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A Comparative study of the Antimicrobial activities of five varieties of essential oils from the seeds of *Artocarpus*

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Abstract: *Hexane and methanolic oil extracts from five varieties of Artocarpus seeds were studied to explore its suitability for ethno medical uses. Crude hexane and methanolic oils were found to shown good to moderate activity against bacteria, in particular Gram +ve (Bacillus cereus, Bacillus subtilis and Staphylococcus aureus) and Gram-ve (Eschirichia coli and Pseudomonas aeruginosa) and fungal stains, more specifically Aspergillus niger, Aspergillus flavans, Candida albicans and Saccharomyces cerevisiae. Maximum activity was observed on bacterial strains compared with fungal strains. Hexane seed oils illustrated profound effect on Staphylococcus aureus bacteria and Aspergillus niger, Aspergillus flavans, Candida albicans fungi whereas methanol seed oils confirmed intense effect on Eschirichia coli, Bacillus subtilis bacteria and Aspergillus flavans, Aspergillus niger fungus. The results of tested extracts on bacterial and fungus were assessed with those of rifampicin and fluconazole standards correspondingly. Minimum inhibitory concentrations and minimum bactericidal and fungicidal concentrations of the hexane and methanolic seed oils varied between 7 to 10 mg/50 µl against all bacterial and fungal strains used in this study. The statistical analysis of all in vitro (n=3) studies with paired samples't' test showed significant antimicrobial difference in between hexane and methanolic extracted seed oils. 'P' value less than 0.5 was considered as significant difference in the analysis. In conclusion, methanol extracted seed oils had superior antimicrobial activities than hexane extracted seed oils, more specifically Artocarpus integer methanol seed oil hadlofty superior antimicrobial activity. However, together they have profound therapeutic potential.*

Keywords: *Artocarpus seed oil, Antimicrobial activity, Gram-positive bacteria, Gram –negative bacteria, Rifampicin and fluconazole.*

I. Introduction

Since the birth of mankind there has been a relationship between life, disease and plants. Ever since time immemorial the men of early ages have used therapeutical agents which were easily available to them mostly from plants. According to WHO, medicinal plants would be the best source to obtain a variety of drugs. Plant derived medicines have made large contributions to

human health (EL-Astal et al 2005).This is due to the significant healing power of the traditional medicinal systems (Adebolu and Oladimeji 2005).Medicinal plants are distributed worldwide but they are most abundant in tropical countries (Elvin- Lewis 2001).The abundance of medicinal plants in nature and the traditional knowledge increase the understanding of medicinal plant properties, safety and efficacy (Nascimento et al 2000). This concern has been expressed because of the resistance of clinically pathogenic microorganisms to antibiotics that have been produced in the last decades (Nascimento et al 2000). In the last decade, studies based on extraction of biologically active compounds from plant species used for medicinal purposes are intensively increased (Nascimento et al 2000; Rios and Recios 2005).

Essential oils have wide and varied applications in many industries such as cosmetics, perfumes, beverages, ice creams, confectionary and backed food products and for the scenting and flavouring of consumer's finished products (Burt 2004). Currently, about 300 essential oils, out of approximately 3,000 are commercially important for the pharmaceutical, agronomic, food, sanitary, cosmetic and perfume industries. Some of the essential oils and their bioactive components such as limonene, geranyl acetate or carvone are used as an important ingredient in tooth pastes and hygienic products. These also act as food preservers and additives, as well as employed for the treatment of different ailments in the folk medicine systems (Burt 2004; Delamareet al 2007).

Antimicrobial properties of essential oils healthier than synthetic antibiotics, due to their wider spectrum of activities. Scientific reports have been focused on the biological activities of essential oils (Hussainet al 2008; Anwar et al 2009). Therefore, the primary objective of this study was to make out the antimicrobial activities of hexane and methanolic *Artocarpus* seed oils. The genus *Artocarpus*, which belong to the Moraceae family (Chandrika et al 2006). The tree is high up to 20m and its fruits are known as jackfruit Jackfruit is the largest tree born fruit in the world, reaching 80 pounds in weight and up to 36 inches long and 20 inches in diameter. The exterior of the compound fruit is green/ yellow when ripe (Gulcin et al 2006). The

interior consist of large edible bulbs of yellow, banana flavoured flesh that encloses a smooth, oval, light brown seed. The seed is 3/4 to 11/ 2 inches long and 1/2 to 3/4 inches thick and is white and crisp within. There may be 100 or up to 500 seeds in a single fruit, which are viable for no more than three or four days. It is reported from the study that plants of *Artocarpus* species have been used by traditional folk medicine against malarial fever, stomachache, ulcers, dysentery, diarrhea and defective urinary secretion. (Shizuo et al 2006).

