A study of phytochemical screening and antibacterial effect of some methanolic plant extracts on *Pseudomonas aeruginosa*

Khoulood A. Hemida¹*, Shimaa Khalid¹, Abdelkarim Mohammed Abdelatif², and Amany M. Reyad¹

¹Botany Department, Faculty of Science, Fayoum University
²Zoology Department, Faculty of Science, Fayoum University

ABSTRACT:

Resistance of the different bacterial strains to conventional antibiotics was noticed, and the need of solutions to come over this problem turn into find natural sources. The efficacy of methanol extracts of different plants is noticed as a powerful way to solve this problem. *Lantana camara, Eucalyptus* sp, *Mentha* sp, *Mangifera indica* leaves were chosen as trails. Efficacy of methanol extracts of *Lantana, Eucalyptus, Mentha, Mangifera* leaves were assessed against pathogenic multi-drug resistant *Pseudomonas aeruginosa*. The resistance of the bacterial strain was screened for all used conventional antibiotics. The extracts from the investigated leaves have been studied for their antimicrobial and antioxidant effects. The disc diffusion method was used for determining the minimum inhibitory concentration (MIC) and the antimicrobial activity. The same MIC (12.5 mg/mL) was recorded for Eucalyptus and Mentha, while MICs were 3.125, 6.25 mg/mL for *Lantana* and *Mangifera*, respectively. Chemical composition of each extract was evaluated using GC-MS giving; hexadecanol as the major compound (15.13%) for *Lantana*, eucalyptol was identified as the major compound (21.41%) for *Eucalyptus*, 2-methyl-5-phenyl Cyclohexen-1-one was identified as the main compound (14.31%) for *Mentha*, and chloroform was identified as the major compound (7.67%) for *Mangifera*. The total phenols, DPPH scavenging activity, and reducing power were estimated under spectrophotometric conditions and supported our GC-MS findings. In this article, different plant leaves extracts act as powerful antibacterial agents, and the MICs values were significantly low against the tested bacterial pathogen.

KEY WORDS: Plant extracts, Antimicrobial, GC-MS.

*Corresponding author Email: kah00@fayoum.edu.eg
Received:27./10./2023 - Accepted: 10./12./2023 - Published:18/2/2024
1. INTRODUCTION:

The pathogenic bacterium *Pseudomonas aeruginosa* is an opportunistic Gram-negative bacterium. It can result in a variety of acute and chronic infections that have the potential to be fatal. Immune system-compromised patients are more likely to contract it. (Ahmed et al., 2019). According to (Alotaibi et al., 2022), it is among the most prevalent nosocomial pathogenic bacteria that infect hospitalized patients. *P. aeruginosa* is a common microbe that can infect patients with immunological deficiencies, burns, cystic fibrosis, and the complication of abnormal neutrophil reduction (Reynolds and Kollef, 2021). *Pseudomonas aeruginosa* (PA) is an opportunistic and widespread pathogen that inhabits a variety of environments, including terrestrial and aquatic ones, with temperatures ranging from 4 to 42°C and plants to mammals as hosts (Guillaume et al., 2022). With a genome that is among the largest among bacteria—nearly 6000 genes—PA has a significant advantage over other microorganisms in terms of competitiveness and high environmental adaptability patients with cystic fibrosis (CF) have been shown to have healthy PA lungs (Feigelman et al., 2017). Antibiotic treatments are no longer effective for treating PA infections once it adheres to the epithelial surface and transforms into a mucoid phenotype (Guillaume et al., 2022). This bacterium resistance to antibiotics has grown, which presents several challenges for treating it (Terreni, Taccani and Pregnolato, 2021). Clinically significant antimicrobial compounds derived from plants with diverse antibiotic mechanisms eradicate bacteria implicated in treating infections brought on by resistant microbial strains (Saeidi and Fazeli Nasab, 2019). As a potential substitute for chemically synthetic drugs, to which many infectious microorganisms have developed resistance, numerous studies have been carried out to identify the various antimicrobial and phytochemical constituents of medicinal plants and use them for the treatment of microbial infections (both topical and systemic applications) (Obiefu et al., 2021). New active molecules are still largely sourced from medicinal plants. According to WHO estimates from 2002, 80% of Africans engaged in this behavior for personal health reasons (Dehou et al., 2021). *Lantana camara* L. was one of the many species that were exploited.

