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THE ANTIMICROBIAL ACTIVITY OF n-C_6H_{14} AND CH_3CH_2OH EXTRACT OF *SOLANUM MELONGENA* FRUIT AND LEAVES OF *MORINGA OLEIFERA*

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Keywords:

Antimicrobial, *Solanum Melongena, Moringa oleifera, E. coli*, *S. aureus* and *K. pneumonia,* Bacteria susceptibility

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ABSTRACT: As part of a research initiative to evaluate plants used for their nutritional and herbal values, the antimicrobial activity of *Solanum Melongena's* fruit *and Moringa oleifera's* leaves were investigated. Each plant part was subjected to selective extraction using solvents of varying polarity: n-C_6H_{14}, CH_2Cl_2, EtOAc and CH_3CH_2OH. The n-C_6H_{14} and CH_3CH_2OH extract of these two plants were tested for their antimicrobial activity at three different concentrations of 5%, 10% and 20% of crude extracts against three pathogenic bacterial strains: *Eschericia coli*, *Staphyloccocus aureus* and *Klebsiella pneumoniae* using the Disc diffusion assay. Both n-C_6H_{14} and CH_3CH_2OH extracts showed antibacterial activity at a higher concentration of 20% of crude extract. The order of bacteria susceptibility to *Moringa oleifera* extract been *S. aureus* > *K. pneumoniae* > *E. coli* whereas that for *Solanum Melongena* extract been *S. aureus* > *E. coli* > *K. pneumonia*. The area of zone of inhibition ranges from 44.15 mm^2 to 53.55 mm^2. These investigations suggest that the extracts of *Moringa oleifera* and *Solanum Melongena* can be used as antibacterial agents in addition to their nutritional value.

INTRODUCTION: Guyana has a rich bio diversified flora whose organic and aqueous extract have been shown to possess potent and selective antimicrobial activity compared with standard antibiotics such as penicillin, nystatin and ampicillin [1-7] etc. Research in the design and syntheses of antimicrobials will be everlasting endeavours on our planet considering the fact that bacteria and fungus developed resistance to antimicrobials over a period of time [8-13]. Antibiotic resistance has become a global concern [13]. This is primarily due to indiscriminate use of commercial antimicrobial drugs used for the treatment of infectious diseases.

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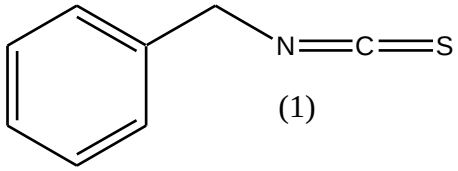
This has led to the search for new antimicrobials, both herbal and synthetic.

However, synthetic drugs/medicine has several adverse side effects which are usually irreversible when administered and the cost of synthesizing drugs in most cases is an expensive endeavour [10-12]. In addition, phytochemical screening and natural products isolation can lead to novel and know natural products whose in *vitro* antimicrobial activity can be correlated with that of the crude plant extract [14-15].

There is also a need to assess the medicinal values of plant used as food source. Thus, efforts should be made to intensify the production of food crops in the agro-industry that have antimicrobial properties in addition to their nutritional properties. As such, the antimicrobial activity of the n-C_6H_{14} and CH_3CH_2OH extract of *Solanum melongena* (Solanaceae) *and Moringa oleifera (*Moringaceae) were investigated in

vitro against pathogenic *Escherichia coli*, *Staphylococcus aureus* and *Klebsiella pneumoniae*. Such an endeavour will be a boost to the agro industry and Health Sector.

Moringa oleifera is the most widely cultivated species of the genus *Moringa*, the only genus in the Moringaceae. This plant is rich in unique compounds such as glucosinolates and isothiocyanates. Natural products such as 4-(4'-O-acetyl-a-L-rhamno pyranosyloxy)benzyl isothiocyanate, 4-(a-L-rhamno pyranosyloxy)benzyl isothiocyanate, niazimicin, pterygospermin (2), benzyl isothio cyanate (1) and 4-(α-L-rhamnopyranosyloxy)benzyl glucosinolate isolated from *Moringa* species have been reported to have hypotensive and anticancer activity. Phytochemicals such as the carotenoids (β-carotene or pro-vitamin A have also been isolated [16, 17]. The structures of two of these compounds are shown in **Fig. 1**.



