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The Antibacterial Effect of *Carica papaya* L. Extracts and Their Synergistic Effect with Antibiotic and Non-antibiotic Drugs

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Authors' contributions

This work was carried out in collaboration between both authors. Author EFF designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed literature searches. Authors EFF and VJ managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: Antibacterial activity of *Carica papaya* leaf and seed extracts, their synergism with antibiotic and non-antibiotic drugs and GC-MS analysis of extracts.
Study Design: Antibacterial activity was evaluated by Disc and Well diffusion method. Synergism with antibiotic drug, Gentamicin, and non-antibiotic drug, Vitamin C, were done by disc diffusion method. GC-MS analysis carried out in GC-MS equipment (Thermo Scientific Co.).
Place and Duration of Study: Study was conducted in Department of Botany and Department of Chemistry, St. Thomas' College, Thrissur between December 2015 to April 2016.
Methodology: We include 3 gram negative (*E. coli, Klebsiella pneumoniae* and *Pseudomonas aeruginosa*) and a gram positive (*Staphylococcus aureus*) bacteria in this study. Antibacterial activity of *Carica papaya* extracts (water, petroleum benzene, chloroform and ethanol extracts) against these bacteria's were studied. Their synergisms with antibiotic as well as non antibiotic drugs were also evaluated. GC-MS analysis of all the extracts were also done.
Results: In the antibacterial activity assessment, all the four extracts of tender leaves were effective

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against *E. coli* than other plant materials. Seed extracts were more effective against *P. aeruginosa* and *S. aureus*. In synergistic analysis, water and ethanol extracts of all the plant materials have an enhanced effect with gentamicin against *E. coli* and *P. aeruginosa.* Yellow leaves extracts along with gentamicin exhibited an inhibition zone which is greater than that of gentamicin alone. Vitamin C gave enhanced activity against all the tested bacteria when combined with papaya extracts. GC-MS analysis proved that more number of bioactive components were present in petroleum benzene extract of tender leaves than all other extracts.

Conclusion: The results shows that *Carica papaya* extracts have antibacterial activity and when they were combined with antibiotic and non antibiotic drugs. In GC-MS analysis, tender leaves exhibited more bioactive components.

Keywords: Carica papaya; antibacterial activity; synergism; antibiotic drug; non-antibiotic drug; GC-MS analysis.

1. INTRODUCTION

Medicines have an important role in our day to day life. Since time immemorial plants have been used for treatment of various ailments. Even today several important drugs used in modern system of medicines are obtained from plants. Use of medicinal plants has figured in several ancient manuscripts like *Rig-Veda.* In *Ayurveda,* definite properties of drugs obtained from plants are used to improve the overall health and well-being. Medicinal importance of a plant is due to presence of some alkaloids, glycosides, resins, volatile oils, gums, tannins, etc. These active principles usually remain concentrated in storage organs of plant, *viz,* roots, seeds, bark, leaves etc.

Papaya is the only species in the genus Carica of the plant family Caricaceae [1]. The papaya is a large, tree-like plant, with a single stem growing from 5 to 10 m tall, with spirally arranged leaves confined to the top of the trunk. The flowers appear on the axils of the leaves, maturing into large spherical or pear shaped fruits – 15–45 cm long and 10–30 cm in diameter. The fruit is a type of berry [2]. They clumped near its top end of the trunk. Inside, the fruit features numerous black pepper-corn like seeds, encased in a mucin coat, at its hollow central cavity. The flesh is orange in color with either yellow or pink hues, soft in consistency and has deliciously sweet, musky taste with rich flavor [3]. Now it is considered as valuable nutraceutical fruit plant. It can be chosen as a source of "Papain" for the development of various industrial and pharmaceutical products for various diseases [4]. Rich loamy soil is most suitable for the growth of papaya. It is usually propagated by seeds obtained from well mature fruits.

So the present study was designed keeping in view the resistance of bacteria to most of the drugs commonly used today. It was aimed to analyze the antibacterial activity and its synergistic effect with antibiotic and non-antibiotic drugs against the most common disease causing bacteria's such as *Escherichia coli, Klebsiella pneumoniae., Pseudomonas aeruginosa* and *Staphylococcus aureus.*

2. METHODOLOGY

2.1 Collection of Plant Materials

Tender leaves, mature green and yellow leaves and mature white seeds of *Carica papaya* L. were collected from different locations in Thrissur. Leaves were dried under shade and seeds under sunlight. Dried leaves and seeds were grinded into fine powder.