II. Materials And Methods

Seed Collection: Five different varieties of jackfruit seeds were collected commencing Visakhapatnam nearby areas Simhachalam and Kaviti. Visakhapatnam district; Andhra Pradesh. India. The five varieties were *Artocarpus heterophyllus (A.heterophyllus), Artocarpus integrifolia (A.integrifolia), Artocarpus hirsitus (A.hirsitus), Artocarpus inciscus (A.inciscus) and Artocarpus integer (A.integer).*

Soxhlet extraction: The seed oil was extracted using a soxhlet extraction method with analytical grade hexane and methanol as refluxing solvents. On completion of the extraction process, the oils were recovered from the mixture by distillation and stored in desiccator until use (Popoola et al 2007).

The percentage of oil content can be calculated as follows:

% of oil = Wt. of oil obtained in gm / Wt. of seed taken in gm X 100

Antimicrobial activity

Microorganisms: Hexane and methanol extracted test oils were individually tested on nine different pathogenic microorganisms. Five were bacteria: Bacillus cereus MTCC430 (Gram +), Bacillus subtilis MTCC441 (Gram +), Escherichia coli MTCC443 (Gram-), Pseudomonas aeruginosa MTCC424 (Gram-) and Staphylococcus aureus MTCC3160 (Gram +). Four were fungal strains: Aspergillus flavansMTCC3396, Aspergillus niger MTCC961, Candida albicans MTCC227 and Saccharomyces cerevisiae MTCC170. These were obtained from the microbial culture collection center in Chandigarh, India.

Inoculum preparation: Bacterial strains were maintained on nutrient agar. Overnight cultures of the bacterial strains were prepared in nutrient broth and they were incubated for 24 h at 37^0C before use and standardized to 0.5 McFarland standards (10^6 cfuml$^-$1). The fungal isolates were grown on PDA at 25^0C until they were sporulated. The fungal spores were harvested after sporulation by pouring a mixture of sterile glycerol and distilled water on the surface of the plate and the spores were later scraped with a sterile glass rod. The harvested fungal spores were standardized to a concentration of 10^6 spores/ml or toan OD_{600nm} of 0.1 before use (Coulidiati et al 2011).

Agar well diffusion method: Antimicrobial assay was carried out by an agar well diffusion method. Twenty milliliters (20 ml) of the molten nutrient agar were seeded with 100 µl inoculum of the test organism in sterile petri dishes rotated slowly to ensure a uniform distribution of the microorganisms and allowed to solidify on the bench for 30 min. The test seed oils of *Artocarpus* were dissolved independently in hexane and methanol to a final concentration of 200 mg/ ml. The 6-mm wells were cut from the agar surface and each well was inoculated with 50 µl of the extract at a concentration of 10 mg well individually. After the incubation period (24 h at 37^0C for bacteria and 25^0C for 96 h for fungi), wells were observed for zones of inhibition. The effect of extract on bacterial and fungal isolates was compared with those of rifampicin and fluconazole at a concentration of 1 mg/ml (Chanda et al 2011).

Minimum inhibitory concentration: Minimum inhibitory concentrations **(**MIC) of oil were prepared in test tubes using a broth dilution method (De and Ifeoma 2002). Fifty microliters of test seed oils at concentrations of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 mg/50 µl was added to 5 ml of nutrient broth for the bacterial strains and potato dextrose broth for the fungi containing cells as described above. A negative control tube was inoculated without extract. The test tubes were incubated for 24 h at 37^0C for bacteria and 48 h at 25^0C for fungi. During the incubation period, the tubes were submitted to a manual agitation every hour. After incubation, the MIC was recorded as the lowest concentration demonstrating no apparent growth compared to the negative control (Rasooli et al 2006).

