

Phytochemical Analysis, Antifungal and Antibacterial Screening of *Artocarpus altilis*: Guyana Flora Extracts

ABSTRACT

The plant material leaves of *Artocarpus altilis* (Breadfruit) were collected from university of Guyana road, Cummings lodge, Guyana. Leaves are dried in oven at 50-55 °C for 72 h. The moisture content is calculated. The dried leaves were grounded and extracted in each acetone, ethanol and methanol solvents. Extracts were collected and evaporation of solvent was done on rotavapour. The respective solvent was added to viscous semi solid liquid extract to make up the desired volume of extract solution. The antimicrobial and antifungal activity of both plants were examined by well diffusion method, poison plate method, paper disc plate method and streak plate methods. In *Artocarpus altilis* leaves extract studies, maximum and minimum antimicrobial potential was observed for methanol and acetone solvent extracts, respectively. All plant extracts showed antimicrobial potential toward the organisms *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans*. The phytochemical analysis of methanol leaves extract of breadfruit tested positive for flavonoids, terpenoids, phenol, phlobatannins, steroids and phytosteroids and negative for tannins, saponins, alkaloids and cardiac glycosides.

Keywords: *Artocarpus altilis*; Leaves extract; Phytochemical screening; Antifungal potential; Antimicrobial potential.

1. INTRODUCTION

According to DNA fingerprinting studies, the wild seeded ancestor of breadfruit is the breadfruit is the breadnut (*Artocarpus camansi*) which is native to New Guinea, the Maluku Islands, and the Philippines. It was one of the canoe plants spread by

Austronesian voyagers around 3,000 years ago into Micronesia, Melanesia, and Polynesia, where it was not native [1,2]. Extent of the Austronesian expansion that carried crops like breadfruit, bananas and coconuts throughout the Indo-pacific Islands.

Breadfruit trees growth to a height of 26 m (85 ft.). The large and thick leaves are deeply cut into pinnal lobes. All parts of tree yield latex [3] which is useful for boat caulking. Flower on an urban cheal axis is male while arising from single point is female. Fruit is cylindrical 9- 29 cm. long by 6 – 20 cm wide. They are normally green while yellow brown on ripe. Average weight of fruit is about 1 to 5 kg.

Breadfruit contains phytochemicals having potential as an insect repellent [4]. Sivagnana Sundaram and Karunanayeke [5] has investigated phytochemical screening and antimicrobial activity of *Artocarpus heterophyllus* and *Artocarpus altilis* leaf and stem hexane, dichloromethane and ethanol extracts. The local uses of paparahua (*Artocarpus altilis*) in Amazonia Ecquadore by phytochemical data review is reported by Luzuriaga-quichimbo et al. [6]. The plant is found to contain terpenoid, stelbenoid and different groups of flavonoids which is effective in a search of novel drugs. Riasari et al. [7] studied antibacterial and antifungal activities methanol extracts of green, fallen yellow, fallen dry breadfruit leaves against *Escherichia coli*, *Staphylococcus epidermidis*, *propionbacterium acnes* and *candida albicans*. Pradhan et al. [8] has explained phytochemical screening and comparative bioefficacy assessment of *Artocarpus altilis* petroleum ethane, methanol and ethylacetate leaf extract for antimicrobial activity. Mbaeyi-Nwaoha and Onwuku [9] has evaluate antimicrobial properties and phytochemical composition of ethanolic, hexane and watery leaf extract of *Artocarpus altilis*. The anti-nutrient analysis of leave extract also revealed the presence of phylate, oxalate, tannin and cyanide. Palupi et al. [10] studied anti-inflammatory, antioxidant and immunosuppressant

properties of ethanolic extract of leaf, fruit and bark from breadfruit (*Artocarpus altilis* [Park] Fosberg). This result indicated the *A. altilis* leaf extract significantly revealed anti-inflammatory, antioxidant and immunosuppressant activities at 200 mg/kg.

Gladys and Bukola [11] has reported that methanol extract of the leaf, root, stem, bark, flower, fruit and wood of *A. altilis* was tested against the fourth instar larvae of *Culex quinquefasciatus* mosquito. Nisa et al. [12] has evaluated antifungal and antibacterial activity of ethanolic and distilled water extracts of *Artocarpus altilis* plant using broth micro-dilution methods. *A. altilis* aqueous extract had the most significant antifungal activity against *Penicillium* sp with AFA value of $140.36 \pm 3.76\%$. Nochera and Ragone [13] has investigated to develop a pasta product using breadfruit flour, test the sensory qualities of the breadfruit pasta product by sensory evaluation, and evaluate the nutritional composition. Rante et al. [14] has studied α -glycosidase inhibitory activities of n-hexane and ethanolic, yellow and green breadfruit leaves extract. Ethanolic leaf extracts were found to have more α -glycosidase inhibitory activity than n-hexane leaf extract.

