World Journal of Pharmaceutical ReseaRch

Volume 3, Issue 3, 3511-3527. Research Article ISSN 2277 – 7105

# LIPID OF SOME EDIBLE SOLANACEAE SPECIES; AND ITS ACTIVITY AGAINST SOME ANTIBIOTIC RESISTANT PATHOGENIC BACTERIA

***Amer, W. M.[1] and Abdelmohsen G. [2]**

[1]Botany & Microbiology Department, Faculty of Science, Cairo University, Egypt.

[2]Phytochemistry Lab, Applied Research Center for Medicinal Plant (NODCAR).

Article Received on
02 February 2014,

Revised on 10 March 2014,
Accepted on 23 March l2014

***Correspondence for Author**

**Dr. Amer, W. M.**

Botany & Microbiology Department, Faculty of Science, Cairo University, Egypt.

## ABSTRACT

The present study was carried out to investigate the antibacterial activity of four common-edible species from family Solanaceae: namely: *Capsicum frutescens* L., *Lycopersicum esculentum* Mill., *Solanum melongena* L. and *Solanum tuberosum* L. Petroleum ether, chloroform, methanol and water extracts of each plant was tested against antibiotic resistant bacteria. 25 bacterial isolates from 25 hospitalized male and female patients, collected subjected to this study. The studied bacterial 25 isolates were antibiotic resistant bacteria namely: *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*. Different extracts of each plant were tested for its antibacterial activity. The lipid fraction (ether extract) showed the highest antibacterial activity; in all the studied species, this antibacterial active fraction (fatty acids and hydrocarbons) was identified using GC/Mass. Sixteen fatty acids were detected hexadecanoic acid (25.5%) and linolenic acid (23.6%) were the major fatty acids in *Solanum melongena*. Similar fatty acids namely: hexadecanoic acid (35%) and linolenic acid (26%) comprised also the major fatty acids in *Lycopersicum esculentum*. While, fifteen hydrocarbons and two sterol were detected from both species, dodecan-2-one (20%) and Pinane (18%) were the major hydrocarbons in *Solanum melongena*, the two compounds also were the major in *Lycopersicum esculentum* with different percentages (dodecan-2-one 40% and Pinane (25%). This work through light on the potential value of some common edible cultivated plant in Egypt.

**Keywords**: Solanaceae, antibacterial activity, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, GC-Mass.

## INTRODUCTION

The potential of higher plants as source for new drugs is still largely unexplored. Among the estimated 250,000-500,000 plant species, only a small percentage has been investigated phyto-chemically and the fraction submitted to biological or pharmacological screening is even smaller (Mahesh and Satish 2008). Plant materials remain an important resource to combat serious diseases in the world. The traditional medicinal plants still play a vital role to cover the basic health needs in the developing countries. The most important chemical bioactive constituents of plants are alkaloids, tannin, flavonoid and phenolic compounds (Edeoga *et al.*, 2005). Consumers are also seeking natural foods and natural preservatives for healthier lifestyles and natural ways of preventing ailments. So, medicinal plants are also being sought for their medicinal value, as antioxidants and as antimicrobials (Tepsorn, 2009). Solanaceae family is almost worldwide in distribution, however, the majority of genera and species are neotropical.

The antibacterial activity of long-chain unsaturated fatty acids has been well known for many years. Fatty acids function as the key ingredients of antimicrobial food additives which inhibit the growth of unwanted microorganisms (Freese *et al.*, 1973 and Agoramoorthy *et al.*, 2007). Long-chain unsaturated fatty acids are bactericidal to important pathogenic microorganisms, including Methicillin- resistant *Staphylococcus aureus* (Knapp & Melly 1986 and Kabara *et al.*, 1972). The extract *Solanum palinacanthum* Dunal (Solanaceae) activity against *Staphylococcus aureus* (Pereira *et al.*, 2008). Also, *S. torvum* showed activity against *Pseudomonas aeruginosa* and *Staphylococcus aureus* aureus (Wiart *et al.*, 2004). The results indicated significant antibacterial activity of *Solanum xanthocarpum* extracts on *Staphylococcus aureus*, and *Escherichia coli* but no inhibition in case of *Pseudomonas aeruginosa* (Sidambaram *et al.*, 2011).

Solanaceae family according to Cuevas-Arias *et al.*, (2008), comprises 96 genera and almost species are *Solanum* L. (1,000 spp.), *Lycianthes* (Dunal) Hassl. (200 spp.), *Cestrum* L. (175 spp.), *Nicotiana* L. (95 spp.), *Physalis* L. (80 spp.) and *Lycium* L. (75 spp.). Hence, these studies are very important in discovering effective but at low cost antimicrobial compounds. Although antimicrobial activities of genus *Solanum* were studied, there is little information about antimicrobial activity of some of the *Solanum* sp. Among them *Solanum melogena* (Hussein *et al.*, 2010). The methanol and aqueous extracts of leaves of five different medicinal plants, *Solanum nigrum* L., *S. torvum* Sw., *S. trilobatum* L., *S. surattense* Burm.

and S. melongena L. are belonging to Solanaceae family were used for the investigation of antibacterial studies. In antibacterial screening performed by disc diffusion method against two gram negative bacteria namely *Xanthomonas campestris* (plant pathogen) and Aeromonas hydrophila (animal pathogen), it was found that the methanol extracts of all the plant samples showed significant activity against the two tested bacteria (Singh *et al.*, 2003;Cuthbertson and Murchie 2005). The extracts of *Solanum xanthocarpum* showed high sensitivity to Kiebsiella pneumoniae and Salmonella typhi, moderate sensitivity to *Escherichia coli* and less sensitivity and resistant to Bacillus cereus (Udayakumar *et al.*, 2003). While, *Solanum palinacanthum* Dunal, which presented activity against Aeromonas hydrophila, Bacillus subtilis, *Staphylococcus aureus* and Aspergillus ochraceus. *Solanum* palinacanthum is a perennial herb or sub-shrub (Pereira *et al.*, 2008). Family Solanaceae is represented in Egyptian flora with ten genera out of the 94 worldwide genera(Boulos 2002). Two species from the two cultivated genera namely: Capsicum (Capsicum frutescens L.) and Lycopersicum (*Lycopersicum esculentum* Mill.), and two cultivated species from genus *Solanum* which represented in Egypt as both cultivated and wild species, these species are: *Solanum melongena* L. and *Solanum* tuberosum L. will be subjected to phytochemical screening. The bioactive fraction against a collection of antibiotic resistant bacteria will be carried out. This study aimed to utilize the common Egyptian genetic resources to obtain cheap antimicrobial drugs.