*Lantana camara* Linn, belongs to the Verbenaceae family and is valued as an ornamental garden plant as well as a notorious weed (Barik, et al., 2020). *L. camara* extract has been used for centuries by traditional healers to treat conditions related to the gastrointestinal tract, inflammation, dermatology, rheumatism, fever, and headaches (Mansoori et al., 2020). According to studies conducted by (Lata, 2020), leaf extracts have been demonstrated to possess antifungal, antiproliferative, antibacterial, nematocidal, germicidal, anthelmintic, and anticancer properties.

A methanolic extract of *L. camara* leaves was found to heal stomach ulcers and inhibit the formation of duodenal ulcers in rats, Fresh leaf extracts are antibacterial and have been used for generations in Brazil as an antipyretic, carminative, and in the treatment of respiratory diseases (Barreto et al., 2010; Darwish et al., 2022). Numerous tested bacteria and fungi were dramatically inhibited in their ability to grow by the chemical composition of *L. camara*, which contains B-caryophyllene, geranyl acetate, terpinyl acetate, bornyl acetate, and limonene. *P. aeruginosa*, *A. niger*, *F. solani*, and *Candida albicans* were the strains that were most sensitive (Ezebo et al., 2021). Triterpenoids, steroids, flavonoids, iridoid glycosides,
Khoulood A. Hemida, et al. demonstrated to have antioxidant, anticancer, insecticidal, antibacterial, antiviral, and antifungal effects (Davari and Ezazi, 2017). These chemical composition has a wide range of bioactivities, such as antioxidant, antimicrobial, insecticide, antibiotic, and fungicide characteristics (Mutlu-Ingok et al., 2020).

*Mangifera* plant leaves have long been used in folk medicine to treat a number of inflammatory illnesses, but scientific evidence for their anti-oxidant and anti-inflammatory qualities is insufficient (Awuchi et al., 2023). Traditionally, different parts of *M. indica* have been used to treat gastrointestinal disorders (dysentery, piles, stomach distress, biliousness, persistent constipation), respiratory diseases and other ailments (bronchitis, asthma, hiccough, throat problems), and genitourinary issues (urinary discharges, leucorrhrea, and vaginal problems)(Kalita, 2014).

Therefore, our study aims to investigate the metabolic crude extract of Leaf for its phytochemical properties and antimicrobial activities and its effect on *P. aeruginosa* in vitro study. GC-MS studies were also performed to find out functional groups and active antimicrobial compounds in the extract of *L. camara, Mentha, Eucalyptus* and *Mangifera*.

2. MATERIALS AND METHODS:

**Bacterial strain**

*Pseudomonas aeruginosa* strain DL001 that was obtained from Microbiology Lab, Botany Department, Fayoum University, and that was previously studied for its resistance by Selim et al., (2022).

**Plant collection and processing**

The mature leaves of *L. camara, Mentha, Eucalyptus* and *Mangifera*.

were obtained from the Garden of Fayoum University in Egypt. To remove dirt and unwanted dust particles, the plant leaves were rinsed with tap water. After being shaded, dried, and powderized with a mechanical blender, the leaves were stored in airtight bottles.

**Preparing the extract**

plant material were extracted according to (Rajagopal et al., 2022).

**Determination of total phenolic content**

**total phenolics** were determined using Folin-Ciocalteu reagent method Ali, et al., (2010).

**Assay for reducing strength**
Oyaizu's process was used to calculate the reductive potential of the extracts (Oyaizu, M. (1986)).

Radical scavenging action of DPPH
Blois' method was used to evaluate the extracts' ability to scavenge 1,1-diphenyl-2-picrylhydrazil radical (DPPH) radicals (Blois, 1958).

GC/MS analysis of plant extract
The GC/MS experiment was carried out on a Thermo Scientific Trace GC Ultra / ISQ Single Quadrupole MS, TG-5MS fused silica capillary column. The quantification of all observed components was investigated using a percentage relative peak area. The compounds were correctly identified by comparing the individual retention times and mass spectra of the chemicals to those of the NIST, WILLY library data from the GC/MS instrument (REYAD, 2022).

