Phytochemical analysis and *in-vitro* antibacterial activity of aqueous methanolic extract of *Strychnos nux vomica* leaves

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**Abstract**

*Strychnos nux vomica* is a non edible tree with a strong content of two poisonous alkaloids, strychnine and brucine. Qualitative phytochemical analysis and antimicrobial activity of the aqueous methanolic extract of its leaves were studied. Alkaloids, triterpenes, oils & fats, phenol, tannins and flavonoids were present. *Escherichia coli* Enterobacter, *Staphylococcus aureus*, and *Pseudomonas* showed susceptibility but *Salmonella typhimurium* survived the inhibition. Minimal inhibitory concentration of the extract for *E. coli* after an overnight incubation was found to be 0.25 mg. In the present study the antibacterial activity of *Strychnos nux vomica* leaves showed inhibitory effects on selective bacteria which could be used to control these microbes.

**Keywords:** *Strychnos nux vomica*, antibacterial activity, qualitative analysis.

1. **Introduction**

Phytochemicals occur in plants are responsible for the colour, flavor and smell of the plants. They bear therapeutic values for human health as reported in the indigenous system of medicine [1]. Plant extracts provide the innumerable opportunities for developing newer drugs for the existing as well as emerging diseases. Traditional use of plant remedies for number of ailments is seen across nations. *Strychnos nux vomica* is an evergreen tree native to South East Asia and India belonging to the family Loganiaceae. It is medium sized tree found mostly in open habitats. Two poisonous alkaloids, Strychnine and brucine are found in this tree [2]. Qualitative phytochemical analysis and antibacterial activity of the methanolic extract of leaves of *Strychnos nux vomica* was studied and its minimal inhibitory concentration against a specific bacterium was also documented.

2. **Materials and methods**

2.1 **Plant collection**

*Strychnos nux vomica* leaves were collected from Ammapettai village near Tiruporur, Tamilnadu state in the month of July, 2013. Botanical identification was done by Prof. P. Jayaraman, Director, Plant Anatomy Research Centre, Medicinal plant research unit, West Tambaram, Chennai.

2.2 **Preparation of leaf extract**

The fully matured plant leaves collected were separated and washed thoroughly with tap water, air dried, homogenized with aqueous methanol, filtered and stored in test tubes and covered with foil sheets.

2.3 **Plant extract**

100 grams of air dried leaves are homogenized with 200 ml of aqueous methanol, filtered and stored.

2.4 **Phytochemical analysis**

To know the compounds present in the aqueous methanol plant extract, the following test are conducted.
2.4.1 Alkaloid test
Plant extract was treated with dil HCL and filtered. The filtrate was taken to perform the following tests.

a. Wagner’s reagent
A fraction of extract was treated with 3-5 drops of Wagner’s reagent [1.27 g of iodine and 2 g of potassium iodide in 100 ml of water] and observed for the formation of reddish brown precipitate (or colouration).

b. Hager’s test
To the one ml of filtrate few drops of Hager’s reagent (saturated aqueous solution of picric acid) was added. A prominent yellow precipitate formed indicates the presence of alkaloids.

2.4.2. Glycosides test
50 mg of the extract was hydrolyzed with dil. HCl, filtered and the filtrate is used to perform the Glycosides test.

a) Modified Borntragers test
To the one ml of extract FeCl3 solution is added and kept in boiling water bath for 5 minutes. The mixture was cooled, and equal volume of benzene was added and shaken well. The benzene layer was separated and treated with ammonia solution. Formation of rose pink colour indicates glycosides.

2.4.3. Saponin test
a. Foam test
To 2 ml of extract was added 6ml of water in a test tube. The mixture was shaken vigorously and observed for the formation of persistent foam that confirms the presence of saponins.

b) Wagner’s reagent
A fraction of extract was treated with 3-5 drops of Wagner’s reagent (saturated aqueous solution of picric acid) was added. A prominent yellow precipitate formed indicates the presence of saponins.

2.4.4. Phytosterol test
Extracts were treated with chloroform and filtered. The filtrate is used to perform the test.

a) Salkowski’s test
The filtrate is treated with few drops of conc. Sulphuric acid, shaked and allowed to stand. Golden yellow colour develop indicates the presence of triterpenes.

2.4.5. Fixed oils and fats
a) Stain test
Small drops of extracts were pressed in between two filter papers. An oily stain on filter paper indicates fixed oils and fats.

b) Acetone water test
Extracts were treated with acetone. Small amount of water was added and shaken. Appearance of turbidity indicates the presence of resins.

2.4.6. Resin test
a) Acetone water test
Extracts were treated with acetone. Small amount of water was added and shaken. Appearance of turbidity indicates the presence of resins.

2.4.7. Phenol test
Ferric Chloride Test
Extracts were treated with few drops of ferric chloride solution. Formation of bluish black color indicates the presence of phenols.

2.4.8. Tannin test
To the extract, 1% gelatin solution was added. White precipitate formation indicates the presence of tannin.