## MATERIAL AND METHODS

### 1- Plant material and extraction

Fresh plant material of *Solanum melongena* L., *Solanum* tuberosum L., *Lycopersicum esculentum* Mill. and Capsicum frutescens L. (Family: Solanaceae) was collected from Cairo University Experimental Farm. Leafy branches of each plant were air-dried in shade, and then subjected to drying oven at 40°C to constant weight. The dried material was powdered and kept in plastic bags, and subjected later to extraction. Fifty grams of air-dried powder of each plant material was extracted successively using the following solvents: petroleum ether, chloroform, methanol and water by using a soxhlet extractor until colorless extract obtained on the top of the extractor. Extracts of each solvent were concentrated under reduced pressure using rotary evaporator and dissolved in dimethyl sulfoxide (DMSO), and then subjected to antimicrobial activity assay according to Thippeswamy *et al.*, (2011).

**Table 1: The studied plant material**.

| Latin name | English name | Arabic name |
|---|---|---|
| Capsicum frutescens L. | Parprika, Cayenne pepper, Red pepper, Chilli | Felfel shata |
| *Lycopersicum esculentum* Mill. | Tomato, Love apple | Tamatem |
| *Solanum* melnongena L. | Egg plant, Brinjial, Aubergine, Jew's apple, Mad apple, Bettingan | Bazengan |
| *Solanum* tuberosum L. | Potato, Irish potato | Batates |

**2- Bacterial isolates and their susceptibility to antibiotics**

Three antibiotic resistant bacterial species were selected to carry out this work due to their health problem namely: (1) *Pseudomonas aeruginosa* is a leading cause of nosocomial infections and is responsible for 10% of all hospital-acquired infections (Morrison *et al.*, 1984 and NNISS 1992). (2) *Escherichia coli* "O157:H7" was first recognized in 1982, about 3,000 cases may develop hemolytic uremic syndrome annually. Surveillance data indicate that the highest incidence of illness from E. coli "O157:H7" occurs in children under 5 years of age (CDC 1999a). And (3) *Staphylococcus aureus* is common disease in both domestic and wild rabbits (Flatt 1974). In Egypt, the effect of S. aureus in rabbits was studies by Abdel-Gwad *et al.*, (2004).

A total of 25 isolates of *Staphylococcus aureus*, *Escherichia coli* and Pseudomonas aeurginosa from different human clinical sources (5 from pus, 3 from throat swab, 4 from blood, 4 from urine, 2 from vaginal swab, 2 from stool, 2 from drainage, 3 from sputum ) were collected from the bacteriology lab of Ain-Shams University Hospitals (Ain-Shams) between Augusts – October 2010. The used reference bacterial strains were: *Staphylococcus aureus* ATCC 29737, Esherichia coli ATCC 25922 and *Pseudomonas aeruginosa* ATTC 27853. The test organisms were sub-cultured at 37°C and maintained on nutrient agar media.

The bacterial isolates were tested for its bacterial resistance using disk diffusion method. Antibiotic disks (Oxoid) used were cefaclor (30 µg), tobramycin (10 µg), chloramphenicol (30 µg), erythromycin (15 µg), levofloxacin (5 µg), ciprofloxacin (5 µg), cefadroxil (30 µg) and sulphamthazole trimethoprim (25 µg). The diameters of inhibition zones were measured. Zones of inhibition were determined according to CLSI M100-S18 (2008), isolates were categorized as susceptible and resistant while intermediate were considered as resistant. The experiment was done three times and the mean values were presented.

**Table 2: The used antibiotics and its references inhibition zones.**

| Antibiotic Class | Antibiotic Name | Symbol | Disc Conc. | Diameter of the inhibition zone in millimeter (mm) | | |
|---|---|---|---|---|---|---|
| | | | | Resistant (R) = or < | Intermediate (I) From- To | Sensitive (S) = or › |
| Amino glycosides | Tobramycin | TOB | 10 µg | 12 | 13-14 | 15 |
| Cephalosporin's | Cefadroxile | CRF | 30 µg | 14 | 15-17 | 18 |
| Macrolides | Erythromycin | E | 15 µg | 15 | 16-20 | 21 |
| Quinolones | Ciprofloxacin | CiP | 5 µg | 15 | 16-20 | 21 |
| | Levofloxacin | Levo | 5 µg | 13 | 14-16 | 17 |
| Sulfonamides | Sulfamethazol Trimethoprime | SXT | 10 µg | 10 | 11-15 | 16 |
| B- lactams | Cefaclor | CEC | 30 µg | 14 | 15-17 | 18 |
| Miscellineous | Chloramphenicol | C | 30 µg | 17 | 18-20 | 21 |

**3- Antibacterial activity**

Petri plates containing 20 ml of Muller Hinton agar medium were seeded with a 24 h culture of the bacterial strains. Wells of 6mm diameter each were cut into the agar; to each well 50 µl (concentration of 100 mg/ml) of the investigated plant extracts were tested added. The inocula size was adjusted so as to deliver final inocula of approximately 108 colony-forming units (CFU)/ml. Incubation was performed at 37°C for 24 h. The assessment of antibacterial activity was based on measurement of the diameter of the inhibition zone around the wells after 24 h.