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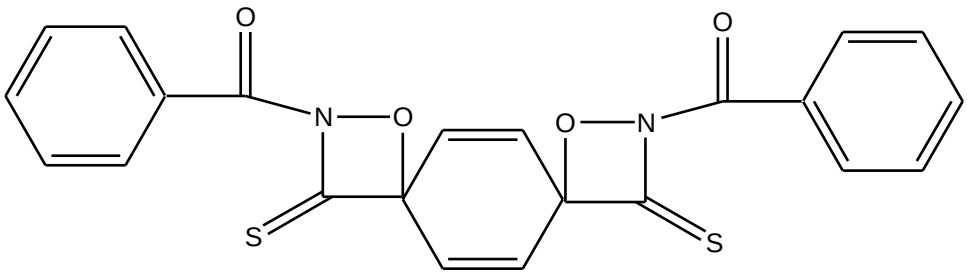

(2)

FIG. 1: BENZYL ISOTHIOCYANATE (1) AND PTERYGOSPERMIN (2) FROM *MORINGA OLEIFERA*

The leaves are the most nutritious and contain significant amount of vitamin B_6, vitamin C, provitamin A, β-carotene, magnesium and protein. Calcium in *Moringa oleifera* leaves are usually complexed as crystals of calcium oxalate.

Moringa oleifera provides a rich and rare combination of zeatin, quercetin, kaempferom and many other phytochemicals such as hexadecanoic acid, ethyl palmitate, palmitic acid, ethyl ester, 2,6-Dimethyl-1, 7-octadiene-3-ol, 4-Hexadecen-6-yne, 2-hexanone, and 3-cyclohexyliden-4-ethyl - E2-Dodecenylacetate [17].

It is very important for its medicinal value. Various parts of the plant such as the leaves, roots, seed, bark, fruit, flowers and immature pods act as cardiac and circulatory stimulants, possess anti-tumour, anti-pyretic, anti-epileptic, anti-inflammatory and anti-ulcer activity [17].

Moringa oleifera preparations have been used for its anti-trypanosomal, hypotensive, antispasmodic, antiulcer, anti-inflammatory, hypocholesterolemic, and hypoglycemic activities, as well as having considerable efficacy in water purification by flocculation, sedimentation, antibiosis and even reduction of Schistosome cercariae titer [18].

A new biflavonol glycoside, Solanoflavone was isolated from aerial part of *Solanum melongena*. The chemical structure was elucidated as isorhamnetin-3-O-beta-D-glucopyranoside-(4'->O->4''')-galangin-3''-O-beta-D-glucopyranoside on the basis of physico-chemical and spectroscopic methods, including 2D NMR spectral techniques [19].

Flavonoids were isolated from *Solanum melongena* and shown to have potent antioxidant activity. Concentrations of malondialdehyde, hydroperoxides and conjugated dienes were lowered significantly [20].

Phenylethyl cinnamides as potential alpha-glucosidase inhibitors were isolated from the roots of *Solanum melongena* (Solanaceae). Bioassay-guided fractionation against alpha-glucosidase resulted in isolation and identification of six phenolic compounds from the 70% EtOH extract of the roots. Three of the phenylethyl cinnamides, N-trans-feruloyl tyramine, N-*trans*-p-coumaroyl tyramine and N-*cis*-p-coumaroyl tyramine possessed inhibitory activity against alpha-glucosidase with IC50 values of 500.6, 5.3 and 46.3 microM, respectively. Mechanisistic studies revealed these phenylethyl cinnamides as non-competitive inhibitors. The above is the first study of the alpha-glucosidase inhibitory activities of the roots of *Solanum melongena*, suggesting potential medicinal use of this herb [22].