Minimum bactericidal and fungicidal concentration: The bactericidal and fungicidal concentration of the oil was determined by a modification of the broth micro dilution method according to the German DIN regulation 58940-7. Samples were taken from test tubes with no visible growth in the MIC assay, subcultured on freshly

prepared nutrient agar plates and Potato dextrose agar plates and later incubated at 37^0C for 48 h and 25^0C for 72 h for bacteria and fungi, respectively. The Minimum bactericidal and fungicidal concentrations were taken as the concentrations of oils that did not show any growth on a set of agar plates.

Statistical analysis

The results of in vitro studies were given as Mean±Standard Deviation (SD). Paired samples't' test was used to know the significance between verified parameters among hexane and methanolic seed oils. 'P' value less than 0.5 was considered as significant difference in the analysis. All the statistical analysis was resolved using SPSS software.

III. Results And Discussion

Antimicrobial activity

Oil extraction was carried out by a soxhlet extraction method according to Association of Official Analytical Chemists - AOAC - recommendations. Hexane and methanol were used as solvents to extract the respective oils from seeds and this was passed out for more than 10 h and the percentage of hexane and methanolic oils extracted were 40 and 30 proceedingly. In the present examine, *Artocarpus* hexane and methanolic seed oils in general showed antimicrobial activity against all the pathogenic bacterial and fungal strains studied. Methanol extracted seed oil had lofty superior antimicrobial activity in contrast with hexane extracted seed oils; in concert have profound therapeutic potential. The bacteria and fungus used in this study were associated with various forms of diseases (Nester 2004).

The outcomes of tested extracts on bacterial and fungal isolates were assessed with those of rifampicin and fluconazole correspondingly and the consequences were put on show along with the test results in respective tables. MICs and minimum bactericidal and fungicidal concentrations for the all tested seed oils were revealed and those were varied between 7-10 mg/50 µL against all bacterial and fungal strains used in this cram.

Results of antimicrobial susceptibility of hexane extracted *Artocarpus heterophyllus* seed oil revealed that Staphylococcus aureus was the most susceptible with an inhibition zone diameter of15±1mmfollowed by Eschirichia coli (12±2 mm) Pseudomonas aeruginosa (11±1).While Bacillus cereus (9±1) and Bacillus subtilis (9±1) showed parallel inhibitory zones. Among fungi, Aspergillus niger was less prone with an inhibition zone diameter of 8±2mm. Remaining three fungal strains Aspergillus flavans, Candida albicans and Saccharomyces cerevisiae exposed analogous inhibitory zones i.e. 10±2mm.

Outcomes of *Artocarpus heterophyllus* methanol extracted seed oil revealed that Bacillus subtilis was the most inclined with an inhibition zone diameter of 17±1 mm followed by Pseudomonas aeruginosa (15 ±1 mm) and Bacillus cereus (14±1 mm). Whereas Staphylococcus aureus and Eschirichia coli were less susceptible with inhibitory zone 12 ±1 mm. Among fungi, Aspergillus flavans was more susceptible with an inhibition zone diameter of 13±1 mm followed by Candida albicans(12±2mm). Remaining two fungal strains Aspergillus niger and Saccharomyces cerevisiae revealed analogous inhibitory zones9 ± 2mm.All the above results along with MIC, MBC and MFC values were displayed in the Table: 1and 2.

Hexane extracted *Artocarpus integrifolia* seed oil as well confirmed significant action on tested strains. Staphylococcus aureus was the most inclined with an inhibition zone diameter of 15±4mm followed by Pseudomonas aeruginosa (14±1 mm) and Eschirichia coli (12±2 mm), while Bacillus cereus and Bacillus subtilis had similar inhibitory zones of 10±4mm.Among fungi, Saccharomyces cerevisiae was less prone with an inhibition zone diameter of 8±2 mm whereas Aspergillus flavans, Candida albicans and Aspergillus niger had analogous inhibitory zones9± 2 mm.