**4- Preparation and identification of the lipids material**

**A- Separation of unsaponifiable lipid fraction**

The extracted lipids (Petroleum ether extracts) of each plant were saponified with alcoholic potassium hydroxide by dissolving about five grams of lipid from each plant in 480ml ethanol. This ethanolic solution was mixed with solution of 40 gram of potassium hydroxide in 100 ml distilled water and the mixture was refluxed for about three hours. The solution was concentrated to two third of its volume, excess water was added and the soap solution was shaken in a separating funnel for several times with fresh portion of peroxide free ether until complete extraction was obtained. The combined ether extracts were washed with water until free from alkalinity as indicating by litmus paper, dried over anhydrous sodium sulfate then filtered. The filtrate was evaporated to dryness under vacuum. Weigh the residue and

this represents the quality of hydrocarbons and sterols obtained and this converted to the methyl ester with ethereal diazomethane as following: Methyl esters were obtained by trans-methylation of the lipids by refluxing them for 90 min with methanol – benzene – sulfuric acid (20:10:1) according to Harborne (1973) and Vogel's (2000) the solution was concentrated to two third of its volume, excess water was added for washings until free from acidity as indicating by litmus paper, dried over anhydrous sodium sulfate and filtered, the filtrate was subjected to analysis using GC/Mass.

**B- Separation of saponifiable lipid fraction**

After removal of unsaponifiable fraction with ether, soapy solution was converted into the corresponding free fatty acid by means of 2.5% sulfuric acid, and the librated free fatty acids were extracted with ether. The ether extract was washed several times with distilled water until free from acids. The ether extract was dried over anhydrous $Na_2SO_4$ and filtered, followed by distillation and the last traces of ether were removed under vacuum at 60 °C, and kept in desiccators. Weigh the residue and this represents the quality of fatty acids obtained and this converted to the corresponding methyl ester which was analyzed by GC/Mass.

**GC/Mass of unsaponifiable and saponifiable fractions (Eaton 1989)**

The investigation carried out by GC/Mass (HP5890), oven program (initial temp: 50 °C, initial time: 2 min, rate 1: 10°C/min, final temp.: 200, final time: 5min), injection temp. : 220, injection volume 1µl, injection mode: splitless, carrier gas: N.gas and Detector temps: 300 °C.

**RESULTS**

The studied 25 isolates, 6 were Gram positive which is *Staphylococcus aureus* and 19 were Gram negative (14 isolates were *Escherichia coli* and 5 isolates were *Pseudomonas aeruginosa*). Isolates that were gram stained gram positive cocci, catalase positive, coagulase positive, and fermenting mannitol on mannitol salt agar medium were identified as *Staphylococcus aureus* (Bergey's Manual of Systematic Bacteriology 1989). Isolates that were gram stained gram negative bacilli, indole positive, oxidase negative, and fermenting lactose on MacConkey agar media were identified as E. coli (York *et al.*, 2000), Isolates that were gram stained gram negative bacilli, oxidase positive, indole negative, and producing yellow-green fluorescent colony under ultraviolet light on Pseudomonas media were identified as Ps. aeruginosa (King *et al.*, 1954). These studied bacterial isolates were tested for its susceptibility to different antibiotics using disk diffusion method. The results presented

in Table (3), indicating that these bacterial isolates are antibiotic resistant to the studied antimicrobial agents as shown in Table (2) namely: Cefaclor, Tobramycin, Chloromphenicol, Erythromycin, Sulphamthazole trimethoprim, Levofloxacin, Ciprofoxacin and Cefadroxil.

**Table (3): Susceptibility test of 6 *Staphylococcus aureus,* 14 Escherichia coli and 6 *Pseudomonas aeruginosa* to standard antibiotics (R= Resistant, S= Sensitive and I= Intermediate)**.

| Antibiotics | CRF | C | E | TOB | SXT | LEV | CIP | CEC |
|---|---|---|---|---|---|---|---|---|
| St. 1 | R | R | R | R | S | R | R | R |
| St. 2 | R | R | R | S | S | I | R | R |
| St. 3 | R | R | R | R | S | R | R | R |
| St. 4 | R | S | R | R | S | R | R | R |
| St. 5 | R | S | R | R | S | R | R | R |
| St. 6 | R | S | R | R | S | S | R | R |
| Ps. 1 | R | R | R | S | R | S | S | R |
| Ps. 2 | R | R | R | R | R | R | S | R |
| Ps. 3 | R | R | R | R | R | R | R | R |
| Ps. 4 | R | R | R | R | R | R | R | R |
| Ps. 5 | R | R | R | R | R | S | S | R |
| E. coli. 1 | R | R | R | R | R | R | R | R |
| E. coli. 2 | R | S | R | R | S | R | R | R |
| E. coli. 3 | R | S | R | S | R | R | R | R |
| E. coli. 4 | R | S | R | R | R | R | R | R |
| E. coli. 5 | R | I | R | R | R | R | R | R |
| E. coli. 6 | R | R | R | S | I | R | R | R |
| E. coli. 7 | R | S | R | R | R | R | R | R |
| E. coli. 8 | R | S | R | R | R | R | R | R |
| E. coli. 9 | R | I | R | R | R | R | R | R |
| E. coli. 10 | R | S | R | R | R | R | R | R |
| E. coli. 11 | R | I | R | R | I | R | I | R |
| E. coli. 12 | R | R | R | R | R | R | R | R |
| E. coli. 13 | R | R | R | R | R | R | R | R |
| E. coli. 14 | R | R | R | R | S | S | R | S |

For the antibiotics abbreviations see Table (2); St: *Staphylococcus aureus*; E. coli: *Escherichia coli* and Ps.: *Pseudomonas aeruginosa*

Extracts of studied plants (ether, chloroform, methanol and water) were screened for their antimicrobial activity against 25 bacterial isolates and the results are presented in Table (4). On application of the ether extract, the inhibition zone ranged from 49mm to 20mm (Table 4). The highest inhibition zone was *Solanum melongena* and *Lycopersicum esculentum.*

The studied antibiotic resistant bacteria showed different responses to the studied ether extracts. *Staphylococcus aureus* showed the highest susceptibility followed by *Escherichia coli* while the *Pseudomonas aeruginosa* was the lowest as shown in Table (4). The results showed that *Lycopersicum esculentum* Mill. and *Solanum melongena* L. revealed the highest inhibition , followed by Capsicum frutescens L. and *Solanum* tuberosum L. both species showed the lower inhibition compared to the two earlier mentioned species (Table 4). The retrieved data denoting that the inhibition zone in case of chloroform extracts are lower than that of ether extract, it ranged from 20 mm to zero mm as shown in (Table 4). Accordingly the ether extracts of the *Lycopersicum esculentum* Mill. and *Solanum melongena* L. were subjected to GC-Mass investigations.