Phytochemical examination of the methanolic and aqueous extracts of the fruit and crown of *Solanum Melongena* showed the presence of alkaloids, saponins, steroids, tannins/ phenolics, flavonoids, proteins and carbohydrates. Ascorbic acid and phenolics both which are powerful antioxidants were present in fruit, the presence of saponins and glycoalkaloids which were also found in the fruit protects plant from microbial pathogens.

Various parts of *Solanum melongena* (Solanaceae) are useful in the treatment of inflammatory conditions, cardiac debility, neuralgia, ulcers of nose, cholera, bronchitis and asthma. Roots are used as anti-asthmatic and general stimulant, juice is employed for otitis, applied to ulcers of the nose. Leaves are used in the treatment of bronchitis, asthma and dysuria, also given in liver complaints and they stimulate inter hepatic metabolism of cholesterol. The fruit of *Solanum melongena* is a high valued vegetable all over the world because of its taste and higher percentage of Vitamin B_2. The fruit is also used in the treatment of diabetes [22].

MATERIALS AND METHODS:

Reagents and materials: Antibiotics, Ampicillin, Mueller Hinton Agar, agar plates were purchased from the International Pharmacy Association (IPA) in Guyana. Bacterial culture was obtained from the Georgetown Public hospital.

Collection of Plant material: Fresh leaves of *Moringa oleifera* and fruits of *Solanum meologena* were handpicked at Friendship village on the Corentyne, Berbice, and placed in bags. These were washed with tap, distilled water and were dried for four (4) hours. They were further air dried for one week and sent for authentication at the Centre for the Study of Biological Diversity, University of Guyana.

Grinding and Extraction: Approximately six hundred grams (600 g) of the fruit of the *Solanum melongena* were cut into small pieces and blended thrice in six hundred milliliters (600 ml) of n-C_6H_{14}. The contents were then filtered into air tight glass containers. The procedure was repeated using the more polar CH_3CH_2OH solvent. Leaves of *Moringa oleifera*, 600 grams in weight was also blended thrice in 600 ml of n-C_6H_{14}. The contents were filtered into air tight glass containers. The procedure was repeated using freshly distilled CH_3CH_2OH. The contents for each extraction was filtered, solvents dried over anhydrous Na_2SO_4 and removed in *vacuo* using a rota vapor, resulting in viscous oils.

Reference and Control: *Ampicillin* was chosen as the reference for all bacteria species used: *E. coli*, *S. aureus* and *Klebsiella pneumoniae*. The Control experiment consists of a plate of solidifying agar onto which was inoculated pure solvent with microorganism mixed in a 1:1 portion [23-24].

Antimicrobial tests: Plant extracts were investigated for their antimicrobial activity using the Disc Diffusion assay [23-24].

Source of microorganisms: Gram negative (-) *E. coli, Klepsiella pneumoniae* and Gram positive (+) strains *Staphylococcus aureus* (ATCC 25923) were obtained from the Georgetown Public Hospital, GPH and stored in a refrigerator until required.

Positive control: In this study, tetracycline was used as a positive control to screen and analyze the antimicrobial properties of the different medicinal plants. This antimicrobial drug is clinically effective against both gram- negative as well as gram positive microbes. Side-effects from tetracycline are not common. Use of the antibiotic have known to cause stomach or bowel upsets and on rare occasions, allergic reactions.