Nayagam et al. [15] has synthesized silver nanoparticles (AgNPs) from plant residue of breadfruit and analyzed for the antibacterial assay against human pathogens. The cyto-toxic activity AgNPs was analyzed with two human cancer cell lines namely MCF₇ lung cancer cell line and A549 breast cancer cell line. Marta et al. [16] has compared the effect of different thermal treatment viz heat moisture treatment (HMT), and osmotic pressure treatment (OPT) on physicochemical and pasting properties of breadfruit starch. Soifoini et al. [17] has described nutritional and nutraceutical traits of *Artocarpus altilis* (Parkinson) Fosberg by characterizing its main bioactive compounds, nutritional traits, and antioxidant properties in order to contribute to the development of traditional and innovative uses of this species as functional food. This anti-

inflammatory activity between fermented and natural-dried breadfruit leaves extract were compared by Riasari et al. [18]. Fermented and dried breadfruit leaves were extracted with Soxhlet device using methanol solvent.

Antioxidant, total phenolic content and FTIR analysis of breadfruit methanolic leaves extract, which are essential in management of diabetes was demonstrated by Leng et al. [19]. Total phenolic content in fresh breadfruit leaves ($144.16\text{mg/g} \pm 17.98$) was comparable to those of green tea. Acute toxicity, antiplasmodial and liver histopathological effects of aqueous extract of breadfruit leaves were explained by Udonkany et al. [20]. The aqueous extract of breadfruit leaves has antiplasmodial properties and is safer at lower doses. The anxiety-like effects of breadfruit methanolic leaves extracts in Swiss mice was explained by Ajah et al. [21]. *Artocarpus altilis* leaf extract was found to possess antidiabetic-like properties. The hepatoprotective effect of ethanolic extract of Indonesian breadfruit leaf in CCR₄ – induced liver injury Wistar rats by measuring Serum Glutamic Pyruvic Transaminase (SGPT) and malondialdehyde (MDA) level was examined by Juliastuti et al. [22]. Ethanol-based breadfruit leaf extract was found to have effect on liver protection by decreased level of MDA and SGPT. The chemical composition, functional, mineral and anti-nutritional properties of composite flour produced from breadfruit and beniseed was discussed by Peters et al. [23]. The 70:30 composite flour showed improved chemical composition and could be utilized for product development in different food system. A review on phytochemistry, bio-efficacy, medicinal and ethno-pharmaceutical importance of breadfruit was demonstrated by Mohanty and Pradhan [24].

The bioactive constituent and influence of ethanol concentration, time and temperature on the anti-oxidant and antibacterial activity of *Artocarpus altilis* leaves in order to find appropriate and effective condition for its extraction was investigated by Saraswaty et al. [25]. It was

recommended to heat the extraction process to 70⁰c in order to obtain both optimal antioxidant and antibacterial activity from ethanol extract of *Artocarpus altilis* leaves. Present work describes phytochemical analysis, antifungal and anti-bacterial screening of *Artocarpus altilis*,

Scientific Classification

Kingdom:	<i>Plantae</i>
Clade:	<i>Tracheophytes</i>
Clade:	<i>Angiosperms</i>
Clade:	<i>Eudicots</i>
Clade:	<i>Rosids</i>
Order:	<i>Rosales</i>
Family:	<i>Moraceas</i>
Genus:	<i>Artocarpus</i>
Species:	<i>Artocarpus altilis</i>

2.METHODOLOGY

2.1Collection of plant materials

The plant material leaves of *Artocarpus altilis* is collected from a yard on 5thStreet, UG Road, Turkeyen, Georgetown. Guyana.

2.2Preparation of plant materials:

The collected leaves sample of *Artocarpus altilis* is weighted on Citizen CTG 3000E electronic balance. The leaves dried in oven (Gallenhamp Incubator Model IH-150) at

50-55°C. The dried leaves were cooled at room temperature and weighted again on same citizen electronic balance. Weight of green leaves, dried leaves and value of percentage moisture content in various samples of *Artocarpus altilis* is given in Table 1.