**Table (4): Inhibition zone (in mm) of the ether and chloroform (between brackets) extracts of the studied plants against the studied 25 bacterial isolates, (St=*Staphylococcus aureus*, E.coli= *Escherichia coli* and Ps= *Pseudomonas aeruginosa*).**

| Bacterial isolates | Studied Species | | | |
|---|---|---|---|---|
| | Capsicum frutescens L. | *Lycopersicum esculentum* Mill. | *Solanum* | |
| | | | melongena | tuberosum |
| St. 1 | 28 (15) | 45 (13) | 49 (13) | 29 (13) |
| St. 2 | 27 (13) | 34 (12) | 30 (11) | 27 (13) |
| St. 3 | 20 (20) | 40 (12) | 35 (15) | 20 (14) |
| St. 4 | 20 (20) | 30 (13) | 35 (15) | 20 (13) |
| St. 5 | 25 (12) | 35 (12) | 36 (18) | 29 (12) |
| St. 6 | 29 (16) | 35 (13) | 40 (12) | 28 (16) |
| E. coli 1 | 29 (-) | 45 ( - ) | 32 (- ) | 29 (- ) |
| E. coli 2 | 25 (12) | 30 (12) | 35 (13) | 28 (15) |
| E. coli 3 | 28 (-) | 40 ( - ) | 40 (15) | 24 (15) |
| E. coli 4 | 24 (13) | 40 (13) | 36 (17) | 25 (15) |
| E. coli 5 | 25 (-) | 35 ( - ) | 35 (25) | 26 (12) |
| E. coli 6 | 25 (11) | 30 ( -) | 30 ( - ) | 22 (- ) |
| E. coli 7 | 25 (-) | 25 ( - ) | 30 ( - ) | 25 (- ) |
| E. coli 8 | 20 (12) | 30 (15) | 40 (20) | 25 (13) |
| E. coli 9 | 28 (11) | 35 (16) | 40 (17) | 27 (14) |
| E. coli 10 | 27 (-) | 40 ( - ) | 40 (- ) | 29 ( - ) |
| E. coli 11 | 29 (-) | 40 ( -) | 40 ( - ) | 29 ( 18 ) |
| E. coli 12 | 28 (-) | 40 ( - ) | 30 ( - ) | 25 ( - ) |
| E. coli 13 | 20 (-) | 30 ( -) | 40 (- ) | 28 ( - ) |
| E. coli 14 | 28 (11) | 35 (15) | 30 (13) | 24 (12 ) |
| Ps. 1 | 24 (15) | 29 (16) | 30 (16) | 24 (15) |
| Ps. 2 | 21(-) | 30 (-) | 30 ( - ) | 24 ( - ) |
| Ps. 3 | 24 (16) | 29 (16) | 30 (14) | 23 (14) |
| Ps. 4 | 20 (15) | 29 ( 0) | 30 (19) | 25 (20) |
| Ps. 5 | 21 (14) | 26 (16) | 28 (15) | 24 (14) |

(-) = No inhibition detected

**GC/Mass results**

**i- Fatty acids**

The ether extracts of the *Lycopersicum esculentum* and *Solanum melongena* which showed higher antibacterial effect (Table 4), were applied to GC-Mass. The resulted are outlined in Table (5). Sixteen fatty acids were detected hexadecanoic acid (25.5%) and linolenic acid (23.6%) were the major fatty acids in S. melongena as shown in total ionic chromatogram Figure (1) and the fragmentation pattern against the authentic samples are outlined in Figures (3 & 4); respectively. Similar fatty acids namely: hexadecanoic acid (35%) and linolenic acid (26%) comprised the major fatty acids in *Lycopersicum esculentum* as shown in total ionic chromatogram Figure (2) and the fragmentation pattern against the authentic samples are outlined in Figures (3 & 4); respectively.

**Table (5): Fatty acids detected and identified by GC- Mass**

| Compounds | Rt. | *Solanum* melnongena | *Lycopersicum esculentum* |
|---|---|---|---|
| 1. Nonanoic acid | 9.5 | 0.3 % | 0.0 |
| 2. Decanoic acid | 10.8 | 0.4 % | 0.0 |
| 3. Permetrinic acid | 12.5 | 0.4 % | 0.0 |
| 4. Lauric acid | 13.2 | 1.4 % | 0.0 |
| 5. Tetradecanoic acid | 15.5 | 5.3 % | 0.0 |
| 6. Pentadecanoic acid | 16.4 | 4.0 % | 0.0 |
| 7. Palmitic acid | 17.5 | 0.0 | 15.0 % |
| 8. Decanedioic acid | 17.6 | 0.0 | 3.0 % |
| 9. 7- hexadecanoic acid | 17.9 | 2.3 % | 0.0 |
| 10. hexadecanoic acid | 18.0 | 25.5 % | 35.0 % |
| 11. 7,10,13-hexadecatrienoic acid | 18.8 | 6.7 % | 0.0 |
| 12. Stearic acid | 20.0 | 12.0 % | 5.0 % |
| 13. 9,12-Octadecadienoic acid | 21.0 | 0.5 % | 16.0 % |
| 14. Cis-linoleic acid | 22.0 | 15.6 % | 0.0 |
| 15. Linolenic acid | 22.3 | 23.6 % | 26.0 % |
| 16. Eicosanoic acid | 23.5 | 2.0 % | 0.0 |