2.2 Extraction of Plant Materials

2.2.1 Aqueous extraction

50 gm of finely powdered leaves and seeds were separately weighed out in a weighing balance and tied up in muslin cloth. It was concentrated by boiling in a beaker of distilled water in a hot plate and then concentrated to dryness with a vacuum evaporator. Dilutions of the concentrated samples were prepared in DMSO and it was used as aqueous extract in the antibacterial analysis. The concentration of plant extracts was fixed as 500 µg/ml for the purpose of this study.

2.2.2 Organic solvent extraction

25 gm of finely powdered plant parts were taken in Soxhlet apparatus along with 300 ml of organic solvents such as petroleum benzene, chloroform

and ethanol based on their polarity. The plant extracts obtained after extraction were concentrated with a vacuum evaporator. The solution was stored in well closed containers under refrigeration conditions and dilutions of the plant extract in DMSO were used for antimicrobial studies. The concentration of plant extracts used for antimicrobial study was 500 µg/ml.

2.3 Antibacterial Activity

Bacterial samples were isolated from a local clinic (Poly Clinic Laboratories, Thrissur, Kerala, India). *Staphylococcus aureus* ATCC 6538, *Klebsiella pneumoniae* ATCC 700603, *Pseudomonas aeruginosa* ATCC 15442 and *Escherichia coli* ATCC 2392 were used in the study.

2.3.1 Paper disc diffusion assay

Suspensions of testing microorganisms were spread on medium. The filter paper discs of 5mm diameter was placed on the agar plates which was inoculated with the tested microorganisms and then impregnating with 20 µl of plant extract. Respective solvents were used as the negative control and gentamicin disc as the positive control. The plates were subsequently incubated at 37℃ for 24 hours. After incubation the growth inhibition zone were quantified by measuring the diameter of the zone of inhibition in mm [5].

2.3.2 Well diffusion assay

An inoculam suspension was swabbed uniformly to solidified Nutrient agar for bacteria, and the inoculam was allowed to dry for 5 min., holes of 5 mm in diameter were made in the seeded agar using cork borer. Aliquot of 20 µl from each plant crude extract was added into each well on the seeded medium and allowed to stand on the bench for 1 hour for proper diffusion and thereafter incubated at 37℃ for 24 hour. Respective solvents were used as the negative control and gentamicin (10 µg/ml) as the positive control. The resulting inhibition zones were measured in mm [6].

2.4 Synergism of Plant Extracts along with Antibiotic and Non-antibiotic Drugs

The bacterium was inoculated on the surface of nutrient agar. Subsequently, the antibiotic disc (diameter=5 mm) was placed on the surface of each inoculated plate and then added 20 µl of *Carica papaya* extract to identify synergism effect between the papaya extracts and antibiotics. To identify synergism between the papaya extracts and Non-antibiotics, 10 µl of Vitamin C and 10 µl of papaya extracts were mixed and put together on a filter paper disc which was left for one hour to dry. The plates were incubated at 37℃ for 24 h. The diameters of clearing zones were measured.

2.5 GC-MS Analysis

2 µl of the petroleum benzene extracts of *Carica papaya* was employed for GC- MS analysis. The phytochemical investigation of petroleum benzene extracts was performed on a GC-MS equipment (Thermo Scientific Co.) Thermo GC-TRACE ultra ver.: 5.0, Thermo MS DSQ II. Experimental conditions of GC-MS system were as follows: TR 5-MS capillary standard non-polar column, dimension: 30 Mts, ID: 0.25 mm, Film thickness: 0.25 µm. Flow rate of mobile phase (carrier gas: He) was set at 1.0 ml/min. In the gas chromatography part, temperature programme (oven temperature) was 40℃ raised to 250℃ at 5℃/min and injection volume was 1 µl. Samples dissolved in chloroform were run fully at a range of 50-650 m/z and the results were compared by using Spectral library search programme. Interpretation on mass spectrum of GC-MS was done using the database of Thermo Scientific GC MS, Department of Chemistry, St. Thomas' College, Thrissur. The mass spectrum of the unknown component was compared with the spectrum of the known components stored in the GC - MS Library.