2.4.9. Flavonoids
a) Alkaline reagent test
Extracts were treated with few drops of sodium hydroxide solution. Formation of intense yellow colour, which becomes colorless on addition of dilute acid, indicates the presence of flavonoids.

2.4.10. Protein and amino acids
a) Ninhydrin test
To the extract 0.25% ninhydrin reagent was added and heated in boiling water bath, blue colour develops indicating the presence of amino acids.

b) Biuret test
To the extract 1 ml of 10% NaOH was added and kept boiling in water bath for 5 minutes, to this added 0.7% CuSO4 solution. Formation of purplish violet colour indicates the presence of proteins.

2.5 Selection of bacterial cultures
2.5.1 Antibacterial activity assay
Antimicrobials are compounds that, at low concentrations, exert an action against micro-organisms and exhibit therapeutic toxicity towards them. These can be substances of natural, synthetic, or semi synthetic origin that may kill microorganisms including bacteria, fungi, protozoa, and viruses. The antimicrobial activity of compounds can be detected by observing the growth of various micro-organisms. If the compounds inhibit the growth of the test organism, and general toxic effects are not present, then the compounds can potentially be used to combat diseases caused by these pathogens. The antimicrobial activities of compounds have formed the basis of many applications, including pharmaceuticals, alternative medicine and natural therapies.

2.5.2 Bacterial strains
The test bacterial species included as E. coli, Pseudomonas aeruginosa, Staphylococcus aureus, Salmonella typhimurium and Enterobacter. These bacteria belong to the most important pathogenic bacteria of human diseases. Bacterial strains were maintained on Nutrient agar. Bacterial cultures were sub cultured (1% inoculum) in nutrient broth at 35 °C for at least two to four days before being used in the screening assays.

2.5.3 Procedure
a) The extract was screened for antibacterial activity using the agar well diffusion method with sterile cork borer of size 6.0 mm. The cultures are of 24 hours old, grown on nutrient broth was used for inoculation of bacterial strain on Muller Hinton agar plates.
b) The extracts, after concentration, were weighed and dissolved in DMSO (1mg in 1ml). Each microorganism was diluted in sterile saline solution and adjusted to 0.1 OD reading.
c) The above said microorganisms were then flooded on the surface of the pre sterilized Muller Hinton Agar plate.
d) Two wells, each 10 mm in diameter, were cut from the agar and 100 microliters (100 ppm) of each compounds was loaded in to one well and antibiotic of same concentration was loaded into the other well.
e) The plates were incubated for 24 hours at 37 °C. The complete antibacterial analysis was carried out under strict aseptic conditions. The zones of inhibition were measured with antibiotic zone scale in mm and the experiment was carried out.
in triplicates.

2.6 Minimal Inhibitory concentration

The extracts were evaluated for their in vitro growth inhibitory activity against Gram-negative bacteria Escherichia coli (ATCC 25922). Antibacterial activities of the compounds were tested by the agar-diffusion method under standard conditions. The bacteria was seeded into the nutrient broth and kept for incubation for 24 hours.

a) A set of sterilized petri dishes was taken and to the petri dish, sterilized, molten Muller Hinton agar medium was poured and allowed to cool and solidified.

b) After solidification, with a sterile cork borer, 6 wells are plucked. Stock solutions of the extracts were prepared in dimethyl sulfoxide (DMSO). Further dilutions were performed with distilled water. The concentration range of the tested compounds was between 0.1 – 6 mg/ml.

A control using DMSO without any test compound was included. The MIC values of the compounds to be tested were obtained as mg ml-1.

c) 50 microliters of each solution was placed in the well plucked in the pre-sterilized petridish. After incubation for 24 h at 25–27 °C, the diameters of the inhibition (sterile) zone (including disc) were measured (in mm).

d) Every test was performed in triplicate.

3. Results and Discussion

Qualitative screening of phytochemicals in the leaves are presented in table 1. of the 10 phytochemicals screened for 6 were present and they include the alkaloids, triterpenes, oils & fats, phenol, tannins and flavonoids. Remarkably, proteins, resins, glycosides and saponins are absent in them.