Artocarpus integrifolia methanol extracted seed oil antimicrobial susceptibility exposed that Bacillus subtilis was the most susceptible with an inhibition zone diameter of 18±2 mm followed by Pseudomonas aeruginosa and Staphylococcus aureus, both have identical inhibitory zones 15±3 mm whereas Eschirichia coli and Bacillus cereus were less susceptible and had matched inhibitory zones13±3 mm. Among fungi, Aspergillus flavans was more susceptible with an inhibition zone diameter of 12±3 mm followed by Candida albicans and Aspergillus niger with analogous inhibitory zone 10±3 mm. Saccharomyces cerevisiae was less disposed with inhibitory zone8±1mm.The intact fallouts along with MIC, MBC and MFC values were exhibited in the Table: 3and 4.

Artocarpus hirsitus hexane seed oil too established significant action on tested strains. Staphylococcus aureus was the most susceptible with an inhibition zone diameter of 13 ±2 mm followed by Eschirichia coli and Pseudomonas aeruginosa, which have same inhibitory zones 12±3 mm. Whereas Bacillus cereus and Bacillus subtilis showed 11 ±1 and 9 ±2 mm inhibitory zones correspondingly. Among fungi, Saccharomyces cerevisiae was less prone with an inhibition zone diameter of7±3 mm. Remaining three fungal strains Aspergillus niger, Aspergillus flavans and Candida albicans exposed analogous inhibitory zones specifically 9±1 mm each.

Antimicrobial susceptibility of *Artocarpus hirsitus* methanol extracted seed oil revealed that Eschirichia coli was the most subjected with an inhibition zone diameter of 18±2 mm followed by Staphylococcus

aureus(14±2mm),Bacillus subtilis(12±3mm) and Bacillus cereus (11±1 mm).Whereas Pseudomonas aeruginosa less susceptible with inhibitory zone of10±2 mm. Among fungi, Aspergillus flavans was added susceptible with an inhibition zone diameter of 12±2 mm followed by Saccharomyces cerevisiae with inhibitory zone of 10 ±1 mm. Candida albicans and Aspergillus niger by analogous inhibitory zones 8±2mm. The above fallouts beside MIC, MBC and MFC values were exhibited in the Table: 5 and 6.

Hexane extracted *Artocarpus inciscus* seed oil as well illustrated customary action on tested strains. Staphylococcus aureus was the most inclined with an inhibition zone diameter of 14±2 mm. Whereas Bacillus subtilis was less liable with an inhibition zone diameter of 9±2 mm. Eschirichia coli and Bacillus cereus have similar inhibition zone diameter,12±2mm.Pseudomonas aeruginosa reveals 10±3 mm inhibitory zone. Among fungi, Candida albicans was most susceptible with an inhibition zone diameter of 12±2 mm. Remaining three fungal strains Aspergillus niger, Aspergillus flavans and Saccharomyces cerevisiae exposed equivalent inhibitory zones specifically 9 ±3 mm.

Artocarpus inciscus methanol extracted seed oil exposed that Eschirichia coli was the most vulnerable with an inhibition zone diameter of 17±3 mm, followed by Staphylococcus aureus(15±2 mm), Bacillus subtilis(14±5 mm) and Bacillus cereus (12±4 mm).Whereas Pseudomonas aeruginosa less susceptible with inhibitory zone of 10±2 mm. Among fungi, Aspergillus flavans was more vulnerable with an inhibition zone diameter of 12±2 mm, followed by Aspergillus niger and Candida albicans with analogous inhibitory zones 10±2 mm. Saccharomyces cerevisiae with less inhibitory zone of 9±2. The results alongside MIC, MBC and MFC values were put on viewed in the Table: 7 and 8.

Finally, *Artocarpus integer* hexane seed oil as well illustrated customary action on tested microbes. Staphylococcus aureus was the most susceptible with an inhibition zone diameter of 13±2 mm, followed by Eschirichia coli (12±2 mm) and Pseudomonas aeruginosa (11±1 mm).Whereas Bacillus cereus and Bacillus subtilis are alike inhibitory zones 9±2mm each. Among fungi, Aspergillus flavans was more vulnerable with an inhibition zone diameter of 10 ±2 mm, followed by Candida albicans and Aspergillus niger with analogous inhibitory zones 9±3 mm. Saccharomyces cerevisiae with less inhibitory zone of 7±2mm.