Assay by disc diffusion
The antibacterial activity of plant extracts was determined using a disc diffusion experiment on Mueller-Hinton agar.

3. RESULTS AND DISCUSSION:
The antimicrobial activity of the four plant extracts under investigation against Pseudomonas aeruginosa (PA) on agar plates demonstrated that each extract inhibited the growth of Pseudomonas aeruginosa (Table 1). The filter paper discs impregnated with the investigated plant extracts develop an inhibition growth zone, or transparent halo, as a result of the inhibitory action. The strongest antibacterial effect among various plant extracts was found in Mentha plant extract, according to the results. The average diameter of the growth inhibition zones of the Mentha plant extract was found to be 1.20 cm, whereas the Lantana camara, Eucalyptus, and Mangifera plants had average diameters of 1.07 cm, 1.03 cm, and 0.77 cm, respectively. Pseudomonas aeruginosa (PA) was susceptible to the antimicrobial activity of several plant extracts. As shown in Table 1, The obtained results of antibacterial activity of the studied Lantana camara, Eucalyptus, Mentha, Mangifera against Pseudomonas aeruginosa on agar plates demonstrated an inhibitory microbial effect of MIC 3.125, 12.5, 12.5, 6.25 mg/ml respectively.

Some previous studies also reported that Lantana camara has antimicrobial activity against many fungi and bacteria (Hernández et al., 2005; Sonibare and Efiong, 2008) showed the MIC of Lantana camara and its constituents for Pseudomonas aeruginosa, the MIC was found 1 mg/ml and that agreed to our results. Mentha has antibacterial activity against Pseudomonas aeruginosa and showed the MIC value 5mg/ml and that agreed to our results (Işcan et al., 2002).
Additionally, Eucalyptus exhibits antibacterial activity against several bacteria and fungi, according to certain earlier investigations, and showed the MIC of Eucalyptus and its constituents for Pseudomonas aeruginosa, the MIC was found 30 mg/ml and that dis agreed to our results (Ait-Ouazzou et al., 2011).

This study reports that the leaf extract of Mangifera has antibacterial activity, and MIC value against Pseudomonas aeruginosa is dis agreed with Bbosa et al. (2007), where the value of MIC was 43.75 mg/ml.

The antimicrobial activity of Lantana camara, Eucalyptus, Mentha, Mangifera is due to their various components including terpenes, aldehydes, alcohols, esters, phenolics, ethers, and ketones (Arjmand and Dastan, 2020). The analysis of the volatile profile of Lantana camara, shows that it mainly contains monoterpene, 1,5-dideuteriopentane, 1-Hexadecanol, Dodecachloroperylene, pregnanoic acid ethyl ester and Tetraanhydrobacterioruberin as the major compounds. The terpenes listed above have biological properties such as antitumor, nematicide, analgesic, antibacterial, anti-inflammatory, sedative, fungicide, pesticide, and insecticide. nematicide insectifuge chemopreventive hypcholesterolemic antiacne (Mariajancyrani et al., 2014). The current study results have been confirmed by the chemical compositions reported from Lantana camara, which are rich in terpenes and also supported and then supplemented previous data (El-Din et al., 2022).

Table 1. Average of the Inhibition Zone diameters and MICs for the four tested plant extracts against Pseudomonas aeruginosa.

<table>
<thead>
<tr>
<th>Plant extract</th>
<th>Inhibition Zone, cm</th>
<th>MIC (mg/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptus</td>
<td>1.03± 0.12&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>12.5</td>
</tr>
<tr>
<td>Lantana</td>
<td>1.07± 0.09&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>3.125</td>
</tr>
<tr>
<td>Mangifera</td>
<td>0.77± 0.03&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.25</td>
</tr>
<tr>
<td>Mentha</td>
<td>1.05± 0.09&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>12.5</td>
</tr>
</tbody>
</table>

(a and b) Average in the same column having different superscripts are differ significantly (P≤0.05).