***In vitro* Antimicrobial Susceptibility Tests:** The Disc diffusion method was used to screen plant extracts for its *in vitro* antimicrobial activity. Plates were labeled according to extract, concentration and bacteria. Using the Disc diffusion assay [24], an inoculum containing bacteria cells were applied onto Mueller Hinton agar plates. A sterile swabbed was dipped into the bacteria culture and was uniformly spread on the surface of the Mueller Hinton agar. This was allowed to dry for 10 minutes. On each plate, four discs were placed equidistant using a sterilized tweesor. One of these is the reference disc onto which antibiotic was also applied and was used as the positive control: ampicillin for the bacteria. The reference antibiotic disc contained 200mg antibiotic/ml. The discs were made by cutting discs (5-6mm) from a filter paper with a sterilized perforator. Each disc was impregnated with the anticipated antimicrobial plant extract of *Solanum Melongena* and *Moringa oleifera* at appropriate concentrations of 5%, 10% and 20 % of n-C_6H_{14} or CH_3CH_2OH extract using a microlitre syringe. The plates were then incubated with the test organism: Bacteria at 37ºC for 24 hours. The antimicrobial compound diffuses from the disc into the medium. Following overnight incubation, the culture was examined for areas of no growth around the disc (zone of inhibition, ZOI). The diameter of the zone of inhibition was measured using a transparent plastic ruler. Each experiment was done in triplicates (**table 1**).

RESULTS:

TABLE 1: MEAN, STANDARD DEVIATION AND AREA OF ZONE OF INHIBITION FOR THE n-C_6H_{14} AND CH_3CH_2OH EXTRACT OF *SOLANUM MELONGENA* AND *MORINGA OLEIFERA*

Sample	Pathogenic Microorganism	Concentration (%)	Mean Diameter	Mean Diameter with Standard deviation	Area of Zone of Inhibition (mm^2)
***Solanum melogena* Hexane**	*E. coli*	5	4.43	4.43 ±3.85	15.04
		10	4.46	4.46 ± 2.97	15.65
		20	7.03	7.03 ± 0.25	38.79
	S. aureus	5	6.77	6.77 ± 1.04	35.87
		10	7.1	7.1 ± 0.22	39.57
		20	5.03	5.03 ± 2.53	19.86
	Klebsiella spp	5	2.33	2.33 ± 1.04	4.26
		10	7.97	7.97 ± 3.87	48.99
		20	7.17	7.17 ± 0.25	40.24
***Solanum melongena* Ethanol**	*E. coli*	5	7.2	7.2 ± 0.71	40.69
		10	7.43	7.43 ± 0.30	43.33
		20	7.63	7.63 ±0.42	45.7
	S. aureus	5	7.87	7.87 ± 0.32	48.49
		10	7.73	7.73 ± 0.64	46.9
		20	8.27	8.27 ± 0.21	53.55
	Klebsiella spp	5	7.03	7.03 ± 0.11	38.79
		10	7.53	7.53 ± 0.32	44.51
		20	7.5	7.5 ±0.17	44.15
***Moringa oleifera* Hexane**	*E. coli*	5	4.4	4.4 ±3.81	15.19
		10	7	7±0.2	38.46
		20	7.06	7.06 ±0.11	39.12
	S. aureus	5	4.66	4.66 ±4.07	17.04
		10	7.4	7.4 ±0.52	42.98
		20	7.53	7.53 ±0.49	44.51
	klebsiella spp	5	7.33	7.33 ± 0.28	42.17
		10	7.26	7.26 ± 0.20	41.37
		20	4.86	4.86 ± 4.23	18.54
***Moringa oleifera* Ethanol**	*E. coli*	5	6.73	6.73 ±0.25	33.55
		10	4.76	4.76 ± 4.12	17.78
		20	7.73	7.73 ± 0.11	46.9
	S. aureus	5	5	5 ± 4.35	38.46
		10	8.1	8.1 ±0.79	51.5
		20	8.1	8.1±0	51.5
	Klebsiella spp	5	6.93	6.93 ±0.05	37.69
		10	7.33	7.33 ±0.05	42.17
		20	7.93	7.93 ±0.11	49.36

Positive control: (Table 2)

TABLE 2: AREA OF ZONE OF INHIBITION, ZOI FOR THE POSITIVE CONTROL, TETRACYCLINE AGAINST PATHOGENS

Microorganism	Area of zone of inhibition (mm^2)
Escherichia.coli	$36cm^2$
Staphylococus. aureus	$37cm^2$
Klebsiella. pneumoniae	$35cm^2$