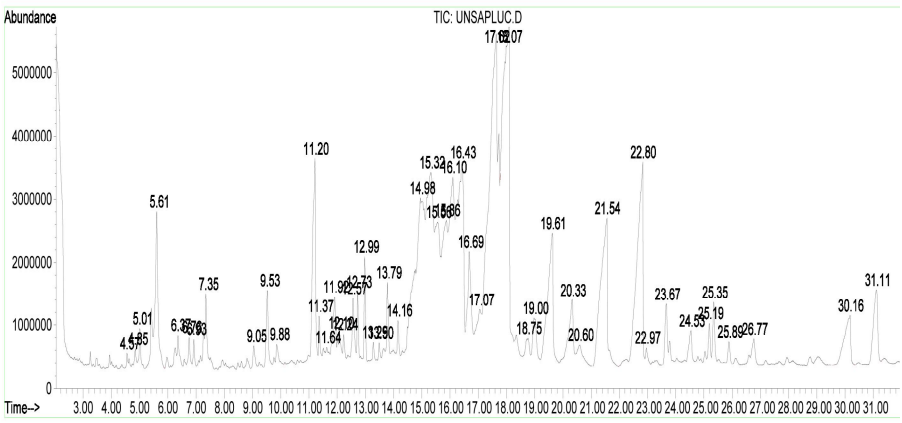


**Figure (1): Total Ionic Chromatogram (TIC) of S. melongena fatty acids identified by GC/Mass.**

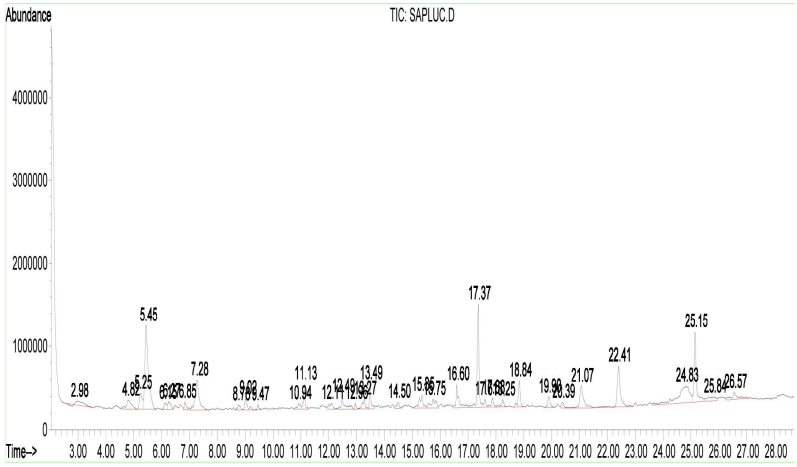


**Figure (2): Toltal Ionic Chromatogram (TIC) of *Lycopersicum esculentum* fatty acids identified by GC/Mass.**

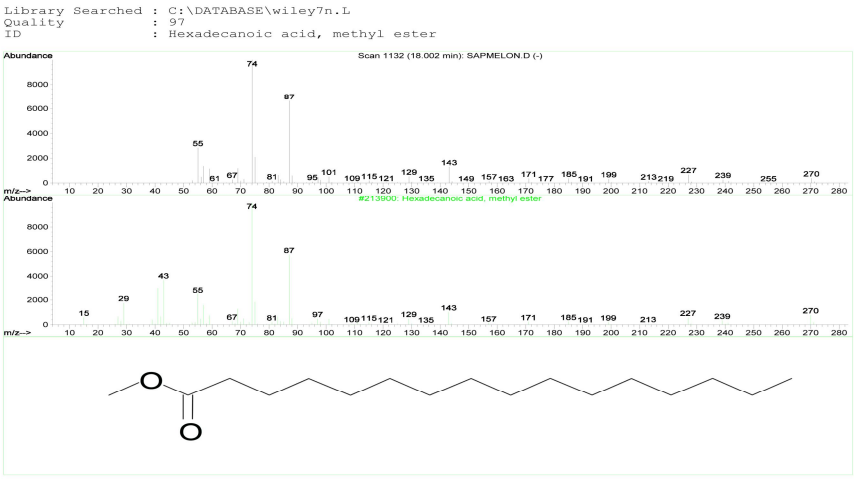


**Figure (3):Fragmentation pattern of hexadecanoic acid using GC/Mass.**

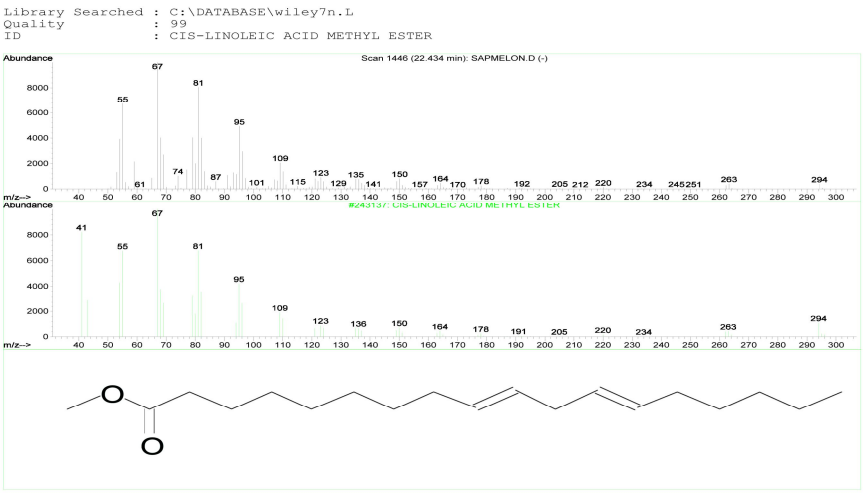


**Figure (4): Fragmentation pattern of Linolenic acid using GC/Mass.**

### ii- Hydrocarbon and sterol

The unsaponified lipid fraction extracted from studied species were applied to GC/Mass, the total number identified compounds in both species are fifteen hydrocarbons and two sterol (Table 6). the total Ionic Chromatogram (TIC) of S. melongena hydrocarbon and sterols identified by GC/Mass is shown in Figure (5). Dodecan-2-one (20%) and Pinane (18%) were the major hydrocarbons in *Solanum melongena*, the two compounds also were the major in *Lycopersicum esculentum* with different percentages (dodecan-2-one 40% and Pinane (25%). In addition to two sterols: 10-Demethyl Sqalene (2.5%) and 24-Beta-Ethyl -5-Delta-Cholesten-3-Beta-ol (6%) were identified only in *Solanum melongena* as shown in Table (6). The fragmentation patterns of Pinane and Dodoecan-2-one against the authentic compounds are outlined in Figure 6 and 7; respectively).

