INTRODUCTION

Medicinal plants have been used for the treatment of illness since before recorded history. The sacred Vedas dating back between 3500 BC and 800 BC gives many references of the utilization of the medicinal plants. “Virikshayurveda” is one of the remotest works in the traditional herbal medicine which was compiled even before the beginning of Christian era. “Rig Veda” is one of the oldest literatures which was written around 2000 B.C. and mentions the use of Cinnamon (*Cinnamomum verum*), Ginger (*Zingiber officinale*), and Sandalwood (*Santalum album*) etc. was used not only in the religious ceremonies but also in the medical preparations (Prasad Palthur *et al.*, 2010). The relationship between food and medicine was quoted as “Let food be thy medicine and medicine be thy food”. Green plants are the indispensable storehouse of many chemical metabolites which are grouped into two categories namely: primary and secondary metabolites. Secondary metabolites are the substances produced by plants as defense chemicals.

The chemical investigation of a plant involved collection and proper identification of the plant materials, extraction, fractionation, purification & isolation of compounds and structural characterization of the purified compounds. Various chromatographic techniques were utilized for isolation and purification of the plant constituents. On the other hand, the structures of the purified compounds
were determined by extensive analyses of UV, IR, NMR and mass spectroscopic data as well as by chemical derivatization, when needed.

**Derivation of Secondary metabolites from Primary metabolites**

Phytochemicals are non-nutritive plant chemicals that have protective or disease preventive properties. They are regarded as secondary metabolites because the plants that manufacture them may have little need for them. The plant produces these chemicals to protect them but recent research demonstrates that they can protect humans and animals against diseases. A number of phytochemical are known, some of which include: alkaloids, saponins, flavonoids,
tannins, glycosides, anthraquinones, steroids and terpenoids. Phytochemicals are a large group of plant derived compounds hypothesized to be responsible for much of the disease protection conferred from diets high in fruits, vegetables, beans, cereals and plant based beverages such as tea and wine. There is ample literature on preliminary phytochemical surveys and the knowledge of the chemical constituents of plants is desirable to understand herbal drugs and their preparations.

Phytochemicals have been recognized as the basis for traditional herbal medicine practiced in the past and currently en vogue in parts of the world (Thamaraiselvi et al., 2012). In the search for phytochemicals that may be of benefit to the pharmaceutical industry, researchers sometimes follow leads provided by local healers in a region (Das et al., 2010). Following such leads, plant parts are usually screened for phytochemicals that may be present. The presence of a phytochemical of interest may lead to its further isolation, purification and characterization. Then it can be used as the basis for a new pharmaceutical product. The most important of these bioactive constituents are alkaloids, tannins, flavonoids, steroids, terpenoids, carbohydrate and phenolic compounds.

**Alkaloids**

Alkaloids are a structurally diverse group of over 12,000 cyclic nitrogen-containing compounds that are found in over 20% of plant species. Although no single classification exists, alkaloids are often distinguished on the basis of a
structural similarity (e.g. indole alkaloids) or a common precursor (e.g. benzylisoquinoline, tropane, pyrrolizidine, or purine alkaloids)

**Terpenes**

Terpenes are a diverse group of more than 30,000 lipid-soluble compounds. Their structure includes 1 or more 5-carbon isoprene units, which are ubiquitously synthesized by all organisms through 2 potential pathways, the mevalonate and, more recently identified, deoxy-\(d\)-xylulose pathways.

**Phenolics**

Phenolics are ubiquitously found across the plant kingdom, with ~10,000 structures identified to date. With a few notable exceptions, phenolic compounds are synthesized from precursors produced by the phenylpropanoid pathway. Structurally, they share at least 1 aromatic hydrocarbon ring with 1 or more hydroxyl groups attached. The simplest compound with this structural motif is the phenol molecule, which itself does not occur in plants. Phenolics range from simple low-molecular weight compounds, such as the simple phenylpropanoids, coumarins, and benzoic acid derivatives, to more complex structures such as flavanoids, stilbenes, and tannins.

The first group of phenols is the flavonoids. Flavonoids are water soluble pigments found in the vacuoles of plant cells. Flavonoids can be further divided into three groups: anthocyanins, flavones and flavnols.