The weight of ground leaves of *Artocarpus altilis* is found to be 561.0 grams.

2.3 Collection of test organism

Three micro-organisms (*Escherichia coli*, *Staphylococcus aureus* and *Candidus albicans*) were used for the study. All the tested strains are reference stains and were collected from the Microbiology Laboratory of Georgetown Public Hospital Corporation, Georgetown (GHPC). All cultures are maintained in nutrient broth (Himedia, M002) at 37°C and maintained on nutrient agar (Himedia, MM012) slants at 4° C.

2.4 Extraction and preparation of test solutions

The grounded leaves of *Artocarpus altilis* was extracted in each acetone ethanol, and methanol solvents. At a time 20 g of dried pulverized leaves were soaked with 200 mL of solvent for 48 h. Solvent is decanted each time and residue again soaked with same solvent for 24 h. The total extract is combined and filtered. The evaporation of solvent was done on rotavapour (Buchi). The respective solvent was added to viscous semi solid liquid extract to make up the desired volume of extract solution.

3.5 Anti-Microbial Assay:

2.5.1 Materials

Mueller Hinton Agar, Agar plates and microbial discs were purchased from the Caribbean medicals, parika in Guyana. Solvents acetone, ethanol, and methanol obtained from Aldrich. Scintillation vials 20 mL were obtained from Meditron Scientific Sales, Georgetown, Guyana.

2.5.2 *Aseptic chamber*

Aseptic chamber consist of a wooden box of L = 1 meter, B = 1 meter and D = 0.5 meter area. Chamber is cleaned with 70 % ethanol twice and irradiated with short wave UV light for 1 h.

2.5.3 *Potato Dextrose Agar (PDA) medium*

Potato Dextrose Agar medium prepared according to method reported by Talaro [26]. This is the medium on which cultured bacteria Escherichia coli and Staphylococcus aureus were grown. The 200 g potato was peeled finely chopped and boiled to a mash in distilled water, Each 12.5 g dextrose and 12.5 g Agar was placed in a 1 L measuring cylinder. Distilled water was added to make the solution to 500 mL. The content was stirred until the consistency of solution mixture. The stirred mixture poured into conical flasks, plugged with cotton wool and tightly wrapped by aluminum foil. The flasks were autoclaved at 121 °C, 15 psi, for 15 minutes.

2.5.4 *Mother plates*

Mother plates were prepared by pouring potato dextrose Agar mixture into Petri dishes and to cool at room temperature, in the aseptic chamber.

2.5.5 *Antimicrobial assay:*

Antimicrobial assay was done by well diffusion method, poison plate method, paper disc method and streak plate methods. Which are as follows:

2.5.5.1 Well diffusion method:

In this method well are made using a sterilized the cork borer on the seeded nutrient agar in a petri dish to which the test compound (leaves extract) of different concentration (25, 50, 75, 100, 125 μL s) are added. The treated petri discs are incubated at room temperature for 24 hrs. The inhibition zone formed around each well indicates the antibacterial activity. The procedure was repeated in duplicate and inhibitory zone was measured by ruler in mm [27].

2.5.5.2 Poison plate method:

The test organism (*S. aureus*, *E. coli*, *C. albicans*) seeded into nutrient medium were poured into petri discs and allow to cool and solidify. A 9 cm sterile cork borer was used to make a disk on pathogen plate. Pathogen disc was taken from pathogen plate and kept at the center of test compound (leaves extract of 25, 50, 75, 100, 125 μL concentrations) seeded plate with the help of a sterile inoculum needle and was incubated for 2 to 3 days. The inoculum needle was sterilized with the alcohol and flame before each application. The experiment was done in duplicate and zone of inhibition was measured [28].

2.5.5.3 Paper disc plate method:

The circular discs of 6 mm diameter was prepared from whatman no.1 filter paper and sterilized in a autoclave. These paper discs were impregnated with test compounds (leaves extract 25, 50, 75, 100, 125 μL s) in respective solvent (acetone, ethanol, methanol) for overnight and placed on nutrient agar plates seeded with test organism (*S. aureus* , *E. coli*, *C.albicans*) . The plates are incubated at room temperature for 12 hr. After 12 h zone of inhibition around each disc was measured by horizontal and vertical method and the diameter was recorded. A reference control was prepared using only the several (

acetone , ethanol, methanol) and kept for comparison . The test done in duplicate to ensure the reliability of the results [29].