3. RESULTS AND DISCUSSION

3.1 Antibacterial Activity Assessment

The water extract of *Carica papaya* tender leaves have shown an inhibitory zone of 15±1.247 mm in disc diffusion method and petroleum benzene extract of tender leaves has highest inhibition zone (9.5±0.236 mm) in well diffusion method in *E. coli* (Table 1). Chloroform extract of seeds of papaya shows an inhibition zone of 7.33±0.272 mm in disc diffusion method and chloroform extract of green leaves has maximum inhibition zone of 22.66 ± 1.905 mm in well diffusion method against *K. pneumoniae* (Table 2). Petroleum benzene extract of seed has maximum inhibition zone in disc diffusion method

(15.0 mm) and in well diffusion method water extract of seed shows maximum diameter in inhibition zone (8.66 ± 0.272 mm) against *P. aeruginosa* (Table 3). The inhibition zone formed by ethanol extract of green leaves is maximum (10±0.707 mm) against *S. aureus* in disc diffusion method. But in well diffusion method chloroform extract of seed has maximum inhibition zone (13.33 ± 1.963 mm) (Table 4).

3.2 Synergism of Plant Extract with Antibiotic Drug Gentamicin

The synergistic effect of *Carica papaya* extracts along with gentamicin shows that there is enhanced effect when water and ethanol extracts of all the plant materials such as tender leaves, green leaves, yellow leaves and seeds combined with gentamicin against *E. coli* (Table 5). Water and petroleum benzene extract of tender leaves of papaya along with gentamicin show enhanced effect against *Klebsiella pneumoniae*. Chloroform and ethanol extracts of tender leaves have enhanced effect on the bacteria when compared to the zone formed by the extracts alone but they have a zone which is lesser than that of Gentamicin alone (Table 6). The tender leaves extract of *Carica papaya* exhibits an enhanced effect on *P. aeruginosa* along with Gentamicin. But its inhibition zone is reduced than that of gentamicin alone (22.33 ± 0.272 mm). Green leaves extracts do not have any effect on *P. aeruginosa*, but when they combines with gentamicin inhibition zone is formed which is smaller than that of inhibition zone formed by gentamicin alone (Table 7). The water extract of tender leaves, all the extracts of green leaves and yellow leaves has much greater effect than that of gentamicin alone (19.66 ± 0.720 mm) against *S. aureus* (Table 8).

3.3 Synergism of Plant Extracts with Non-antibiotic Drug Vitamin C

Ethanol extract of tender leaves and petroleum benzene and chloroform extract of green leaves have an enhanced effect on *E. coli* when combined with Vitamin C (Table 9). Chloroform and ethanol extract of tender leaves; petroleum benzene extract of green leaves and chloroform extract of yellow leaves and seeds along with Vitamin C have an enhanced effect on *Klebsiella pneumoniae* (Table 10). Ethanol extract of tender leaves and green leaves and chloroform extract of green leaves and seeds have an enhanced effect when combined with Vitamin C (Table 11). Chloroform and ethanol extracts of tender leaves along with Vitamin C produces an inhibition zone having diameter of 6.0 mm in *S. aureus* (Table 12).

3.4 GC-MS Analysis

GC MS analysis of petroleum benzene extract of tender leaves shows a chromatogram having 15 peaks (Fig. 1-A). The chemical constituents comprises 9-octadecenoicacid(z)-tetradecylester; Decyl oleate; Cyclobuta(a)dibenzo(c,f)cyclo heptadiene,7-oxo-; Naphthalene-1,2,3,4-tetrahydro-1-phenyl-; Benzene-1, 1'-(1,2-cyclobutanediyl)bis-,trans-; Benzene-1,1'-(1,1,2,2-tetramethyl-1,2-ethanediyl)bis-; Caffeine; Hexa decanoicacid, ethylester; 2,3-Dihydroxypropylelaidate; Hexadecanoic acid,1-(hydroxylmethyl)-1,2-ethanediylester; Linoleicacid ethylester; 9,12,15-octadecatrienoic acid, 2,3-dihydroxypropylester,(z,z,z); N,N'-Bis(carbobenzyloxy)-lysine methyl(ester); Octadecane,3-ethyl-5-(2-ethylbutyl)- and Oleicacid, eicosyl ester.