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Antimicrobial and anti-inflammatory activity of *S.campanulata* and *D.elata*
REVIEW OF LITERATURE

The preliminary phytochemical analysis of *Alangium salvifolium* showed the presence of flavonoids, amino acids, carbohydrates, saponins, tannins, steroids and alkaloids. The qualitative Phytochemical screening of *Dioscorea deltoidea* revealed the presence of glycosides, flavonoids, phenols, resin and tannins (Subash Chandra *et al.*, 2013).

The phytochemical screening of fresh leaves *Ochnandra travancorica* revealed the presence of alkaloids, flavanoids, tannins, saponins and aminoacids. It was concluded that plant extract can be used as a preservatives against the human pathogens pathogens (Bharathidasan *et al.*, 2012).

Phytochemical screening of the crude extracts of stems/leaves revealed the presence of different kind of chemical groups such as tannin, flavonoids, phenolic acids and coumarins. The amounts of total phenolics and flavonoids in the solvent extracts (methanol and water extract) were determined spectrometrically (Amel Bendiabdellah *et al.*, 2012). The flower extract of *Bauhinia tomentosa* revealed the presence of constituents such as flavonoids, alkaloids and saponins (Sathya *et al.*, 2013).

Phytochemical screening revealed the presence of glycosides, saponins and flavonoids in *Vitex negundo* and coumarins in *Aegle marmelos*. Krupavaram *et al.* (2007) have found out that alcoholic and chloroform extracts obtained from the roots of *Boerhavia diffusa* had significantly increased the anoxicous test tolerance time in mice.
The alcoholic extracts contained alkaloids, glycosides, carbohydrates, flavonoids, tannins, triterpenoids and saponins, whereas the chloroform extracts contained the same components of alcoholic extracts except tannins. Among the various root extracts of *Moringa oleifera* the aqueous extract indicated the presence of carbohydrates, glycosides, saponins and triterpenoids. Alcoholic extracts indicated the presence of alkaloids and glycosides only. These two extracts exhibited antiarthritic property in albino rats (Karadi *et al.*, 2006).

The crude extracts of *Dennetia tripetala* were subjected to qualitative phytochemical screening using standard procedures. Results showed that nine of thirteen phytochemicals such as alkaloid, cardiac glycosides, carbohydrate, flavonoids, phenols, saponins (Ugochuhukwu *et al.*, 2013). Qualitative phytochemical analysis of *Momordica charantia* confirmed the presence of various phytochemicals like sterols, flavonoids, terpenoids, proteins, alkaloids, quionens and anthocyanins (Annapoorani and Manimegala, 2013).

The qualitative and quantitative analysis of the major bioactive constituents of medicinally important plant *Taraxacum officinale* in its aqueous and methanol extract of root, stem and flower. Saponins, flavonoids, alkaloids, phenols were highly concentrated in the stem, root and flower, with the higher concentration of flavonoids in the flower extracts. Phenols and steroids were also found present in the investigated plant parts (Amin Mir *et al.*, 2013).

The phytochemical screening of the solvent extracts from *Myrothamnus flabellifolius* revealed the following phytoconstituents like alkaloids, flavanoids,
gums, glycoside, saponins, reducing sugar, amino acids, phenolics, tannins and steroids (Molefe-Khamanga et al., 2012).

**MATERIALS AND METHODS**

Phytochemical screening of crude extracts of *Spathodea campanulata* and *Delonix elata* was carried out according to the methods described by Trease and Evans (1997). Qualification phytochemicals analysis of the crude powder of the samples for the identification of phytochemicals like as a tannins, alkaloid, steroid, phenols and terpenoid, flavonoid etc.

**Test for alkaloids**

Five ml of the extract was added to 2ml of HCL. To this acidic medium, 1ml of Dragendorff’s reagent was added. An orange or red precipitate produced immediately indicates the presence of alkaloids.

**Test for flavonoids**

One ml of the extract, a few drops of dilute sodium hydroxide was added. An intense yellow color was produced in the plant extract, which become colorless on addition of a few drops of dilute acid indicates the presence of flavonoids.

