Introduction

Plants, being the basis of refined traditional medicinal systems have been in life since thousands of years and continue to provide mankind with new remedies. Plant therapy is based on the empirical findings from ancient times. The first records, written on clay tablets in cuneiform, were from Mesopotamia, which dates back to 2600 BC; among the substances used were the oils of Cedrus species (Cedar), Cupressus sempervirens (Cypress), Glycyrrhiza glabra (Licorice), Commiphora species (Myrrh) and Papaver somniferum (Poppy juice), all of which are used till date for the treatment of ailments ranging from cough and colds to parasitic infections and inflammation in humans (Gurib-Fakim, 2006).

The faster pace of life and the need for rapid cure has led to the development of synthetic drugs. However, the synthetic drugs do reveal side effects that result in complications. Therefore, treatment with herbal medicine is the alternative to treat a large number of diseases. The World Health Organization (WHO) has emphasized the need to restore the indigenous systems of medicine based on the locally available raw materials. The WHO reports that about 4 billion people depend on the herbal medicine (Sultan et al., 2013). The growing population of the world at an alarming rate has led to the increased demand for medicines, for which steps are being taken to escalate the cultivation of important economic and medicinal plants to suit the desires of mankind. Based on the ethnobotanical informations, several active compounds from plants have been discovered and patented directly as drugs.

Of the 3,50,000 plant species identified so far, about 70,000 are used worldwide for the medicinal purposes and less than 0.5% of these have been chemically investigated (Kumar et al., 2011). India being one of the leading countries in Asia in terms of the assets of traditional knowledge systems related to the use of plant species is also one of the world’s 12 biodiversity centers with the presence of over 60,000 different plant species. About 20,000 plants have good medicinal values of which, 7,000-7,500 species are used for
their medicinal values by traditional communities (Joy et al., 2001). In India, drugs of herbal origin have been used in the traditional systems of medicines such as Ayurveda and Unani. Ayurveda, the science of life and the tradition of India, dates back to the days of Charaka Samhitha and Sushrutha Samhitha (1,200 AD) and emphasizes the equilibrium between body and mind. To achieve this, the drug-yielding plants have been acknowledged throughout the centuries (Jain et al., 2006). Reportedly, Ayurvedic medicine includes about 2000 plant species. Other traditional medicinal systems of India also employ large numbers of species: Siddha (1121 species), Unani (751 species) and Tibetan (337 species) (Kala, 2005).

At present, about 65% of the Indian population is dependent on the traditional system of medicine (Prashanthkumar and Vidyasagar, 2008). Documenting the traditional knowledge through ethno-botanical survey has been found to be one of the reliable approaches to drug discovery. The global market for the medicinal plants and herbal medicine is estimated to be worth US$800 billion per annum and the market for Indian traditional systems of medicine is about Rs. 4000 crores per year (Kumar et al., 2011).

The phytochemical research based on ethnopharmacology is considered as an effective approach to drug discovery. All the extraction, purification and separation processes are performed in order to “find and follow” the supposed pharmacological activity with the final aim of isolating and identifying the bioactive compounds. An overview on the methodologies involved in this selected approach is depicted in Figure 1.
Fig. 1. Methodology involved in the ethnopharmacology approach

**Source:** Brusotti et al. (2013).
The Family Araliaceae

The Araliaceae, known as the ginseng family comprise 55 genera and 1,500 species (Plunkett et al., 2005).