GC MS analysis of petroleum benzene extract of green leaves produce a chromatogram (Fig. 1-B) having peaks of 10 compounds. They includes Ethanol,2-(9-octadecenyloxy)-,(z); n-Hexadecanoic acid; 3-oxo-5-phenylpentanoicacid, ethylester; 5,9-undecadien-2-one,6,10-dimethyl-,(E)-; 4-Hydroxy-β-ionone; Octahydrobenzo[b]pyran,4a-acetoxy-5,5,8a-trimethyl-; 13,heptadecyn-1-ol; Hexadecanoic acid, ethyl ester and 9-octadecenoicacid(z)-2-hydroxy-1-(hydroxymethyl) ethyl ester.

12 peaks are seen in the chromatogram of yellow leaves. The major components present in the yellow leaves are 5,9-undecadien-2-one,6,10-dimethyl-(E)-; Ingol 12-acetate; 2,7-Diphenyl -1,6-dioxopyridazino[4,5:2',3']pyrrolo[4',5'-d]pyridazine; Ethyl iso-allocholate; (5,9-Dimethyl-1-(3-phenyl-oxiran-2-yl)-deca-4,8-dienylidene-1-(2-phenyl-aziridine-1-yl)-amine;13-Heptadecyn-1-ol;1-Heptatriacotanol;Ethanol,2-(9-octadecenyloxy)-,(z)-; 9,19-cyclolanost-24-en-3-ol,acetate,(3β)-; 1H-cyclopropa(3,4) benz(1,2-e)azulene-5,7b,9,9a-tetrol,1a,1b,4,4a,5,7a,8,9-octahydro-3-(hydroxylmethyl)-1,1,6,8-tetrame thyl-5,9,9a-triacetate,[1aR-(1aα,1bβ,4aβ,5β,7bα,8α,9β,9aα)]- and Cholest-22-ene-21-ol,3,5-dehydro-6-methoxy-, pivalate.

Table 1. Antibacterial activity against *E. coli*

Method	Inhibition zone (mm)*									
	Disc diffusion method					Well diffusion method				
Solvent / Plant extract	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin
Tender leaves	15.0±1.247	6.0±0	6.0±0	6.66±0.544	19.0±3.742	----	9.5±0.236	11.0±2.160	10.66±0.98	28.33±2.178
Green leaves	----	----	----	8.0±0.707	18.0±0.943	----	----	10.66±098	11.33±0.72	22.0±0.471
Yellow leaves	----	----	----	----	20.0±0	----	----	11.0±0.943	10.0±0.471	21.66±0.272
Seed	----	----	----	6.33±0.272	16.0±0.816	----	----	12.66±1.186	15.33±1.089	19.0±0.943
Negative Control	----	----	----	----		----	----	7.0±0	6.0±0	

** Mean±SE*

Table 2. Antibacterial activity against *Klebsiella pneumonia*

Method	Inhibition zone (mm)*									
	Disc diffusion method					Well diffusion method				
Solvent / Plant extract	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin
Tender leaves	6.0±0	----	6.0±0	6.5±0.354	14.66±0.683	----	----	9.0±0.471	9.66±0.981	20.66±0.544
Green leaves	----	----	----	9.0±0	14.33±0.72	----	----	22.66±1.905	12.66±0.544	18.0±0.943
Yellow leaves	7.0±0	----	6.0±0	8.33±0.544	12.66±0.272	----	----	13.33±2.596	10.33±1.186	21.33±0.544
Seed	7.33±0.272	----	7.33±0.272	----	13.0±0	----	----	12.5±1.768	14.33±2.177	20.0±0.471
Negative control	----	----	----	6.0±0		----	----	7.0±0	9.0±0	