Last of all *Artocarpus integer* methanol extracted seed oil proved that Bacillus subtilis was the most susceptible with an inhibition zone diameter of 18±2 mm followed by Eschirichia coli (17±2 mm), Staphylococcus aureus (15±5 mm) Bacillus cereus (14±3 mm) and Pseudomonas aeruginosa(12±1 mm).Along with fungi, Aspergillus niger was more liable with an inhibition zone diameter of 13±3 mm, followed by Aspergillus flavans(11±3mm).Candida albicans and Saccharomyces cerevisiae had analogous inhibitory zones 10±3 mm. The results together with MIC, MBC and MFC values were revealed in the Table: 9 and 10.Basing on the above consequences, we found that both hexane and methanolic extracted *Artocarpus* seed oils showed significant stroke on bacterial strains compared with fungal strains. Hexane seed oils illustrated profound effect on Staphylococcus aureus bacteria and Aspergillus niger, Aspergillus flavans, Candida albicans fungi whereas methanol seed oils confirmed intense effect on Eschirichia coli, Bacillus subtilis bacteria and Aspergillus flavans, Aspergillus niger fungus. Next to that, it is evidently pointed out; methanol extracted seed oils had higher antimicrobial activities than hexane extracted seed oils, more specifically *Artocarpus integer* methanolic seed oil had lofty superior antimicrobial activity. However, together they have profound therapeutic potential.

The varying degrees of susceptibilities of the bacterial and fungal strains may be due to the intrinsic tolerance of the microorganisms and the nature and combinations of phyto compounds present in the oil. The fatty acids are potent antimicrobial agents with an inhibitory action has long been known (Bayliss 1936). Trace amounts of fatty acids have been shown to influence the growth of microorganisms in a very specific manner; some fatty acids, such as lauric acid, have been shown to have greater inhibitory action than others (Nieman 1954).Kabara and coworkers (1972) examined several specific straight-chain saturated fatty acids and found lauric acid to be one of the most potent bacteriostatic fatty acids when tested on gram positive organisms. In a study by Bergsson et al (2001) capric acid was found to inhibit the growth of Candida albicans, a fungal organism responsible for many infections. Medium chain free fatty acids and their corresponding 1-monoglyrides have been found to have a broad spectrum of microbicidal activity against enveloped viruses and various bacteria in vitro (Isaacs et al 1995; Kabara 1978) including pathogens such as herpes simplex virus (Thormar et al 1987). Neisseria gonorrhoeae (Bergsson et al 1999).Chlamydia trachomatis, group A streptococci, group B streptococci, and Staphylococcus aureus (Bergsson et al 1998).An important characteristic of essential oils and their components is their hydrophobosity which enables them to partition the lipids of the bacterial cell membrane and mitochondria, disturbing the cell structures and rendering them more permeable (Knobloch et al 1986). Extensive leakage from bacterial cells or the exit of critical molecules and ions will lead to death (Denyer et al 1991). The activity of the essential oils would be expected to relate to the structural configuration of the constituent components of the volatile oils and their functional groups and possible synergistic interactions between components (Dorman and Deans 2000). There were some reports about antimicrobial activity of terpinen-4-ol, eugenol, and linalool components (Simić et al 2004;Ozcan and Erkmen 2011). Indeed, the antibacterial activity of crude extracts has been attributed to the presence of some of the

phytochemical components such as alkaloids, flavonoids, saponins and tannins which was in agreement with our results (Musa et al 2008; Adebayo-Tayo and Ajibesin 2008). The antimicrobial and antifungal activity of the essential oils of L. nobilis and Ceiba pentandra seeds has been demonstrated previously and reported stumpy antifungal activities (Simic et al 2004; Ravi et al 2012). All the above fallouts are in accordance with prior outcomes. The statistical analysis of all in vitro (n=3) studies with paired samples't' test showed significant antimicrobial difference in between hexane and methanolic extracted seed oils. 'P' value less than 0.5 was considered as significant difference in the analysis.