Total phenolics and antioxidant activity: The DPPH scavenging capability was used to evaluate the antioxidant behaviour of different extracts. The results in (Fig. 1) indicate that the lantana extract has a higher scavenging capability of DPPH and reducing power, but Eucalyptus has a higher content of total phenolic than the other extracts. Additionally, there was a direct correlation between DPPH scavenging capability, and the reducing power assay.
The antimicrobial effect of *Lantana* extracts is owing to their high phenolic and antioxidant content, which is consistent with the findings of Baba and Malik (2014). They stated that *Gentiana kurroo* royle methanol extracts of roots and leaves had an antibacterial effect and concluded that the root methanol extract had a strong effect against selected pathogenic bacteria due to its high phenolic content. The presence of hydroxyl groups with significant free radical scavenging activities mediates the antioxidant and antibacterial effects of phenolic compounds (Bouarab-Chibane et al., 2019). The specificity of the diverse *Lantana, mentha, Eucalyptus, and Mangifera* extracts against *Pseudomonas aeruginosa* was demonstrated by their associated behavior, which may be attributed to the broad spectrum of phenolic and antioxidant bioactive pharmacological compounds (Gilles et al. (2010), Husain et al., 2017). There was agreement in total phenolic content, DPPH scavenging, and reducing power activity, and these findings are supported by the results obtained by (Zhang and Wang, 2009); that demonstrated a direct relationship between antioxidant behavior and total phenolic compounds.

**Chemical composition of plant extracts**

The GC/MS study of *Eucalyptus* methanol extract revealed 50 organic compounds, including alkaloids, terpenes, alkanes/alkenes, aldehydes/ketones, esters, ethers, and organic acids, the majority of which are Eucalyptol (21.41%), Thiophene (8.02%), dichloro methyl propyl sulfone (4.68%), and 3-Eicosene, (E) (3.02%) as the major compounds (Table 2).
Table 2. The major detectable chemical compounds in Eucalyptus using GC-MS.

<table>
<thead>
<tr>
<th>Chemical compound</th>
<th>Rt (min)</th>
<th>(Area %)</th>
<th>M.wt</th>
<th>M.formula</th>
<th>S.Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalyptol</td>
<td>9.28</td>
<td>21.41</td>
<td>154</td>
<td>C₁₀H₁₈O</td>
<td><img src="image1" alt="Structure" /></td>
</tr>
<tr>
<td>Thiophene-D1</td>
<td>5.22</td>
<td>8.02</td>
<td>84</td>
<td>C₄H₃DS</td>
<td><img src="image2" alt="Structure" /></td>
</tr>
<tr>
<td>2,12-Dibromo-6,7,8,9,16,17-hexahydro-5h-dibenzo[f,m][1,4,8,12]tetraazacyclonickel (ii)</td>
<td>5.14</td>
<td>5.49</td>
<td>518</td>
<td>C₁₉H₁₈Br₂N₄Ni</td>
<td><img src="image3" alt="Structure" /></td>
</tr>
<tr>
<td>Dichloromethyl propyl Sulfone</td>
<td>5.35</td>
<td>4.68</td>
<td>190</td>
<td>C₄H₈Cl₂O₂S</td>
<td><img src="image4" alt="Structure" /></td>
</tr>
<tr>
<td>1-Chloro-1,1,2-Trifluoro-2-Tridecene</td>
<td>28.15</td>
<td>3.24</td>
<td>270</td>
<td>C₁₃H₂₂ClF₃</td>
<td><img src="image5" alt="Structure" /></td>
</tr>
<tr>
<td>3-Eicosene, (E)-</td>
<td>23.86</td>
<td>3.02</td>
<td>280</td>
<td>C₂₀H₄₀</td>
<td><img src="image6" alt="Structure" /></td>
</tr>
</tbody>
</table>

RT: retention time, peak area % represents the concentration, M. wt: molecular weight, M. formula: molecular formula, C. structure: compound structure

The GC/MS study of *Lantana* methanol extract revealed 52 organic components, including 1,5-dideuteriopentane (15.13%), 1-Hexadecanol (CAS) (3.08%), and Dodechloroperylene (2.54%) as the major compounds (Table 3).
Table 3. The major detectable chemical compounds in *Lantana* using GC-MS