** Mean±SE*

Table 3. Antibacterial activity against *P. aeruginosa*

Method	Inhibition zone (mm)*									
	Disc diffusion method					Well diffusion method				
Solvent / Plant extract	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin
Tender leaves	----	----	6.0±0	9.0±0.471	19.0±0.471	----	----	8.66±0.981	9.0±0.816	29.0±0.471
Green leaves	----	----	----	----	22.0±0.943	----	----	7.0±0	9.33±0.981	28.66±.544
Yellow leaves	----	----	----	----	23.0±0.471	----	----	8.33±0.544	10.0±0.471	29.33±0.272
Seed	7.66±0.544	15.0±0	----	7.33±0.667	20.66±0.272	8.66±0.272	----	14.0±2.449	11.66±1.44	29.0±0.471
Negative Control	----	----	----	----		----	----	8.0±0	7.0±0	

** Mean±SE*

Table 4. Antibacterial activity against *S. aureus*

Method	Inhibition zone (MM)*									
	Disc diffusion method					Well diffusion method				
Solvent / Plant extract	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin	Water	Petroleum benzene	Chloroform	Ethanol	Gentamicin
Tender leaves	----	----	----	6.66±0.272	23.33±1.361	----	----	9.0±0.816	12.0±1.972	30.0±0
Green leaves	----	----	----	10.0±0.707	19.0±0	----	----	8.0±0.707	8.0±0	26.0±0.471
Yellow leaves	----	----	7.0±0	7.66±0.544	19.66±0.72	----	----	11.0±1.699	12.0±2.824	29.66±0.272
Seed	7.0±0	8.0±0.707	6.5±0.354	7.66±0.544	20.33±0.544	----	----	20.33±1.963	13.66±0.272	28.0±0
Negative control	----	----	----	----		----	----	7.0±0	6.0±0	

** Mean±SE*

Table 5. Synergism with gentamicin against *E. coli*

Plant extracts	Gentami-cin alone*	Tender leaves*		Green leaves*		Yellow leaves*		Seeds *	
		Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen
Water	19.0±3.742	15.33±1.44	21.0±0.471	13.33±0.72	18.66±1.905	12.66±0.72	17.0±0.816	13.33±0.72	19.0±1.247
Petroleum benzene		----	19.0±0.471	----	19.0±1.247	----	19.66±1.186	----	13.66±0.544
Chloroform		6.0±0	19.66±0.272	----	17.33±1.186	----	18.33±0.544	----	18.0±0.471
Ethanol		7.0±0	18.33±0.272	6.0±0	16.0±1.247	6.0±0	15.33±2.126	6.33±0.272	17.33±1.186

** Mean±SE*

Table 6. Synergism with gentamicin against *Klebsiella pneumonia*

Plant extracts	Gentami-cin alone*	Tender leaves*		Green leaves*		Yellow leaves*		Seeds *	
		Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen
Water	14.66±0.683	6.0±0	15.66±0.720	----	14.0±0.471	----	13.33±0.272	6.0±0	12.33±0.272
Petroleum benzene		----	15.33±0.981	----	15.66±0.981	----	15.66±0.544	----	6.66±0.331
Chloroform		----	13.33±0.272	----	10.33±0.272	----	16.33±0.720	----	14.33±0.272
Ethanol		6.0±0	14.0±0.471	6.33±0.272	15.66±0.544	----	17.0±0.471	6.0±0	13.0±0.943

** Mean±SE*

Table 7. Synergism with gentamicin against *P. aeruginosa*

Plant extracts	Antibiotic alone*	Tender leaves*		Green leaves*		Yellow leaves*		Seeds *	
		Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen
Water	22.33±0.272	----	19.0±0	----	20.66±0.544	7.5±1.061	19.0±0.471	----	17.66±1.089
Petroleum benzene		6.0±0	19.0±0.471	----	21.66±0.272	----	20.66±0.544	----	13.0±0.816
Chloroform		6.66±0.272	20.0±0.471	----	21.66±0.272	----	16.66±2.596	----	15.33±2.228
Ethanol		6.33±0.272	20.0±0.943	----	22.0±0.816	6.0±0	19.0±0.816	7.0±0	17.66±1.186

** Mean±SE*

Table 8. Synergism with gentamicin against *S. aureus*

Plant extracts	Antibiotic alone*	Tender leaves*		Green leaves*		Yellow leaves*		Seeds *	
		Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen	Ext	Ext+Gen
Water		12.66±0.72	20.66±0.544	15.0±1.247	22.33±1.361	15.66±0.272	22.33±1.186	17.0±5.312	14.0±0.816
Petroleum benzene		----	19.33±0.544	----	23.33±1.361	----	22.0±0.943	6.5±0.354	15.0±2.357
Chloroform	19.66±0.72	6.5±0.354	18.66±1.186	----	22.66±3.662	----	23.33±2.177	----	15.66±1.905
Ethanol		----	18.0±0.943	7.33±0.720	23.33±1.785	6.5±0.354	23.66±1.515	6.0±0	14.0±0.471