Tables:

Table: 1. Antimicrobial activities of Hexane and methanolic *Artocarpus heterophyllus* seed oils

Artocarpusheterophyllus	**Hexane**	**Methanol**	**Rifampicin**	**T value**	**Significance**
E. coli	12±2	12±1	20±1	1.000	0.121
P. aeruginosa	11±1	15±1	19±2	-11.000	0.333
B. cereus	9±1	14±1	19±2	-8.660	0.667
B.subtilis	9± 1	17±1	20±2	-8.693	0.333
S. aureus	15±1	12 ±1	20±1	3.780	0.333
			Fluconazole		
A. niger	8±2	9 ± 1	16±2	-4.000	0.212
A. flavans	10±1	13±1	16±1	-10.000	0.333
C. albicans	10±2	12±2	16±1	-2.000	0.609
S. cerevisiae	10±2	9 ± 2	15±2	0.500	0.000

Table: 2.Minimum inhibitory concentrations and minimum bactericidal and fungicidal outcomes of *Artocarpus heterophyllus* seed oils

Artocarpusheterophyllus	**Hexane**		**Methanol**	
	MIC (mg/50µl)	**MBC**	**MIC (mg/50µl)**	**MBC**
E. coli	9	9	10	10
P. aeruginosa	10	10	9	9
B. cereus	10	10	9	9
B.subtilis	10	10	7	7
S. aureus	8	8	10	10
	MIC (mg/50µl)	**MFC**	**MIC (mg/50µl)**	**MFC**
A. niger	10	10	10	10
A. flavans	9	9	9	9
C. albicans	9	9	9	9
S. cerevisiae	9	9	10	10

Table: 3. Antimicrobial activities of Hexane and methanolic *Artocarpus integrifolia* seed oils

Artocarpusintegrifolia	Hexane	Methanol	Rifampicin	T value	Significance
E. coli	12±2	13±2	20±1	-1.000	0.667
P. aeruginosa	14 ±1	15±3	19±2	-1.000	0.212
B. cereus	10±2	13±3	19±2	-1.387	0.546
B.subtilis	10±4	18±2	20±2	-2.234	0.249
S. aureus	15±4	15±2	20±1	-0.139	1.000
			Fluconazole		
A. niger	9± 1	10± 2	16±2	-1.000	0.667
A. flavans	9± 2	12±3	16±1	-0.971	0.091
C. albicans	9± 1	10± 3	16±1	-0.866	0.000
S. cerevisiae	8±2	8±1	15±2	0.000	0.154

Table: 4.Minimum inhibitory concentrations and minimum bactericidal and fungicidal outcomes of *Artocarpus integrifolia* seed oils

Artocarpusintegrifolia	Hexane		Methanol	
	MIC (mg/50µl)	MBC	MIC (mg/50µl)	MBC
E. coli	9	9	9	9
P. aeruginosa	8	8	8	8
B. cereus	10	10	9	9
B.subtilis	10	10	7	7
S. aureus	8	8	8	8
	MIC (mg/50µl)	MFC	MIC (mg/50µl)	MFC
A. niger	10	10	9	9
A. flavans	10	10	9	9
C. albicans	10	10	9	9
S. cerevisiae	10	10	10	10

Table: 5.Antimicrobial activities of Hexane and methanolic *Artocarpus hirsitus* seed oils.

Artocarpushirsitus	Hexane	Methanol	Rifampicin	T value	significance
E. coli	12 ±2	18±2	20±1	-3.000	0.667
P. aeruginosa	12 ±3	10 ±2	19±2	3.464	0.000
B. cereus	11 ±1	11±1	19±2	-2.000	0.667
B.subtilis	9 ±2	12±3	20±2	-0.819	0.154
S. aureus	13 ±2	14±2	20±1	-5.000	0.154
			Fluconazole		
A. niger	9±1	8 ±2	16±2	4.000	0.212
A. flavans	9±1	12 ±2	16±1	-3.780	0.333
C. albicans	9±1	8 ±2	16±1	0.866	1.000
S. cerevisiae	7 ±3	10 ±1	15±2	-2.598	0.212