DISCUSSION: Antimicrobial properties of *Solanum melogena* and *Moringa oleifa* C_2H_5OH and n-C_6H_{14} extracts were investigated in *vitro* at concentrations of 5%, 10% and 20% using the Disc diffusion assay. Investigations were done against three pathogenic microorganisms: *E. coli*, *S. aureus* and *Klebsiella* pneumonia using the Disc diffusion assay. The area of zone of inhibition was used as the guage of the plant's antimicrobial properties. Larger the diameter of zone of inhibition, greater is the plant's antimicrobial activities. It is anticipated through the antimicrobial activity of plant extract, no area of growth will be induced around the disc. Bacteria colonies sensitive to the antimicrobial are inhibited at a distance from the disc whereas resistant strains grow up to the edge of the disc. Discs applied to the plates already streaked with bacteria and the fungus.

A comparison of the effect of the various solvent extracts against the three pathogenic microorganisms at three different concentrations can be discussed. In general, there seem to be an increase in the plant's extract antimicrobial activity as the concentration of the extract is increased. For example, *Solanum melongena* C_2H_5OH extract induces area of zone of inhibition (ZOI) of 40.69, 43.33 and 45.7 mm^2 against *E.coli* as the concentration of the plant extract increased from 5% to 20%. Likewise *Moringa oleifera* CH_3CH_2OH extract induces area of zone of inhibition of 37.69, 42.17 and 49.36 mm^2 against *Klebsiella pneumoniae* at concentration of 5, 10 and 20% of extract respectively.

However, there were exceptions to the above general increase in bacterial activity. For example, *Solanum melogena* n-C_6H_{14} extract showed an increase in antimicrobial activity against *S.aureus* followed by a decrease at the 20% concentration. For example, area of zone of inhibition of 35.87 mm^2, 39.57 mm^2 and 19.86 mm^2 was observed at concentration of 5, 10 and 20% of extract. *Moringa oleifera* C_2H_5OH extract also showed a decreased in antimicrobial activity followed by an increase.

For example, against *Klebsiella* species value of 33.35 mm^2, 17.78 mm^2 and 46.0 mm^2 were obtained at the respective concentrations of 5, 10 and 20 % of extract. Of significance, there was a decrease in the area of zone of inhibition for *Moringa oleifera* hexane extract against *Klebsiella* species at all three concentrations. Area of zone of inhibition of 42.17 mm^2, 41.37 mm^2 and 18.54 mm^2 were obtained against *Klebsiella* species at concentrations of 5, 10 and 20% of extract. The highest area of zone of inhibition of 53.55 mm^2 induced by *Solanum melogena* C_2H_5OH extract against *S. aureus* at 20% concentration of extract.

The smallest area of zone of inhibition of 15.04 mm^2 was induced by *Solanum melogena* n-C_6H_{14} extract against *E. coli*, where values of 15.04 mm^2, 15.65 mm^2 and 38.79 mm^2 were registered at the respective concentration. The C_2H_5OH extract of either plant seems to be more antimicrobial than the n-C_6H_{14} extract, suggesting greater localisation of plant natural products antimicrobial agents or the interactions of natural products via non covalent interactions to produce novel antimicrobial systems or assemblies. For example, *Solanum melogena* n-C_6H_{14} extract induces area of zone of inhibition of 35.37 mm^2, 39.57 mm^2 and 19.86 mm^2 against *S. aureus*. However, *Solanum melogena* CH_3CH_2OH extract induced area of zone of inhibition of 48.49 mm^2, 46.9 mm^2 and 53.53 mm^2 against *S. aureus* at concentration of 5%, 10% and 20% concentration respectively.