**Test for Cardiac glycosides**

The extract was hydrolysed with HCL for few hours on a water bath. To the hydrolysate, 1 ml of pyridine was added and a few drops of sodium nitroprusside solutions were added and then it was made alkaline with sodium
hydroxide solution. Appearance of pink to red color shows the presence of glycosides.

**Test for saponins**

The extract was diluted with 20ml of distilled water and it was agitated in a graduated cylinder for 15 minutes. The formation of 1 cm layer of foam showed the presence of saponins.

**Test for steroids**

One ml of the extracts was dissolved in 10ml of chloroform and equal volume of concentrated sulphuric acid was added by sides of the test tube. The upper layer turns red and sulphuric acid layer showed yellow with green fluorescence. This indicated the presence of steroids.

**Test for tannins**

Five ml of the extract and a few drops of 1% lead acetate were added. A yellow precipitate was formed, indicates the presence of tannins.

**Test for triterpenoids**

Ten mg of the extract was dissolved in 1ml of chloroform; 1ml of acetic anhydride was added following the addition of 2ml of Conc.H$_2$SO$_4$. Formation of reddish violet color indicates the presence of triterpenoids.
Test for Phenolic compounds

To 2 ml of filtered solution of the aqueous macerate of the plant material, 3 drops of a freshly prepared mixture of 1 ml of 1% ferric chloride and 1 ml of potassium ferrocyanide was added to detect phenolic compounds. Formation of bluish-green colour was taken as positive.

Anthraquinones (Borntrager’s test)

The hydro-alcoholic extract of the plant material (equivalent to 100 mg) was shaken vigorously with 10 ml of benzene, filtered and 5 ml of 10% ammonia solution added to the filtrate. Shake the mixture and the presence of a pink, red or violet color in the ammonia (lower) phase indicated the presence of free anthraquinones.

RESULTS

Methanol and aqueous extracts of the selected medicinal plants were subjected to qualitative phytochemical analyses. Extracts of *S.campanulata* and *D.elata* answered positively saponins, phenolic compounds, carbohydrates & glycosides, terpenoids, protein & amino acids. Methanol extract of *S.campanulata* positively answered for alkaloids, steroids, tannins and anthraquinones. Saponins, steroids and terpenoids were identified in the aqueous extract of *S.campanulata*. Steroids and phenolic compounds were identified in the aqueous extract of *D.elata* (Tables 7.1 & 7.2).
### Table 7.1
**Phytochemical screening of *Delonix elata***

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Phytoconstituents</th>
<th>Methanol</th>
<th>Aqueous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alkaloids</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Saponins</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>Steroids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4</td>
<td>Phenolic compounds</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5</td>
<td>Tannins</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>Flavonoids</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>Terpenoids</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>Carbohydrate &amp; Glycosides</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9</td>
<td>Protein &amp; Amino acids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>Anthraquinones</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>

`+` indicates presence  
`-` indicates absence

### Table 7.2
**Phytochemical screening of *Spathodea campanulata***

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Phytoconstituents</th>
<th>Methanol</th>
<th>Aqueous</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alkaloids</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Saponins</td>
<td>+</td>
<td>+</td>
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<td>3</td>
<td>Steroids</td>
<td>-</td>
<td>+</td>
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<td>Terpenoids</td>
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<td>9</td>
<td>Protein &amp; Amino acids</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10</td>
<td>Anthraquinones</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

`+` indicates presence  
`-` indicates absence

Antimicrobial and anti-inflammatory activity of *S.campanulata* and *D.elata*
DISCUSSION

Medicinal plants are the richest bioresource of drugs of traditional systems of medicine, modern medicines, nutraceuticals, food supplements, folk medicines, pharmaceutical intermediates and chemical entities for synthetic drugs. Plants are rich in a wide variety of secondary metabolites, such as tannins, terpenoids, alkaloids and flavonoids which have been found in vitro to have antimicrobial properties. The phytochemical screening of the crude extracts showed that the alkaloids, flavonoids, steroids, tannins and phenolic compounds.