Table: 6.Minimum inhibitory concentrations and minimum bactericidal and fungicidal outcomes of *Artocarpus hirsitus* seed oils

Artocarpushirsitus	Hexane		Methanol	
	MIC (mg/50µl)	MBC	MIC (mg/50µl)	MBC
E. coli	9	9	7	7
P. aeruginosa	9	9	9	9
B. cereus	9	9	9	9
B.subtilis	10	10	9	9
S. aureus	9	9	8	8
	MIC (mg/50µl)	MFC	MIC (mg/50µl)	MFC
A. niger	9	9	10	10
A. flavans	9	9	9	9
C. albicans	9	9	10	10
S. cerevisiae	10	10	9	9

Table: 7. Antimicrobial activities of Hexane and methanolic *Artocarpus inciscus* seed oils

Artocarpusinciscus	Hexane	Methanol	Rifampicin	T value	significance
E. coli	12 ±2	17±3	20±1	-8.660	0.212
P. aeruginosa	10±3	10 ±2	19±2	0.000	0.333
B. cereus	12±2	12±4	19±2	0.189	0.439
B.subtilis	9±2	14±5	20±2	-2.646	0.000
S. aureus	14±2	15±2	20±1	-0.480	0.333
			Fluconazole		
A. niger	9±1	10 ±2	16±2	-1.732	0.333
A. flavans	9±3	12 ±2	16±1	-8.000	0.073
C. albicans	12 ±2	10 ±1	16±1	1.309	0.667
S. cerevisiae	9±1	9 ±2.	15±2	0.000	0.454

Table: 8.Minimum inhibitory concentrations and minimum bactericidal and fungicidal outcomes of *Artocarpus inciscus* seed oils

Artocarpusinciscus	Hexane		Methanol	
	MIC (mg/50µl)	MBC	MIC (mg/50µl)	MBC
E. coli	9	9	7	7
P. aeruginosa	9	9	10	10
B. cereus	9	9	9	9
B.subtilis	10	10	8	8
S. aureus	8	8	8	8
	MIC (mg/50µl)	MFC	MIC (mg/50µl)	MFC
A. niger	10	10	10	10
A. flavans	10	10	9	9
C. albicans	9	9	10	10
S. cerevisiae	10	10	10	10

Table: 9. Antimicrobial activities of Hexane and methanolic *Artocarpus integer* seed oils

Artocarpus integer	Hexane	Methanol	Rifampicin	T value	significance
E. coli	12±2	17±2	20±1	-8.000	0.333
P. aeruginosa	11±1	12±1	19±2	-1.732	0.667
B. cereus	9±2	14±3	19±2	-5.000	0.333
B.subtilis	9±1	18±2	20±2	-5.892	0.667
S. aureus	13±2	15±5	20±1	-0.795	0.667
			Fluconazole		
A. niger	9 ±2	13 ±3	16±2	-6.928	0.121
A. flavans	10 ±2	11±3	16±1	-1.000	0.454
C. albicans	9 ±3	10 ±3	16±1	-1.732	0.212
S. cerevisiae	7 ±2	10 ±2	15±2	-8.000	0.121

Table: 10.Minimum inhibitory concentrations and minimum bactericidal and fungicidal outcomes of *Artocarpus integer* seed oils

Artocarpus integer	Hexane		Methanol	
	MIC (mg/50µl)	MBC	MIC (mg/50µl)	MBC
E. coli	9	9	9	9
P. aeruginosa	9	9	10	10
B. cereus	10	10	10	10
B.subtilis	10	10	8	8
S. aureus	8	8	9	9
	MIC (mg/50µl)	MFC	MIC (mg/50µl)	MFC
A. niger	10	10	9	9
A. flavans	9	9	9	9
C. albicans	10	10	10	10
S. cerevisiae	10	10	10	10

IV. Conclusion

The present study of *Artocarpus* seed oils revealed the importance, in controlling resistant bacteria and fungi which are becoming a threat to human health. This can hand out as a practical policy for the expansion of economical, protected and efficient natural medicines. Usefulness of Seed oils cannot be completely esteemed until methods of comparison with other compounds are standardized and reproducible results are obtained.

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