<table>
<thead>
<tr>
<th>Chemical compound</th>
<th>Rt(min)</th>
<th>Area%</th>
<th>M.wt</th>
<th>M.formula</th>
<th>S.Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,5-Dideuteriopentane</td>
<td>5.15</td>
<td>15.13</td>
<td>72</td>
<td>C₅H₁₀D₂</td>
<td></td>
</tr>
<tr>
<td>1-Hexadecanol (CAS)</td>
<td>35.61</td>
<td>3.08</td>
<td>242</td>
<td>C₁₆H₃₄O</td>
<td></td>
</tr>
<tr>
<td>Methyl 2-methyl-4H-3,1-benzo xathiine-2-carboxylate</td>
<td>19.72</td>
<td>3.02</td>
<td>224</td>
<td>C₁₁H₁₂O₃S</td>
<td></td>
</tr>
<tr>
<td>Dodecachloroperylene</td>
<td>19.62</td>
<td>2.54</td>
<td>660</td>
<td>C₂₀Cl₁₂</td>
<td></td>
</tr>
<tr>
<td>3,5-Cyclo-6-methoxy-à (iodotetradecyl) Pregnanoic acid ethyl ester</td>
<td>53.70</td>
<td>2.47</td>
<td>696</td>
<td>C₃₈H₆₅I O</td>
<td></td>
</tr>
<tr>
<td>Tetraanhydrobactioruberin</td>
<td>53.96</td>
<td>2.24</td>
<td>668</td>
<td>C₅₀H₆₈</td>
<td></td>
</tr>
</tbody>
</table>

**RT**: retention time, peak area % represents the concentration, M. wt: molecular weight, M. formula: molecular formula, C. structure: compound structure.

The GC/MS study of *Eucalyptus* methanol extract revealed 50 organic components, including alkaloids, terpenes, alkanes/alkenes, aldehydes/ketones, esters, ethers, and organic acids (Table 4), the majority of which are Cyclohexen-1-one, 2-methyl-5-(1-methyle phenyl (14.31%), Methane oxybis [dichloro] (5.33%), methyl-6,8-diox-abicyclo[3.2.1]octane (3.87%), and 4-(Acetylacetyl)-5-hydroxy-3- (4-chloropheneth yl)-1-phenylpyrazole (2.65%) as the major compounds (Table 4).
Table 4. The major detectable chemical compounds in *Mentha* using GC-MS.

<table>
<thead>
<tr>
<th>Chemical compound</th>
<th>Rt (min)</th>
<th>(Area%)</th>
<th>M.wt</th>
<th>M.formula</th>
<th>S. Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Cyclohexen-1-one, 2-methyl-5-(1-methylethenyl)-, (R) (CAS)</td>
<td>15.37</td>
<td>14.31</td>
<td>150</td>
<td>C_{10}H_{14}O</td>
<td></td>
</tr>
<tr>
<td>Methane, oxybis[dichloro-(exo)-4,5,7,7-Tetramethyl-1,3-dioxabicyclo[3.2.1]octan](</td>
<td>32.06</td>
<td>3.87</td>
<td>170</td>
<td>C_{10}H_{18}O2</td>
<td></td>
</tr>
<tr>
<td>5(Dibromomethyl)-1,3-bis(tribromomethyl)benzene</td>
<td>35.62</td>
<td>2.90</td>
<td>744</td>
<td>C_{9}H_{4}Br_{8}</td>
<td></td>
</tr>
<tr>
<td>4-(Acetylacetyl)-5-hydroxy-3-(4'-chlorophenethyl)-1-phenylpyrazole</td>
<td>5.21</td>
<td>2.65</td>
<td>382</td>
<td>C_{21}H_{19}ClN_{2}O_{3}</td>
<td></td>
</tr>
<tr>
<td>Phenol, 2,4-bis(1,1-dimethylethyl) - (CAS)</td>
<td>22.30</td>
<td>2.62</td>
<td>206</td>
<td>C_{14}H_{22}O</td>
<td></td>
</tr>
</tbody>
</table>

RT: retention time, peak area % represents the concentration, M. wt: molecular weight, M. formula: molecular formula, C. structure: compound structure.