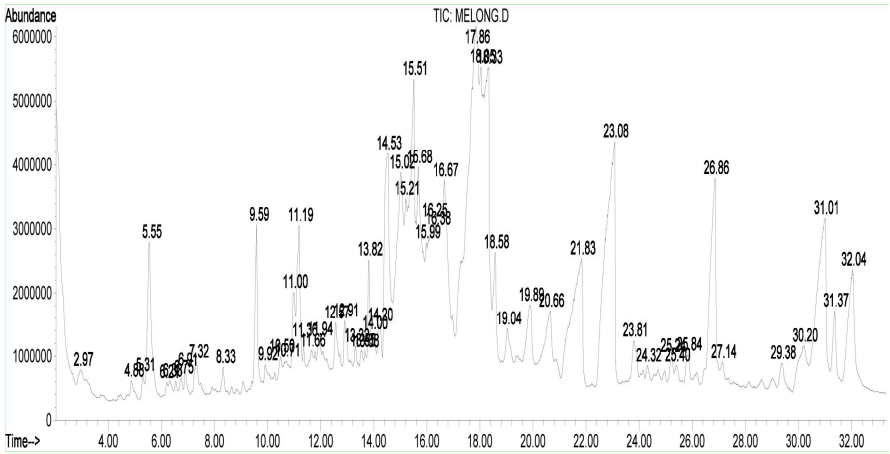


**Figure (5): Total Ionic Chromatogram (TIC) of S. melongena hydrocarbon and sterols identified by GC/Mass.**

**Table (6): Hydrocarbon and sterol detected and identified by GC- Mass.**

| Compounds | Rt. | *Solanum* melnongena | *Lycopersicum esculentum* |
|---|---|---|---|
| 1. Methyl tetradecanoate | 10.2 | 3.0 % | 0.0 |
| 2. Octadecane | 10.99 | 1.8 % | 0.0 |
| 3. Pinane | 11.4 | 18.0 % | 25.0 % |
| 4. 6,10,14-Trimethyl-2 pentadecanone | 11.5 | 7.0 % | 0.0 |
| 5. 3-Eicosyne | 11.6 | 0.0 | 8.0 % |
| 6. Dodecan-2-one | 11.7 | 20.0 % | 40.0 % |
| 7. Dotriacontane | 18.0 | 0.3 % | 0.0 |
| 8. n-Docosane | 18.7 | 2.4 % | 0.0 |
| 9. 10-Demethyl Sqalene (Sterol) | 19.7 | 2.5 % | 0.0 |
| 10. Hexadecane | 21.7 | 0.0 | 19.0 % |
| 11. 2 methyl- Tricosane | 22.4 | 4.0 % | 0.0 |
| 12. n-Eicosane | 23.4 | 5.0 % | 0.0 |
| 13. Tetratriacontane | 23.8 | 0.0 | 8.0 % |
| 14. Docosane | 23.9 | 15.0 % | 0.0 |
| 15. 24-Beta -Ethyl -5-Delta-Cholesten-3-Beta-ol (Sterol) | 24.5 | 6.0 % | 0.0 |
| 16. Tridecane | 24.9 | 9.0 % | 0.0 |
| 17. n-Heneicosane | 26.9 | 6.0 % | 0.0 |