** Mean±SE*

Table 9. Synergism with vitamin C against *E. coli*

Plant extracts	Vitamin C alone	Tender leaves*		Green leaves*		Yellow leaves*		Seeds*	
		Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC
Water		----	----	7.0±0	6.0±0	----	----	6.0±0	7.0±0
Petroleum benzene		6.0±0	----	----	6.0±0	----	----	----	6.0±0
Chloroform	----	6.0±0	6.0±0	----	6.0±0	----	----	----	6.0±0
Ethanol		6.0±0	6.33±0.272	7.0±0.471	6.0±0	6.0±0	6.5±0.354	6.33±0.272	6.33±0.272

** Mean±SE*

Table 10. Synergism with vitamin C against *Klebsiella pneumonia*

Plant Extracts	Vitamin C alone	Tender leaves*		Green leaves*		Yellow leaves*		Seeds*	
		Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC
Water		----	----	----	----	----	----	6.5±0.354	6.0±0
Petroleum benzene		6.0±0	6.0±0	----	6.0±0	----	----	----	----
Chloroform	----	----	6.0±0	----	----	8.0±0	----	----	6.33±0.272
Ethanol		6.0±0	6.33±0.272	6.33±0.372	6.0±0	6.0±0	6.5±0.354	7.66±0.544	6.0±0

** Mean±SE*

Table 11. Synergism with vitamin C against *P. aeruginosa*

Plant extracts	Vitamin C alone	Tender leaves*		Green leaves*		Yellow leaves*		Seeds*	
		Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC
Water		----	----	----	----	----	----	----	----
Petroleum benzene		6.0±0	6.0±0	----	----	----	----	----	----
Chloroform	----	6.33±0.272	6.0±0	----	6.5±0.289	----	----	----	6.0±0
Ethanol		6.66±0.474	7.33±0.469	7.0±0.471	8.0±0	7.5±0.354	6.66±0.272	6.66±0.544	6.0±0

** Mean±SE*

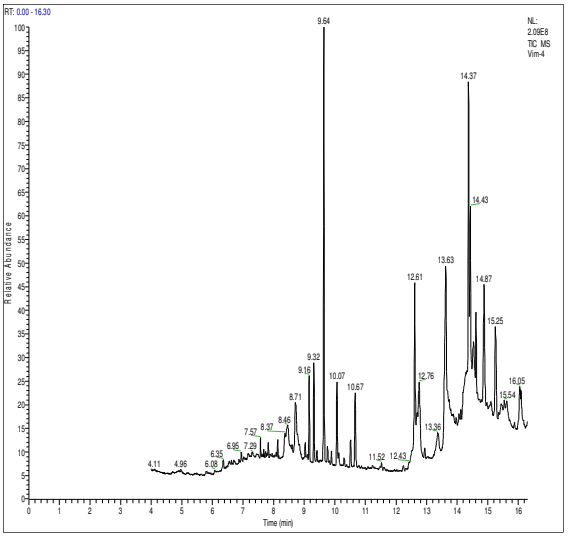
Table 12. Synergism with vitamin C against *S. aureus*

Plant extracts	Vitamin C alone	Tender leaves*		Green leaves*		Yellow leaves*		Seeds*	
		Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC	Ext	Ext+VitC
Water		----	----	----	----	----	----	----	----
Petroleum benzene		----	----	----	----	----	----	----	----
Chloroform	----	----	6.0±0	----	----	----	----	----	----
Ethanol		6.0±0	6.0±0	7.0±0.471	----	----	----	7.0±0	6.0±0