<table>
<thead>
<tr>
<th>Sl. NO</th>
<th>Phytochemical test</th>
<th>Remarks</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alkaloid test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wagner’s test</td>
<td>Presence of Reddish brown precipitate</td>
<td>Presence of alkaloids</td>
</tr>
<tr>
<td></td>
<td>Hager test</td>
<td>Presence of yellow precipitate</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Glycoside test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bornfrager’s test</td>
<td>No change observed</td>
<td>Absence of Glycosides</td>
</tr>
<tr>
<td>3</td>
<td>Saponin test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Froth test</td>
<td>No frothing &amp; foaming</td>
<td>Absence of Saponins</td>
</tr>
<tr>
<td>4</td>
<td>Phytosterols</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salkowski’s test</td>
<td>Appearance of Golden yellow</td>
<td>Presence of Triterpenes</td>
</tr>
<tr>
<td>5</td>
<td>Oils and fats</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Stain test</td>
<td>Stain is observed</td>
<td>Presence of oils &amp; fats</td>
</tr>
<tr>
<td>6</td>
<td>Resins test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acetone water test</td>
<td>No turbidity appeared</td>
<td>Absence of Resins</td>
</tr>
<tr>
<td>7</td>
<td>Phenols Test</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Phenol test</td>
<td>Appearance of Black colour</td>
<td>Presence of phenols</td>
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<tr>
<td>8</td>
<td>Tamin test</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Gelatin test</td>
<td>White precipitate formed</td>
<td>Presence of Tannins</td>
</tr>
<tr>
<td>9</td>
<td>Flavanoids test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alkaline test</td>
<td>Intense yellow appeared</td>
<td>Presence of flavonoids</td>
</tr>
<tr>
<td>10</td>
<td>Protein test</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ninhydrin test</td>
<td>No blue colour</td>
<td>Absence of proteins</td>
</tr>
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</table>

In the present investigation antibacterial activity of aqueous methanolic extracts of the leaves of strychnos nux vomica were tested against five human pathogenic bacteria. The antimicrobial activity was compared against the antibiotic ciprofloxacin by antibiotic sensitivity test.

Antibacterial activity of methanolic extract of Strychnos nux vomica leaves was tested against, Staphylococcus aureus, Escherichia coli, Enterobacter, Pseudomonas, and Salmonella typhimurium. Methanolic extract of the Strychnos nux vomica showed maximum inhibition zone against E. coli (1.8 mm) and Pseudomonas (1.8 mm). But the extract never showed any inhibition for Salmonella typhimurium.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Extract 1</th>
<th>E. coli</th>
<th>Pseudomonas</th>
<th>Enterobacter</th>
<th>S. aureus</th>
<th>S. typhimurium</th>
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<tr>
<td>1</td>
<td>R1</td>
<td>1.6 cm</td>
<td>1.6 cm</td>
<td>1.2 cm</td>
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<tr>
<td>2</td>
<td>R2</td>
<td>1.8 cm</td>
<td>1.2 cm</td>
<td>1.4 cm</td>
<td>1.5 cm</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>R3</td>
<td>1.8 cm</td>
<td>1.8 cm</td>
<td>1.6 cm</td>
<td>1.7 cm</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>Ciprofloxacin</td>
<td>2 cm</td>
<td>2.1 cm</td>
<td>1.8 cm</td>
<td>2 cm</td>
<td>2 cm</td>
</tr>
</tbody>
</table>

Minimum inhibitory concentrations (MICs) are defined as the lowest concentration of antimicrobial that will inhibit the visible growth of a micro-organism after overnight incubation. It was found to be 0.25 mg of the methanolic extract at which the zone of inhibition was 0.8 mm which occurred for the standard antibiotic ciprofloxacin even at a concentration of 0.1 mg (Table 3).
Table 3: Minimal inhibitory concentration exhibited by methanolic extract of Strychnos nux vomica leaves for *E. coli*.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Extract 0.1 mg</th>
<th>0.25 mg</th>
<th>0.5 mg</th>
<th>1.5 mg</th>
<th>3.00 mg</th>
<th>6.00 mg</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>R1 ---</td>
<td>0.8 mm</td>
<td>1 mm</td>
<td>1.4 mm</td>
<td>1.8 mm</td>
<td>2.1 mm</td>
</tr>
<tr>
<td></td>
<td>R2 ---</td>
<td>---</td>
<td>0.8 mm</td>
<td>1.2 mm</td>
<td>1.6 mm</td>
<td>1.6 mm</td>
</tr>
<tr>
<td></td>
<td>Ciprofloxacin</td>
<td>0.8 mm</td>
<td>1 mm</td>
<td>1.2 mm</td>
<td>1.8 mm</td>
<td>2.2 mm</td>
</tr>
</tbody>
</table>

The present investigation was carried out with the aqueous methanolic extract of Strychnos nux-vomica leaves for qualitative phytochemical analysis and the antimicrobial activity. Antimicrobial potential of plant extract was compared according to their zone of inhibition against the several pathogenic organisms [4]. Resistance against various antibiotic drugs by the pathogenic bacteria has become a serious concern these days, and hence there is a continuous search for control agents from plants and related sources is being undertaken [5, 6]. Non edible plants and their products are found to be suitable for antimicrobial activities against pathogenic bacteria [7].

4. Conclusion
The present study indicated a significant antibacterial effect of the methanolic leaf extracts of Strychnos nux vomica and exposes the existing potential of the other parts of the tree to be explored for other medicinal benefits of the human kind.

5. Acknowledgment
Authors thank, Dr. Menaga Mahendran, and Dr. Mahendran of Bioneemtec India private limited, A unit at Women’s Biotech park, Promoted by Department of Biotechnology & MS Swaminathan Research Foundation, Chennai for their guidance in the laboratory work done at their research facility.

6. References