The family is broadly distributed in the tropics and sub-tropics (especially in southern Asia and the Pacific islands), but several genera from the temperate zones are documented as well (viz., Aralia, Hedera, Oplopanax and Panax). The family includes a number of medicinally important plants, such as Panax (ginseng) and Eleutherococcus (Siberian ginseng) and several well-known ornamentals, including Hedera (English ivy), Schefflera (the umbrella trees), and Polyscias. The Araliaceae have traditionally been allied with Apiaceae on the basis of morphological (Judd et al., 1994) and anatomical evidence (Metcalfe and Chalk, 1950), and by molecular studies (Plunkett et al., 1996a and 1997). The Araliaceae are characterized by relatively conserved floral, but diverse vegetative features. The leaves vary from simple, to variously lobed or divided, to palmately and/or pinnately compound. Although most species are trees, shrubs, or woody climbers, there are also a few herbaceous perennials (Panax and Aralia species). Members of the family possess five sepals, 5-10 (-12) petals, which are free or form calypters (as in Pentapanax and Tupidanthus), mostly 5-10 stamens (rarely to numerous, e.g., 120 in Tupidanthus), and a gynoeicum with 2-10 (mostly five, rarely up to 200 in Tupidanthus, or one in Seemannaralia) locules, and an inferior ovary (rarely superior as in Dipanax) with a nectary disk. Most araliads produce berries or drupaceous fruits that are dispersed by birds (Wen et al., 2001).

Commercial products of medicinally important species - Araliaceae

The name ginseng is derived from the Chinese words ‘Jen Sheng’ meaning ‘man-herb’, because of the humanoid shape of the root, which is most commonly used for the extraction. The generic name of ginseng, Panax is derived from the Greek word ‘Pan’ - ‘all’, ‘akos’ - ‘cure’, meaning “cure all” or “all healing” which describes the traditional belief that ginseng has properties to heal all aspects of the body ailments. About thirteen species of ginseng
have been identified all over the world. The most commonly used species of ginseng are *Panax ginseng* (Asian ginseng) and *Panax quinquefolius* (American ginseng) (Yun, 2001; Sun, 2004).

*P. ginseng* Meyer is considered as the most important genus of Araliaceae because of its medicinal properties. The history of the use of ginseng began 4,500 years ago, and its first record was written 2,000 years ago (Baeg and Ho So, 2013). Ginseng has been one of the important trade goods for healthcare and in the treatment of diseases in Asia especially in Korea and China, and is currently distributed in 35 countries around the world. The four leading producers of ginseng in the world are China (44,749 tonnes), South Korea (27,480 tonnes), Canada (6,486 tonnes), and the United States (1,054 tonnes). The total produce by these countries is 79,769 tonnes, which is approximately 99% of the world’s ginseng production (80,080 tonnes). *P. ginseng* produces the most ginsengs while, *P. quinquefolius* L. and *P. notoginseng* Burkill produce in the decreasing order. Ginseng is distributed to different countries in various forms such as fresh, dried, boiled and dried (Taekuksam), red ginseng and related products, etc., and is consumed as food, dietary supplements, functional food, medicinal supplies etc. The world ginseng market including ginseng root and the processed products is estimated to be worth $ 2,084 million. Korea is the largest distributor of ginseng in the world, with a turnover of $ 1,140 million per annum. Since the interests in the alternative medicine and healthy food is increasing globally, the consumer market of ginseng with many features and the processed products are expected to expand continuously (Baeg and Ho So, 2013). Currently, ginseng is available in the market in the trade name of ‘Livertox’, ‘Ginseng Booster Capsules, Ginseng Complex Capsules, Hi-Ener-G Triple Ginseng etc., which are mainly used for liver ailments and general health.
Botanical description of *Schefflera* species

**Kingdom**: Plantae  
**Division**: Magnoliophyta  
**Class**: Magnoliopsida  
**Sub-Class**: Rosidae  
**Family**: Araliaceae  
**Genus**: *Schefflera*

*Schefflera* Forster, are usually trees or epiphytes or climbing shrubs with alternate, digitate or compound digitate leaves. The leaflets are usually coriaceous, entire or distally toothed with long petioles. Stipules are usually connate within the petiole. The flowers are usually in panicles of umbels or compound racemes, usually terminal in position. The bracts are usually deciduous, with zero or few bracteoles which are sometimes united in a tube. The pedicels if present are not jointed. The mouth of the calyx is truncate or toothed. Five to six petals with valvate aestivation is usually seen. Stamens are as many as the petals. Ovary-cells are as many as the petals, style usually small, separate or combined in a column. Fruit is a subglobose, five to six angled dry drupe. Seeds are compressed and albumen is uniformly distributed (Gamble, 1926).