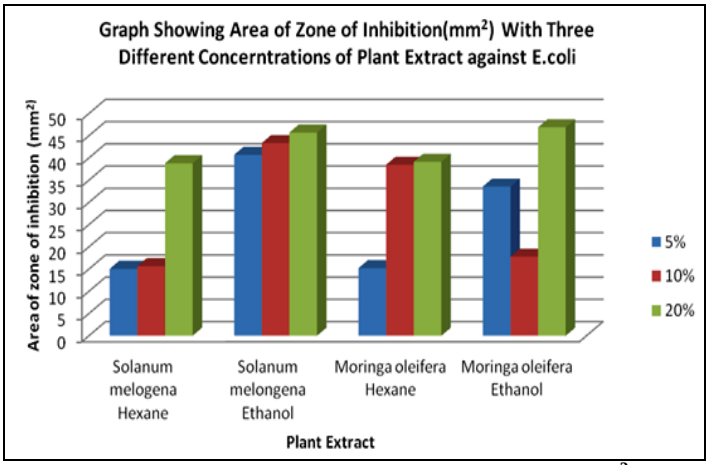

FIG. 2: AREA OF ZONE OF INHIBITION (mm^2) OF PLANT EXTRACTS AGAINST *E. COLI* AT CONCENTRATION of 5, 10 and 20%

Graph 1 shows the area of ZOI (mm^2) at 5%, 10%, & 20% concentrations of both plant extracts against colonies of *E. coli*.

From the graph it can be observed that the n-C_6H_{14} extract of *Moringa oleifera* was more antibacterial. Values of 38.79 mm^2 and 39.12 mm^2 were recorded against *E. coli*. Also, at the 20% concentration, *Moringa oleifera* C_2H_5OH extract was more antimicrobial than *Solanum melogena*. Values of 46.9 mm^2 and 45.7 mm^2 were registered respectively.

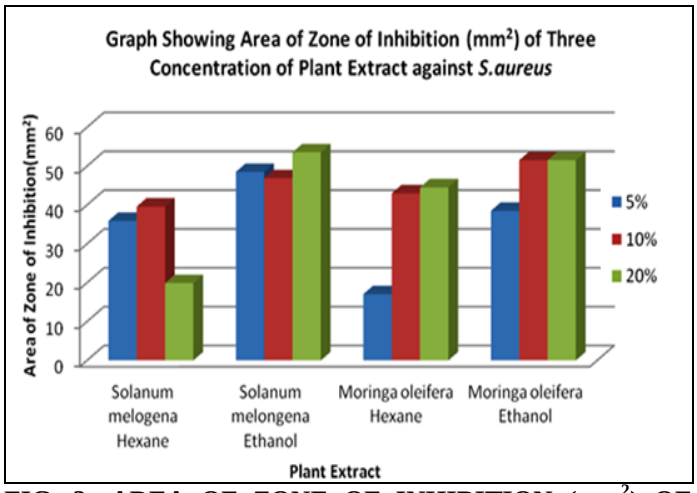

FIG. 3: AREA OF ZONE OF INHIBITION (mm^2) OF PLANT EXTRACTS AGAINST *S. AUREUS* AT CONCENTRATION OF 5, 10 AND 20%.

Graph 2 shows the area of ZOI (mm^2) at 5%, 10%, & 20% concentrations of both plant extracts against colonies of *S. aureus*. From the graph, the n-C_6H_{14} extract of *Moringa oleifera* is more antimicrobial than that of *Solanum melogena*. Values of 44.51 mm^2 and 19.86 mm^2 were observed respectively. However, *Solanum Melongena* C_2H_5OH extract is more antimicrobial against *S. aureus* than *Moringa's* C_2H_5OH extract at the 20% concentration. Values of 53.55 mm^2 and 51.5 mm^2 were observed respectively.