2.5.5. 4 **Streak plate method:**

The molten agar medium (20 m L) and each leaves extract and each leave extract (25, 50, 75, 100, 125 μ L) was poured into a sterile petri dish under aseptic condition. It was cooled at room temperature. After cooling the each bacterial culture was taken at 12, 24, 36 hour intervals and using the surface of agar medium in the form of parallel strokes (streaks). The test repeated in duplicates. The plates were incubated at room temperature for 24 hours and inhibitory zone was measured. Control plates without the plant extract were also maintained for the reference [30].

2.6 Phytochemical analysis of the plant extracts

2.6.1 Materials

Glacial acetic acid, thionyl chloride, dichloromethane, copper sulfate, lead acetate, diethyl ether, ferric chloride, acetic anhydride, antimony chloride, amyl chloride etc. obtained from Aldrich.

2.6.2 Method

Phytochemical analysis of all the aqueous plant extracts was carried out by suitable methodologies in search of active ingredient responsible for antimicrobial toxicity.

The phytochemicals include under study were saponins, terpenoids, alkaloid,

cardiac glycoside, phenol, steroidphytosteroid, tannins, phlobatannins and

flavonoids the analysis was carried out according to the methodologies of

Edeoga et al. [31].

**Table 1: PERCENTAGE MOISTURE CONTENT FOR ARTOCARPUS
ALTILIS LEAVES**

(Oven temperature 50 – 55 ° C)

Sample Number	Weight of green leaves (gram)	Weight of dry leaves at 10 am(grams)	Weight of dry leaves at 4 pm (grams)	Percentage moisture content %
1	283	96	96	66.07
2	438	128.5	128.5	70.66
3	389	115	115	70.44
4	409	125	125	69.44
5	370	127.5	127.5	65.254

$$\text{Percentage moisture content} = \frac{\text{Weight of green leaves} - \text{weight of dry leaves}}{\text{weight of green leaves}} \times 100$$

3.RESULTS

3.1 Well diffusion method

Antimicrobial activity of Artocarpus altilis leaves extract against E coli, S. aureus and C. albicans are summarized in **Tables 2-4** by well diffusion methods.

Table 2. Antimicrobial activity of crude leaves extracts of Artocarpus altilis in various solvents against E. coli.

Compared with control by well diffusion method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.10	0.16	0.20
	50	0.25	0.20	0.25
	75	0.30	0.26	0.30
	100	0.35	0.30	0.35
	125	0.35	0.32	0.39

- Duplicate

Table 3. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *S. aureus*.

compared with control by well diffusion method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.21	0.22	0.28
	50	0.25	0.25	0.29
	75	0.35	0.30	0.30
	100	0.38	0.32	0.33
	125	0.42	0.34	0.35

*Duplicate

Table 4. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *C. albicans*.

Compared with control by well diffusion method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.15	0.21	0.25
	50	0.20	0.25	0.29
	75	0.25	0.29	0.30
	100	0.30	0.32	0.42
	125	0.35	0.35	0.49

* Duplicate

3.2 Poison plate method

Antimicrobial activity of *Artocarpus altilis* leaves extract against *E. coli*, *S. aureus* and *C. albicans* are summarized in **Tables 5 -7** by poison plate methods.

Table 5. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *E. coli*.

Compared with control by poison plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
<i>Artocarpus altilis</i> (Breadfruit)	25 control	0	0	0
	25	0.22	0.20	0.25
	50	0.31	0.22	0.27
	75	0.32	0.26	0.29
	100	0.44	0.30	0.33
	125	0.50	0.33	0.34

*duplicate

Table 6. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *S. aureus*.

Compared with control by poison plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
<i>Artocarpus altilis</i> (Breadfruit)	25 control	0	0	0
	25	0.19	0.28	0.29
	50	0.22	0.32	0.30
	75	0.26	0.33	0.32
	100	0.28	0.45	0.34
	125	0.30	0.52	0.35

*duplicate

Table 7. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *C. albicans*.

Compared with control by poison plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.18	0.24	0.33
	50	0.20	0.25	0.34
	75	0.22	0.26	0.35
	100	0.24	0.28	0.46
	125	0.26	0.29	0.53

*duplicate

3.3 Paper disc method

Antimicrobial activity of *Artocarpus altilis* leaves extract against *E. coli*, *S. aureus* and *C. albicans* are summarized in **Tables 8-10** by paper disc plate methods.

Table 8 Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *E. coli*.

Compared with control by paper disc plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.22	0.23	0.24
	50	0.31	0.25	0.25
	75	0.32	0.27	0.38
	100	0.44	0.29	0.30
	125	0.51	0.30	0.32

*duplicate

Table 9. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *S. aureus*.