The alkaloids are known to have antimicrobial and antiparasitic properties. Verpoorte (1998) have reported about 300 alkaloids showing such activity. Similar results on antibacterial activity were reported on related species of the genus Mahonia by Duraiswamy et al. (2006), Livia et al. (2004) and Li et al. (2007). Generally, the plant extracts inhibited the Gram-positive bacteria better than the Gram-negative ones. This is in agreement with reports on plant extracts by Tomas-Barberan et al. (1988); Vlietinck et al. (1995); Rabe and Van Staden (1997). The reason could be attributed to the presence of extra outer membrane in their cell wall acting as barrier for the compound(s) to diffuse into the bacterial cells. The alkaloids sanguinarine, berberine, jatrorrhizine and palmatine are known to inhibit the multiplication of bacteria, fungi and viruses (Schiff, 1987; Schmeller et al., 1997). Therefore the antibacterial activity observed in the present investigation is attributed to the alkaloids which have been widely known to occur
Saponins are bioactive compounds produced mainly by plants, but also by some marine organisms and insects. Chemically, they generally occur as glycosides of steroids or polycyclic triterpenes. Saponin has the property of precipitating and coagulating red blood cells (Sodipo et al., 2000; Okwu, 2004). Saponins have been ascribed a number of pharmacological actions (Sun et al., 2009; Setzer and Setzer, 2003; Fuchs et al., 2009) the important ones being permeabilizing of the cell membrane, lowering of serum cholesterol levels (Francis et al., 2002), stimulation of luteinizing hormone release leading to abortifacient properties (Francis et al., 2002) immunomodulatory potential via cytokine interplay (Sun et al., 2009), cytostatic and cytotoxic effects on malignant tumor cells (Bachran et al., 2008) adjuvant properties for vaccines as immunostimulatory complexes (Sjolander et al., 1998) and synergistic enhancement of the toxicity of immunotoxins (Heisler et al., 2005; Bachran et al., 2008).

Steroid hormones act by binding to their respective intracellular receptors. These receptors change their conformation subsequently by dissociation from chaperone molecules, for example, the heat shock proteins, and translocate to the nucleus where they bind as homo or heterodimers to the respective response elements that are located in the regulatory regions of target promoters (Rupprecht, 2003). Steroids have shown numerous important modulatory effects on brain functions and brain diseases. These effects are exerted by modulating almost all kinds of classical synaptic transmission including glutamatergic, GABAergic,
cholinergic, noradrenergic, dopaminergic and serotonergic synaptic transmission, either by altering the responsiveness of postsynaptic (Banso and Adeyemo, 2007) receptors or by the presynaptic release of neurotransmitters (Zheng, 2009).

Plant tannins, one of the major groups of antioxidant polyphenols found in food and beverages, have attracted a lot of attention in recent years because of their multifunctional properties beneficial to human health. Tannins have stringent properties; hasten the healing of wound and inflamed mucous membranes. Several plants which are rich in tannins have been shown to possess antimicrobial activities against a number of microorganisms. For example investigated the antibacterial activity of leaf extract *Dichrostachys cinerea* and reported that tannins, alkaloids and glycosides were detected.

Epidemiological and *in vitro* studies indicate that food products containing phytochemicals such as phenolic compounds have potential protective effects against different diseases. These phytochemicals can be used as anti-inflammatory, anti-mutagenic, antiviral and antibacterial, agents (Senevirathne *et al*., 2006). Strong evidence exist which emphasize that the consumption of different types of phenolic compounds from natural foods may decrease the risk of serious health problems due to their antiradical and antioxidant activities (Surh, 2002). Flavonoids, on the other hand are potent water soluble antioxidants and free radical scavengers, which prevent oxidative cell damage, have strong anticancer activity (Doss, 2009).
Cardiac glycosides on the other hand are known to hamper the Na⁺ / K⁺ pump. This results in an increase in the level of sodium ions in the myocytes which then enhance in the level of calcium ions. This consequently increases the amount of Ca²⁺ ions available for contraction of the heart muscle, which improves cardiac output and reduces distention of heart and thus are used in the treatment of congestive heart failure and cardiac arrhythmia.