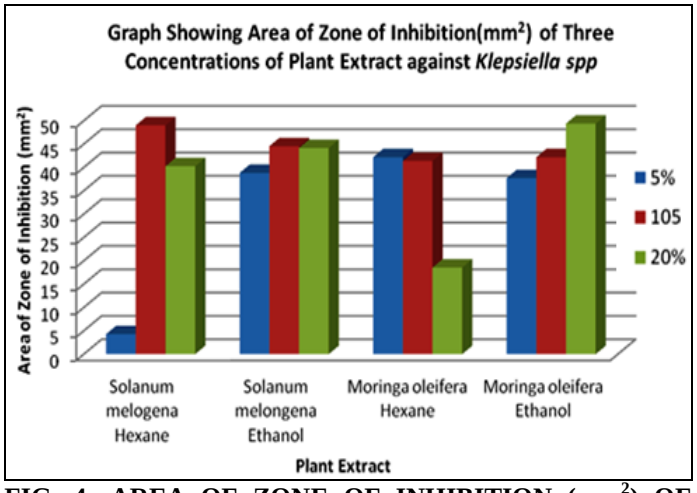

FIG. 4: AREA OF ZONE OF INHIBITION (mm^2) OF PLANT EXTRACTS AGAINST *KLEPSIELLA SPECIES* AT CONCENTRATION OF 5, 10 AND 20%.

Graph 3 shows the area of ZOI (mm^2) at 5%, 10% and 20% concentrations of plant extract against colonies of *Klebsiella pneumoniae*. From the graph it can be observed that the n-C_6H_{14} extract of *Solanum melogena* induces a higher area of zone of inhibition against *Klebsiella pneumoniae* compared with *Moringa oleifera* at the 20% concentration. Values of 40.24 cm^2 and 18.54 cm^2 were registered respectively. Likewise, C_2H_5OH extract of *Solanum Melongena* were more antimicrobial than Moringa *oleifera* at 20% concentration of plant extract. Areas of ZOI registered were 44.15 mm^2 and 49.36 mm^2 respectively.

Antimicrobial activity was also investigated for the positive control, tetracycline against the pathogens. It is found that the diameter of the zone of inhibition, ZOI is less than that induced by the n-C_6H_{14} and CH_3CH_2OH extract of both plants. This suggests and justifies the use of these fruits as potent antimicrobial agent in addition to their nutritional status.

CONCLUSION: From this study, it can be concluded that n-C_6H_{14} and CH_3CH_2OH extract of *Solanum melogena* and *Moringa oleifera* possess antibacterial activity as significant zone of inhibition were observed. The area of ZOI ranges from 19.86 mm^2 to 53.55 mm^2. The CH_3CH_2OH extracts showed more potential antimicrobial properties than the n-C_6H_{14} extract. The n-C_6H_{14} and CH_3CH_2OH extract of both plants showed selective antimicrobial activity against the three pathogens: *E. coli*, *S. aureus* and *Klebsiella pneumoniae*. Against, *E. coli* and *S. aureus*, *Moringa oleifera* n-C_6H_{14} is more resistant than *S. melogena*. *Solanum melogena* extract is more resistant against *Klebsiella pneumonia compared to Moringa oleifera* extract. For CH_3CH_2OH extract, against *E. coli* and *Klebsiella pneumoniae*, *Moringa oleifera* extract is more resistant. However, *Solanum melogena* extract is more resistant against *S. aureus*.

REFERENCES:

1. Jagessar R.C and Mohamed N: Antimicrobial activity of selected plants extracts from Guyana's flora, Journal of Pure and Applied Microbiology 2010; 4(2): 533-540.
2. Jagessar RC and Allen R: Antimicrobial Potency of the Aqueous Extract of leaves of *Terminalia catappa*. Academic Research International 2011; 13: 362-371.
3. Jagessar RC, Mars A and Gomathigayam S: Selective Antimicrobial properties of Leaf extract of *Samanea saman* against *Candida albicans*, *Staphylococcus aureus* and *Escherichia coli* using several microbial techniques. Journal of American Science 2011; 7(3): 108-119.