Compared with control by paper disc plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.15	0.26	0.23
	50	0.17	0.28	0.25
	75	0.19	0.29	0.28
	100	0.20	0.41	0.30
	125	0.21	0.48	0.33

*duplicate

Table 10. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *C. albicans*.

Compared with control by paper disc plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.15	0.21	0.27
	50	0.30	0.25	0.31
	75	0.35	0.28	0.32
	100	0.39	0.30	0.45
	125	0.35	0.34	0.51

*duplicate

3.4 Streak plate method

Antimicrobial activity of *Artocarpus altilis* leaves extract against *E. coli*, *S. aureus* and *C. albicans* are summarized in **Tables 11-13** by Streak plate methods.

Table 11. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *E. coli*.

Compared with control by streak plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.16	0.20	0.23
	50	0.18	0.22	0.24
	75	0.19	0.25	0.26
	100	0.20	0.27	0.28
	125	0.24	0.29	0.30

*duplicate

Table 12. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *S. aureus*.

Compared with control by Streak plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.16	0.18	0.20
	50	0.17	0.19	0.22
	75	0.19	0.21	0.24
	100	0.21	0.23	0.29
	125	0.23	0.25	0.31

*duplicate

Table 13. Antimicrobial activity of crude leaves extracts of *Artocarpus altilis* in various solvents against *C. albicans*.

Compared with control by Streak plate method.

Plant	Leaves extract solvent (μL)	Diameter of the inhibitory (mm)*		
		Acetone	Ethanol	Methanol
Artocarpus altilis (Breadfruit)	25 control	0	0	0
	25	0.20	0.22	0.23
	50	0.22	0.25	0.26
	75	0.25	0.29	0.29
	100	0.29	0.33	0.31
	125	0.31	0.35	0.36

*duplicate

3.5 Phytochemical analysis:

Phytochemical analysis **Table 14** of the *Artocarpus altilis* (breadfruit) leaves extracts revealed the presence of tannins, saponins, flavonoids, alkaloids, cardiac glycosides, terpenoids, phenol, phlobatannins, steroids and phytosteroids.

Table 14 :Phytochemical analysis breadfruit *Artocarpus altilis* leaves extracts

S. No.	Phytoconstituents	
1	Tannins	Absent
2	Saponins	Absent
3	Flavonoids	Present
4	Alkaloids	Absent
5	Cardiac glycosides	Absent
6	Terpenoids	Present
7	Phenol	Present
8	Steroids and phytosteroids	Present
9	Steroids and phytosteroids	Present

4. DISCUSSION

It is observed from **Tables 2-4** that (i) In acetone solvent maximum (0.42 mm: 125 μ L) inhibitory zone was observed for *S. aureus* and minimum inhibitory zone (0.10 mm: 25 μ L) was observed for *E. coli*. (ii) In ethanol solvent maximum (0.35 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.16 mm: 25 μ L) was observed for *E. coli*. (iii) In methanol solvent maximum (0.49 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.20 mm: 25 μ L) was observed for *E. coli*.

It is clear from **Tables 5-7** that (i) In acetone solvent maximum (0.50 mm: 125 μ L) inhibitory zone was observed for *E. coli* and minimum inhibitory zone (0.18 mm: 25 μ L) was observed for *C. albicans*. (ii) In ethanol solvent maximum (0.52 mm: 125 μ L) inhibitory zone was observed for *S. aureus* and minimum inhibitory zone (0.20 mm: 25 μ L) was observed for *E. coli*. (iii) In methanol solvent maximum (0.53 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.25 mm: 25 μ L) was observed for *E. coli*.

It is seen from **Tables 9-10** that (i) In acetone solvent maximum (0.51 mm: 125 μ L) inhibitory zone was observed for *E. coli* and equal (0.15 mm: 25 μ L) inhibitory zone was observed for *S. aureus* and *C. albicans*. (ii) In ethanol solvent maximum (0.48 mm: 125 μ L) inhibitory zone was observed for *S. aureus* and minimum inhibitory zone (0.21 mm: 25 μ L) was observed for *C. albicans*. (iii) In methanol solvent maximum (0.51 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.23 mm: 25 μ L) was observed for *S. aureus*.