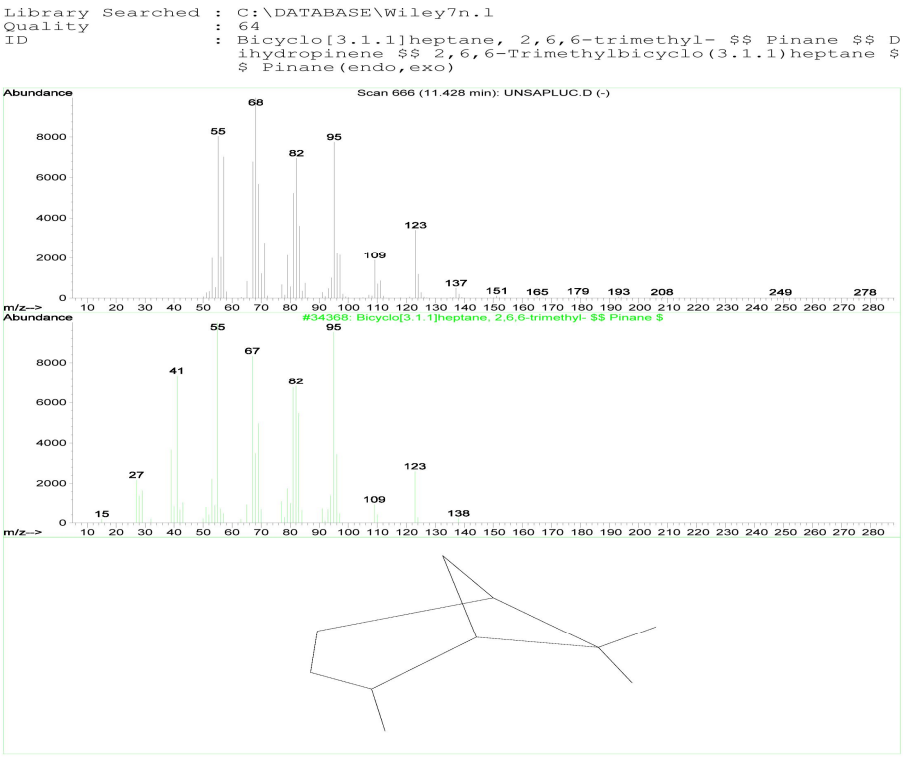


**Figure (6): Fragmentation pattern of Pinane using GC/Mass.**

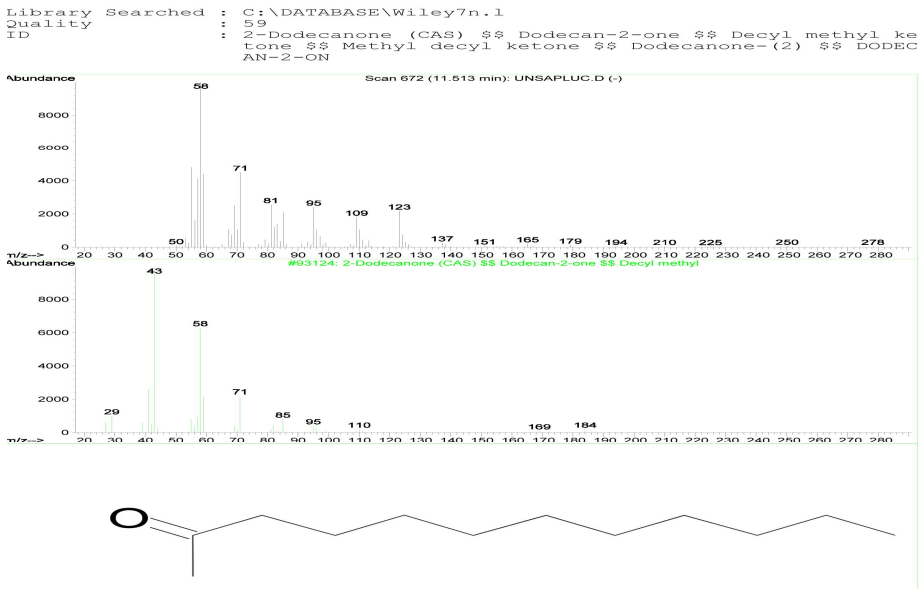


**Figure (7): Fragmentation pattern of Dodecan-2-one using GC/Mass.**

## DISCUSSION

The studied lipid material (fatty acids and hydrocarbons), extracted from the foliar parts of both of *Solanum melongena* and Lycopersicum esculentum showed antibacterial effect against 25 bacterial isolates of antibiotic resistant strains identified as: *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa* (Table 3). This result was supported by Bhattacharjee *et al.* (2005), who claimed that the fatty acids of *Cestrum* diurnum (Solanceae) with its main constituents as Palmitic, Stearic and Oleic showed antibacterial activity against the pathogenic strains of *Staphylococcus aureus*, Bacillus subtilis, Esherichia coli and Pseudomonus aeruginosa. The retrieved data in this study was supported by similar data obtained from the lipid material of the wild *Solanum* elaeagnifolium (Amer *et al.*, 2013). Also, similar data reported from *Solanum* torvum by Wiart *et al.* (2004); and *Solanum* trilobatum (Doss *et al.*, 2009); against the same studied antibiotic resistant bacteria namely: *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. On the other hand, *Solanum xanthocarpum* showed activity against the same bacterial types except Pseudomonus aeruginosa (Sidamburam *et al.*, 2011). Also, *Staphylococcus aureus* was inhibited by *Solanum* palincanthum extracts (Pereira *et al.*, 2008).

Two fatty acids out of the identified sixteen fatty acids from both of the studied species (*Solanum melongena* and Lycopersicum esculentum), showed higher percentages as follows: hexadecanoic acid (25.5%) and linolenic acid (23.6%) in S. melongena, the similar fatty acids were detected in *Lycopersicum esculentum* with 35% and 26%; respectively

(Table 5). The antibacterial activity of these species against the studied bacterial isolates may be attributed to the biological activity of the long chain fatty acids. The idea was established by Zhenga *et al.* (2005), who mentioned that antibacterial actions of fatty acids are usually attributed to long-chain unsaturated fatty acids including oleic acid, linoleic acid, and linolenic acid. On the other hand, McGaw *et al.*, (2002) and Seidel & Taylor (2004) reported that Lauric, palmitic, linolenic, linoleic, oleic, stearic and myristic acids are known to have potential antibacterial and antifungal agents.

However, this study showed that the methanol and water extracts of the studies *Solanum melongena* and Lycopersicum esculentum had a negative effect on the studied bacteria. The earlier work of Gandhiappan & Rengasamy (2012), reported that the methanolic extract of leaves from 6 *Solanum* species (S. anguivi, S. *nigrum*, S. pubescens, S. surratense, S. torvum, S. Swartz, S. trilobatum) showed moderate activity against human pathogenic bacteria such as *Staphylococcus aureus* MTCC 96, Micoccus luteus ATCC 4698, Vibro cholerae ATCC 14035 and Klebsiella pneumoniae MTCC 109. Also, De Britto *et al.*, (2011) reported that often, the methanol extract of some *Solanum* species showed high antibacterial activity, and significant antibacterial activity of methanol extracts of S. surattense; followed by S. *nigrum* then *S. torvum* against Xanthomonas campestries (plant pathogen) were observed. Also, Parameswari *et al.*, (2012) mentioned that the methanolic extracts of *Solanum nigrum* showed highest antibacterial activity (against Bacillius subtilis, *Escherichia coli*, Klebsiella pneumoniae and Pseudomonus aeruginosa), compared to ethanol extract.

This study recommend that we can use the leafy part of the common edible fruit Solancaeae species (*Solanum melongena* and Lycopersicum esculentum) to treat antibiotics resistant pathogenic bacteria as *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*.

**REFERENCES**

1. Abdel-Gawad A.M., Abdel-Rahman A.A. and Ali M.M. (2004). Significance of *Staphylococcus aureus* in rabbits in Assiut governorate. Ass. Univ. Bull. Environ. Res. 7(1): 77-84.
2. Agoramoorthy G., Chandrasekaran M., Venkatesalu V. and Hsu M.J. (2007). Antibacterial and antifungal activities of fatty acids methyl ester of blind-your-eye mangrove from India. Brazilian Journal of Microbiology, 38: 739-742.