4. Jagessar RC, Mars A and Gomes G: Leaf extract of *Smilax schomburgkiana* exhibit selective antimicrobial properties against pathogenic microorganisms. Life Science Journal 2009; 6(1): 76-83.
5. Jagessar RC, Mars A and Gomes G: Selective antimicrobial properties of *Phylanthus acidus* leaf extract against *Candida albicans*, *Escherichia coli* and *Staphylococcus aureus* using Disk diffusion, Well diffusion, Streak plate and a Dilution method. *Nature and Science* 2008; 6(2): 24-38.
6. Jagessar RC, Mohamed A and Gomes G: Antibacterial and antifungal activity of leaf extracts of *Luffa operculata vs Peltophorum Pterocarpum* against *Candida albicans*, *Staphylococcus aureus* and *Escherichia coli*. Nature and Science 2007; 5(4): 81-93.
7. Jagessar RC, Mohammed A and Gomes G: An evaluation of the antibacterial and antifungal activity of leaf extracts of *Momordica Charantia* against *Candida albicans*, *Staphylococcus aureus* and *Escherichia coli*. Nature and Science 2008; 6(1): 1-14.
8. Wilms LR: Guide to Drugs in Canada. Leo Paper Products, Third Edition 2009.
9. Smith CM and Reynard AM: Textbook of Pharmacology. W.B. Saunders Company, Third Edition 1992, 96-1174.
10. Macor JE. Annual reports in Medicinal Chemistry, sponsored by the Division of Medicinal Chemistry of the American Chemical Society 2008; 43. Elsevier Inc. 3-497.
11. Wood A: Topics in Drug design and discovery, Annual Reports in Medicinal Chemistry, Elsevier Inc. 41: 2008: 353-409.
12. Bonner J: Filling the Antibiotic Gap, Chemistry World, Royal Society of Chemistry 2009; 6 (8): 16.
13. Westh H, Zinn CS, Rosdahl VT.: Sarisa Study Group, An international multicenter study of antimicrobial consumption and resistance in *Staphylococcus aureus* isolates from 15 hospitals in 14 countries. Microbial Drug Resistance 2004; 10: 169-176.
14. Woldemichael GM, Wachter G, Singh, MP, Maiese WM and Timmermann BN: Antibacterial Diterpenes from Calceolaria *pinfolia*. Journal of Natural Products 2003; 66: 242-246.
15. Shen CC, Syu Wan-Jr, Li. Y, Shyh, LH, Chia, L, Gum H, Sun, CM: Antimicrobial Diterpenes, Journal of Natural Products2002; 65: 1857-1862.
16. Fahey JW, Zalcmann AT and Talalay P: The chemical diversity and distribution of glucosinolates and isothiocyanates amongst plants. *Phytochemistry* 2001; 56: 5–51.
17. Bennett RN, Mellon FA, Foidl N, Pratt JH, DuPont MS, Perkins L and Kroon PA, Profiling glucosinolates and phenolics in vegetative and reproductive tissues of the multipurpose trees *Moringa oleifera L* and *Moringa stenopetala L*. Journal of Agriculture and Food Chemistry 51: 3546-3553.
18. Makonnen E, Hunde A and Damecha G.: Hypoglycaemic effect of *Moringa stenopetala* aqueous extract in rabbits. Phytother Res 1997; 11: 147–148.
19. Shen G, Van Kiem P, Cai XF, Li G, Dat NT, Choi YA, Lee YM, Park YK and Kim YH: Solanoflavone, a new biflavonol glycoside from *Solanum melongena*: seeking for anti-inflammatory components, Archives Pharm Research 2005; 28(6): 657-659.
20. Sudheesh S, Sandhya C, Koshy AS and Vijayalakshmi, NR: Antioxidants activity of Flavonoids from *Solanum melongena*, *Phytotherapy research* 1999: 13(5): 393-396.
21. Liu X, Luo, J and Kong L: Phenylethyl cinnamides as potential alpha-glucosidase inhibitors. *Natural product communications* 2011; 6:6: 851-853.
22. Tiwari ARS, Jadon RS, Tiwari P and Nayak S**:** Phytochemical Investigations of Crown of *Solanum melongena* fruit. International Journal of Phytomedicine 2009; 1: 9–11.
23. Murray PR, Baron EJ, Pfaller MA, Tenover, FC, Yolke, RH: Manual of Clinical Microbiology, 6th ed. Mosby Year Book, London 1995.
24. Talaro A and Talaro K,: Foundations in Microbiology, W. C. Brown Publishers, U.S.A 1993.

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