The GC/MS analysis of *Mangifera* revealed a total of 48 organic compounds, the majority of which are Chloroform (7.67%), decachloro-2,3-benzo-fluorene (3.27%), 1-bromo-2-chloro-1,1-difluoro-2-tridecane (2.89%), and Formy-2- (2-hydroxy ethyl)-2-devinylorin trimethyl ester (2.34%) as the major compounds (Table 5).
Table 5. The major detectable chemical compounds in *Mentha* using GC-MS

<table>
<thead>
<tr>
<th>Chemical compound</th>
<th>Rt (min)</th>
<th>(Area%)</th>
<th>M. wt</th>
<th>M. formula</th>
<th>S. Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chloroform</td>
<td>5.11</td>
<td>7.67</td>
<td>118</td>
<td>CHC_{13}</td>
<td></td>
</tr>
<tr>
<td>Dodecachloro-2,3-benzo Fluorene</td>
<td>5.26</td>
<td>3.27</td>
<td>624</td>
<td>C_{17}C_{12}</td>
<td></td>
</tr>
<tr>
<td>1-Bromo-2-chloro-1,1-d ifluoro-2-tridecene</td>
<td>32.06</td>
<td>2.89</td>
<td>330</td>
<td>C_{13}H_{22}BrClF_{2}</td>
<td></td>
</tr>
<tr>
<td>3,3',5'-Tri-iodo-4'-isopro poxy-6-methoxy-2'-met hyl-2-nitrobiphenyl</td>
<td>16.13</td>
<td>2.64</td>
<td>679</td>
<td>C_{17}H_{16}I_{3}NO_{4}</td>
<td></td>
</tr>
<tr>
<td>Grcchpaegknynsc/3</td>
<td>7.55</td>
<td>2.62</td>
<td>1495</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>ä-Formyl-2-(2-hydroxy ethyl)-2-devinylorin e6 trimethyl ester</td>
<td>6.57</td>
<td>2.34</td>
<td>684</td>
<td>C_{38}H_{44}N_{4}O_{8}</td>
<td></td>
</tr>
<tr>
<td>Ethyl)-2-devinylorin e6 trimethyl ester</td>
<td>8.90</td>
<td>2.45</td>
<td>818</td>
<td>C_{44}H_{28}Br_{2}N_{4}Ti</td>
<td></td>
</tr>
</tbody>
</table>

RT: retention time, peak area % represents the concentration, M. wt: molecular weight, M. formula: molecular formula, C. structure: compound structure.
The analysis of the compound profile of Mentha, shows that it mainly contains 2-Cyclohexen-1-one, 2-methyl-5-(1-methylethphenyl), Phenol, (1,1-di methyl Ethyl) and Tri bromo methyl benzene as the major compounds, that’s disagree with Mahboubi and Kazempour, 2014 who stated that menthol as the main component of mentha. Plant extract compositions can vary greatly based on geographical region, plant types and age, and extraction procedures.

The chemical analysis of Eucalyptus showed that Eucalyptol, Thiophene, Eicosene and Dichloro methyl propyl Sulfone as the major compounds, that’s confirmed and agreed with results of Gilles et al. (2010).

It has been observed the enrichment of the analyzed volatiles of leaves of Mangifera with Chloroform, 2,3-Benzofluorene, 1-bromo-2-chloro-1,1- Difluoro-2-tridecene, and Formyl-2-(2-hydroxy ethyl)-2-devinylorin e6 trimethyl ester, as the major compounds. Our results agreed with the results of Husain et al. (2017) GC-MS analysis of the extract had confirmed the presence of Esters (Formyl-2-(2-hydroxy ethyl)-2-devinylorin e6 trimethyl ester), phenols (hexadecanol), Bacterioruberin, Eucalyptol, Chloroform, and Flavonoids. Each of the isolated fractions is known to possess antibacterial activity due to various bioactivities.

In our study we found that Lantana camara the highest value in DPPH and reducing power, but in the total phenolic Eucalyptus is the highest value. Based on the findings, we propose in a conclusion that Lantana, mentha, Eucalyptus, and Mangifera extracts can be used as an immunization strategy or a line of defense against dangerous bacteria as Pseudomonas aeruginosa.

4. REFERENCES:


Khoullood A. Hemida, et al.

Methanol Extracts of Lantana camara Leaf. World News of Natural Sciences, 37, 151-163.


induced gastrointestinal tract infection in adult Wistar rat. GSC Biological and Pharmaceutical Sciences, 14(1), 055-064.


Sharma, R. 2023. ‘Development and Evaluation of Polyherbal Formulations Against MDR Bacteria Staphylococcus aureus Causing Skin Disease’.