3. Amer, W. M.; Abouwarda, A.M.; El Garf; I. A.; Dawoud, T. M. and Abd Elmohsen, G. (2013). *Solanum* elaeagnifolium Cav. And its antimicrobial activity. International Journal of Biology, Pharmacy and Allied sciences. 2013, 2(6): 1282-1306.
4. Bergey's Manual of Systematic Bacteriology (1989). Williams ST, Sharpe ME, Holt JG (editors). The Williams and Wilkins Co. Baltimore. Vol. 4. Pp 399.
5. Bhattacharjee I., Ghosh A. and Chandra G. (2005), Antimicrobial activity of the essential oil of *Cestrum* diurnum (L.) (Solanales: Solanaceae), African Journal of Biotechnology 4(4): 371-374.
6. Boulos L. (2002). Flora of Egypt 3: verbenaceae- compositeae: vol. 3, Pp.373; Al Hadara publishing co., Cairo – Egypt.
7. CLSI: Clinical and Laboratory Standards Institute (2008). Performance standards for antimicrobial susceptibility testing; 18th Informational Supplement; Wayne, Pennsylvania. CLSI Document M100- S18.
8. Cuevas-Arias C.T., Vargas O. and Rodríguez A. (2008). Solanaceae diversity in the state jalisco, Mexico, Revista Mexicana de biodiversidad, 79: 67-79.
9. Cuthbertson A.G.S and Murchie A.K. (2005). Economic spray thresholds in need of revision in Northern Irish Bramley orchards. Biological News, 32: 19.
10. De Britto A.J., Gracelin D.H.S. and kumar P.B.J.R., (2011). Antimicrobial Activity of a few medicinal plants against gram negative bacteria, International Journal of Applied Biology and Pharmaceutical Technology, 2: 457-461.
11. Doss A., Mubarack M.H. and Dhanabalan R., (2009) Antibacterial activity of tannins from the leaves of *Solanum* trilobatum Linn., Indian Journal of Science and Technology, 2 :41:43.
12. Edeoga H.O., Okwu D.E. and Mbaebie B.O. (2005). Phytochemical constituents of some Nigerian medicinal plants. Afr. J. Biotech., 4: 685-688.
13. Flatt R.E. (1974). The biology of the laboratory rabbit. Eds. Weisbroth, S.H.Flatt, R.E. and Kraus, NewYo
14. Freese E., Shew C.W. and Galliers E. (1973). Function of lipophilic acids as antimicrobial food additives. Nature, 241: 321– 325.
15. Gandhiappan J. and Rengasamy R. (2012), Comparative Evaluation of Antimicrobial Activities of the Members of Solanaceae, Pelagia Research Library Der Pharmacia Sinica, 3 (3): 357-360.
16. Harbone J.B. (1984). Phytochemical method. Published in USA by Chapman and Hall, London, New York. P. 735.

17. Hussein A.A., AL-Janabi S. and AL-Rubeey S.A.H., (2010). Detection of Antimicrobial Activity of *Solanum melogena* L. (Egg plant) Against Pathogenic Microorganisms, Pharmacognosy Journal, 2: 35- 39.
18. Kabara J.J., Swieczkowski D.M., Conley A.J. and Truant J.P. (1972) Fatty acids and derivatives as antimicrobial agents. Antimicrob. Agents Chemother, 2: 23–28.
19. King E.O., Ward M.K., and Raney D.E. (1954). Two simple media for the demonstration of pyocyanin and fluorescein. J. Lab. Clin. Med. 44:301.
20. Knapp H.R. and Melly M.A. (1986). Bactericidal effects of polyunsaturated fatty acids. J. Infect. Dis. 154: 84–94.
21. Mahesh B. and Satish S. (2008). Antimicrobial activity of some important medicinal plants against plant and human pathogens. World J. Agric. Sci., 4: 839-843
22. McGaw L.J., Jäger A.K. and Van-Staden, J. (2002). Isolation of antibacterial fatty acids from Schotia brachypetala. Fitoter., 73: 431-433.
23. Morrison A.J.Jr. and Wenzel R.P. (1984). Epidemiology of infection due to *Pseudomonas aeruginosa*. Rev. Infect. Dis. 6(Suppl. 3): 627–642.
24. NNISS: National Nosocomial Infection Surveillance System (1992). System report, data summary from January through June 2004. Am. J. Infect. Control 32: 470–485.
25. Parameswari K., Aluru S. and Kishori B. (2012). In vitro antibacterial activity in the extracts of *Solanum nigrum*. Indian Streams Research Journal, 2:1- 4.
26. Pereira A.C., Oliveira D.F., Silva G.H., Figueiredo H.C.P., Cavalheiro A.J., Carvalho D.A., Souza L.P. and Chalfoun S.M. (2008). Identification of the antimicrobial substances produced by *Solanum palinacanthum* (Solanaceae), Annals of the Brazilian Academy of Sciences, 80 (3):427-432.
27. Seidel V. and Taylor P.W. (2004). In vitro activity of extracts and constituents of Pelagonium against rapidly growing mycobacteria. Int. J. Antimicrob. Agen., 23: 613-619.
28. Sidambaram R.R., Dinesh M.G., Jayalakshmi E.T., Subair S. and Chandrasekaram K. (2011). Antibacterial, Antifungal and Cytotoxic Studies on leaf and seed extracts of *Solanum xanthocarpum* SHRAD AND WENDL, International Journal of Phytopharmacology. 2(2): 61-65.
29. Singh H.P., Batish D.R. and Kohli R.K. (2003). Allelopathic interactions and alleloc-hemicals: New possibilities for sustainable weed management. Cri. Rev. Plant Science, 22: 239-311.

30. Tepsorn R. (2009). Antimicrobial Activity of Thai Traditional Medicinal Plants Extract Incorporated Alginate-Tapioca Starch Based Edible Films against Food Related Bacteria Including Foodborne Pathogens. Food Science and Technology Pattani, Thailand Hohenheim, P. 357.
31. Thippeswamy S., Praveen P., Mohana D.C. and Manlunath K. (2011). Antimicrobial evaluation and phytochemical analysis of a known medicinal plant Samanea saman (JACQ.) Merr. Against Some human and pathogenic bacteria and fungi, Int. J. Pharma and Bio Sci., 2: 443-452.
32. Udayakumar R., Velmurugan K., Srinivasan D. and Ramkrishna R. (2003). Phytochemical and Antimicrobial Studies of extracts of *Solanum xanthocarpum*, Ancient Science of Life XXIII (2): 1-5.
33. Vogel's (2000). Textbook of quantitative chemical analysis. Published by pearson Education (Sinapore) pte. Ltd. Indian Branch, 482 F.I.E patpargani, Delhi 110092, India.
34. Wiart C., Mogana S., Khalifah S., Mahan M., Ismail S., Buckle M., Narayana A.K. and Sulaiman M., (2004). Antimicrobial screening of plants used for traditional medicine in the state of Perak, Peninsular Malaysia. Fitoterapia, 75: 68–73.
35. York M.K., Baron E.J., Clarridge J.E., Thomson R.B. and Weinstein M.P. (2000). Multilaboratory validation of rapid spot tests for identification of *Escherichia coli*. J. Clin. Microbiol., 38: 3394-3398.
36. Zhenga C.J., Yooa J., Leeb T., Choc H., Kimd Y. and Kima W. (2005). Fatty acid synthesis is a target for antibacterial activity of unsaturated fatty acids. FEBS Letters 57