, saponins, resins and proteins were absent similar to the reports of Choudhury *et al*.,[38] and Minal *et al*.,[39].The ethanolic extract of *M. indica* in the current study revealed the presence of tannins, flavanoids, alkaloids, terpenoids, glycosides and carbohydrates in concordance with the results of Luka and Mohammed,[40]; Jose *et al*.,[41] and Pratul and Ranjit.,[14]. In the present study, the chloroform extract of *M. indica* showed the presence of tannins, flavonoids, terpenoids, glycosides, saponins, resins and carbohydrates but proteins and alkaloids were absent whereas Hossain *et al*.,[42] has reported the presence of tannins, flavonoids, alkaloids and saponins and absence of terpenoids. The ethylacetate extract of *M .indica* revealed the presence of flavonoids, terpenoids, glycosides and carbohydrates but saponins, resins, proteins, alkaloids and tannins were absent. In the present study, the hexane extract of *M. indica* revealed the presence of flavonoids, terpenoids, glycosides, and carbohydrates similar results have been reported by Aiyelaagbe and Paul,[43] for the presence of flavonoids and glycosides. In the current investigation, the methanolic extract of *P. betle* showed the presence of tannins, flavonoids, alkaloids, terpenoids, glycosides and carbohydrates but saponins, resins and proteins were absent. Jayalakshmi *et al*.,[44] has reported the presence of tannins, flavonoids, glycosides, saponins, carbohydrates and proteins and absence of alkaloids, terpenoids. Prakash *et al*.,[45] have reported the presence of tannins, flavonoids and terpenoids int e methanol extracts of four cultivars of *P. betle*. In the present study, the ethanolic extract of *P. betle* showed the presence of tannins, flavonoids, alkaloids, terpenoids, glycosides and carbohydrates but saponins, resins, and proteins were absent. Similarly Arani *et al*., [15] and Kaveti *et al*., [46] also reported the presence of tannins, flavonoids, carbohydrates and proteins. In the current study, the chloroform extract of *P. betle* revealed the presence of flavonoids, terpenoids, glycosides, carbohydrates, saponins, and resins whereas alkaloids, proteins, and tannins were absent. In contrast Jayalakshmi *et al*.,[44] has reported the presence of alkaloids, glycosides and proteins and absence of tannins, flavonoids, terpenoids, saponins and carbohydrates. In the current investigation, the ethylacetate leaf extract of *P. betle* showed the presence of flavonoids, terpenoids, glycosides and carbohydrates. Similar finding have been reported by Jayalakshmi *et al*.,[44]. In the present study alkaloids and terpenoids were absent in the ethylacetate leaf extract of *P. betle* which concurs with the findings of Devjani and Barkha, [47].In the present study the methanolic extract of *M. indica* showed no antibacterial activity in contrast to Jose and Beegum, [48] reports that methanol extract of *M. indica* showed a zone of inhibition of more than 10mm for *S.mutans*. In the current study the ethanolic extract of *M. indica* showed a zone of inhibition at 50µg/ml in concordance with the results of Ammara *et al*., [49] and Kabuki *et al*., [50]. The ethylacetate extract of *M. indica* was effective against *S.mutans* and *S.aureus* with a zone of inhibition of 14mm and 16mm respectively. Similarly 12mm zone of inhibition was recorded by the ethylacetate extract of *M. indica* against *S.mutans* and *Staphylococcus aureus* by Lubna *et al*., [51]. In the present study there was no antibacterial activity for methanolic leaf extract of *P. betle* against *S.aureus* but Devjani *et al*., [52] has reported a zone of inhibition at a concentration of 5mg/ml. Shitut *et al*.,[50] and Arani *et al*.,[15] has reported that ethanolic betle leaf extract was effective against *S.aureus* with a zone of inhibition of 13mm similar to the present study but the zone of inhibition was much greater (16mm).

CONCLUSION

The results of the present study revealed the presence of several phytochemical compounds like flavonoids, alkaloids, terpenoids, glycosides, saponins, carbohydrates in *Mangifera indica* and *Piper betle* which are potential bioactive compounds. These phytochemical compounds may contribute as useful source of drug against bacteria as seen from the current antibacterial activity studies. Further isolation and purification of the compounds that are responsible for the activity will help in drug designing by providing lead molecules for various ailments.

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CONFLICT OF INTEREST

Conflict of interest declared none.

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