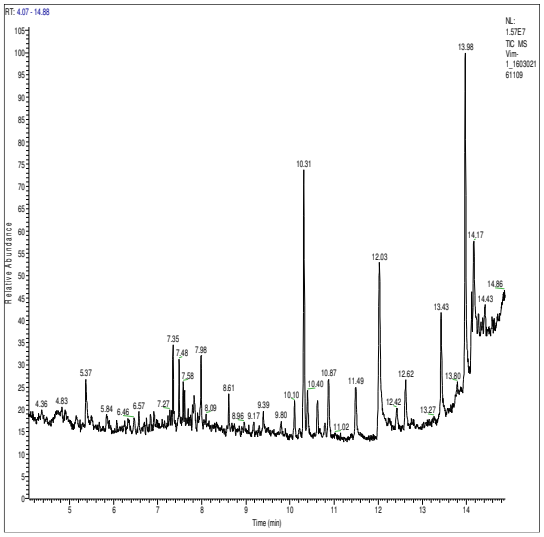
In all the tables values are expressed as Arithmetic Mean $(\overline{x})$ ±S.E of three replicates

The GC MS analysis of seed extract produces a chromatogram of 5 peaks (Fig. 1-c). They include Benzene, (isothiocyanatosmethyl)-, Hexadecanoic acid, methyl ester; n-Hexadecanoic acid; 9-octadecenoicacid(z)-methyl ester and 6-octadecenoic acid. The major component is the 6-octadecenoic acid which is followed by the n-Hexadecanoic acid and Benzene, (isothiocyanatomethyl).

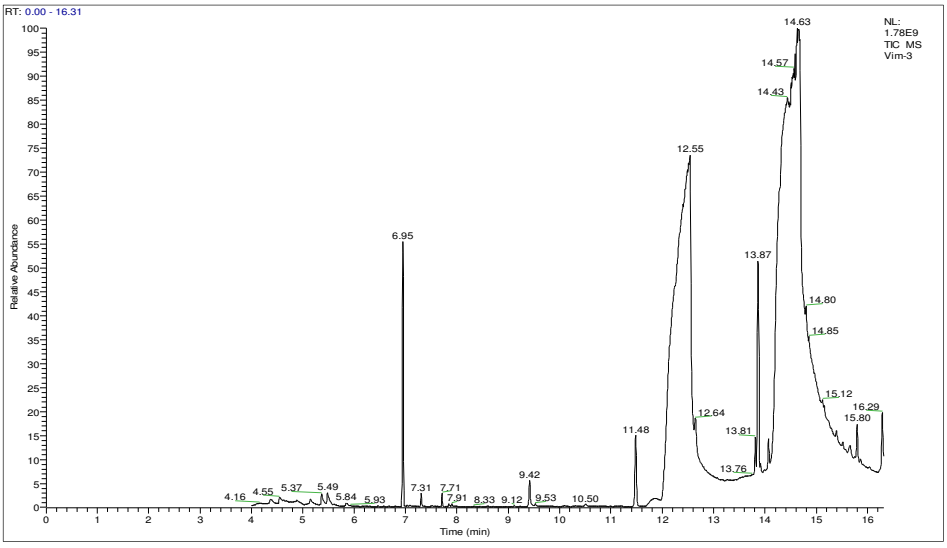
Ethyl iso-allocholate present in yellow leaf extract is a sterol with antimicrobial, diuretic, anti-inflammatory, antiasthmatic, anti tumor, cancer preventive and chemopreventive activities. Ingol 12-acetate is a diterpene with antileukemic properties. 5,9-undecadien-2-one,6,10-dimethyl ester is a proven anticancer agent, used as an antidote, it decreases endothelial platelet adhesion and epinephrine production [7].



A. Chromatogram of tender leaves



B. Chromatogram of green leaves



C. Chromatogram of seed

Fig. 1. Chromatograms of petroleum benzene extracts

4. CONCLUSION

The aqueous and organic solvents extracts of leaves and seed of *Carica papaya* exhibits antibacterial activity against the most common disease causing bacteria's such as *E. coli, K. pneumoniae., P. aeruginosa* and *S. aureus*. They also found to have synergistic effect with an antibiotic drug Gentamicin and a non-antibiotic drug Vitamin C. The presence of various bioactive compounds justifies the use of the whole plant for various ailments by traditional practitioners. It could be concluded that *Carica papaya* L. plant is of phytopharmaceutical importance. Studies with these compounds may yield nature friendly strong anti-microbial agents of agricultural importance and anti-cancer drugs.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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