The **Tables 11-13** indicated that (i) In acetone solvent maximum (0.31 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and equal (0.16 mm: 25 μ L) inhibitory zone was observed for *E. coli* and *S. aureus*. (ii) In ethanol solvent maximum (0.35 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.18 mm: 25 μ L) was observed for *S. aureus*. (iii) In methanol solvent maximum (0.36 mm: 125 μ L) inhibitory zone was observed for *C. albicans* and minimum inhibitory zone (0.20 mm: 25 μ L) was observed for *S. aureus*.

In general it is clear from **Tables 2-13** that (i) inhibitory zone follow the order :Methanol > ethanol > acetone in most of the assay studies. This may due to high polarity of methanol solvent. (ii) In most of the essay studies inhibitory zones among the methods follow the order

well diffusion method > poison plate method > paper disc method > streak plate method. (iii) It is seen from **Tables 2-13** that inhibitory zone or antimicrobial potential increases as the amount of leaves extract increases from 25 μL to 125 μL . this may be due to increase in amount of extracts. (iv) It is clear from **Tables 2-13** that all plant extract showed antimicrobial potential activity toward the gram positive bacteria staphylococcus aureus also gram negative bacteria Escherichia coli and fungus C. albicans.

The phytochemical analysis of methanol leaves extract of Artocarpus altilis (**Table 14**) tested positive for flavonoids, terpenoids, phenol, phlobatannins, steroids and phytosteroids, and negative for tannins, saponins, alkaloids and cardiac glycosides. Medical benefits of breadfruit extracts include, cardiovascular health, good for skin, reduce diabetes, dental health, energy booster, bone health, sleep better at night, resistance against infection etc. The wood of breadfruits one of the most valuable timbers in the construction of traditional houses. Breadfruit contains phytochemicals having potential as an insect repellent.

List 1 :Breadfruit (Artocarpus altilis), Nutritive Value per 100 g. (Source: USDA National Nutrient data base) are as follow

Principle	Nutrient Value	Percentage of RDA
Energy	103 Kcal	5%
Carbohydrates	27.12 g	21%
Protein	1.07 g	2%
Total Fat	0.20 g	1%
Cholesterol	0 mg	0%
Dietary Fiber	4.9 g	13%

Vitamins

Folates	14 μg	3.5%
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Niacin	0.900 mg	6%
Pyridoxine	0.100 mg	8%
Riboflavin	0.030 mg	2%
Thiamin	0.110 mg	9%
Vitamin A	0 IU	0%
Vitamin C	29 mg	48%
Vitamin E	0.10 mg	1%
Vitamin K	0.5& mug	<1%

Electrolytes

Sodium	2 mg	0%
Potassium	490 mg	10.5%

Minerals

Calcium	17mg	2%
Copper	0.084 mg	9%
Iron	0.54 mg	7%
Magnesium	25 mg	6%
Manganese	0.060 mg	2.5%
Phosphorus	30 mg	4%
Selenium	0.6µg	1%
Zinc	0.12 mg	1%

Photo-nutrients

Carotene-B	0µg	--
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Crypto-xanthin-B	0 μ g	--
Lutein-zeaxanthin	22 μ g	--

Medical benefits include, cardiovascular health, good for skin, reduced diabetes, dental health, energy booster, bone health, sleep better at night, resistance against infections, etc.

The wood of the breadfruit was one of the most valuable timbers in the construction of traditional houses in Samoan architecture. The part of fruit that are discarded can be used to feed livestock. The leaves of the breadfruit trees can also browse by cattle. Breadfruit tree with fruit and leaves is shown in Figure 1.

5. CONCLUDING REMARKS

- (i) It is found from present studies that inhibitory zone or antimicrobial potential of leaves extract increases as their amount increases.
 - (ii) In general among four methods used for antimicrobial studies well diffusion method and streak plate methods were found to have highest and lowest inhibitory zone, respectively.
 - (iii) In most of the essay studies maximum and minimum antimicrobial potential was observed for methanol and acetone solvent extract, respectively.
- (i) The phytochemical flavonoids, terpenoids, phenol, phlobatannins, steroids and phytosteroids are found to present in methanol leaves attract of *Artocarpus altilis*.
 - (ii) The phytochemicals tannins, saponins, alkaloids and cardiac glycosides are found to be absent in methanol leaves attract of *Artocarpus altilis* (breadfruit).

- (iii) It is observed from the present studies that leaves extract of *Artocarpus altilis* have antimicrobial property and its potential increases as their amount increases.
- (iv) Present research work is very useful for the researchers of similar research interest.

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Figure 1. Breadfruit tree with leaves and fruits

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