*Schefflera venulosa* (W. & A.) Harms.


**Distribution**: Usually found in the Western Ghats, Coorg, on the eastern slopes; Deccan, in hilly sites of Horsleykonda, Chittoor; frequent on trees near villages.

**Habit**: A large straggling or climbing shrub, with coriaceous shining leaves, sometimes epiphytic. Bark grey, shining, leaflets coriaceous, the main nerves are much more prominent than the secondary and the reticulations, very
oblique, about 30° with the midrib; panicles with a short rachis (Gamble, 1926).

*Schefflera wallichiana* (W. & A.) Harms.

**Synonyms:** *Heptapleurum wallichianum* Cl., *Paratropia wallichiana* (W. & A.)

**Distribution:** Usually found in the Western Ghats, Coorg, Nilgiris, Pulneys and hills of Tirunelvelly and Travancore up to 6,000 ft.

**Habit:** Apparently a climbing shrub or arbores or a medium sized tree (Bourdillon), with large coriaceous leaflets, the main nerves nearly horizontal, the flowers hexamerous, leaflets are prominently reticulated, oblong, acute, coriaceous up to 10 inch long, four inch broad, petiole seven to fifteen inch long, petioles five to ten, two inch long or longer; umbels in large panicles up to 12 inch long (Gamble, 1926).

*Schefflera racemosa* (Wight) Harms.

**Synonyms:** *Heptapleurum racemosum* (Wight) Bedd., *Hedera racemosa* (Wight), *Agalma racemosum* (Wight) Seem.

**Distribution:** Usually found in the Western Ghats, in the Shola forests of Nilgiris, Pulneys and southwards, at 3,000-7,000 feet.

**Habit:** A large tree, conspicuous for its large racemose inflorescence, the leaflets oblong-lanceolate, the petioles one to two inch long. Wood is soft and grey. Flowers in racemes, in panicles up to one feet long from the wood of the previous year; bracts, bracteoles and pedicels rusty pubescent; leaflets glaucous beneath, the nerves not conspicuous (Gamble, 1926).

*Schefflera stellata* (Gaertn.) Harms.

**Synonyms:** *Heptapleurum stellatum* Gaertn., *Paratropia terebinthinacea* (Vahl) Arn.

**Distribution:** Usually found in the Western Ghats, in Nilgiris and Pulneys up to 6,000 feet.
**Habit:** A large straggling or climbing shrub with small flowers, the petals usually falls as an operculum. Leaflets obovate, rounded or emarginated at apex or very slightly obtusely pointed, the main nerves oblique, petioles slender, one to two inch long; umbels in racemes in a terminal panicle often one feet long (Gamble, 1926).

**Phytochemistry**

Medicinal plants are the reservoirs of various important chemicals or metabolites that have diverse biological properties. Metabolites are the compounds synthesized by the plants for both essential functions, such as growth and development (primary metabolites), and specific functions, such as pollinator attraction or defense against herbivores (secondary metabolites). Primary metabolites comprise different types of organic compounds, including, but not limited to carbohydrates, lipids, proteins and nucleic acids. They are found universally in the plant kingdom because they are the components or products of fundamental metabolic pathways or cycles such as glycolysis, Krebs cycle and Calvin cycle. Because of the importance of these and other primary pathways in enabling the plant to synthesize, assimilate, and degrade organic compounds, the primary metabolites are essential (Gadhvi et al., 2013). The chemicals which are responsible for colours and smell into the plant are known as secondary metabolites or phytochemicals. Phytochemicals are the organic, non-nutritive, naturally occurring chemicals found in plant foods. Even though they are non essential nutrients, they are not needed to sustain life, they may prolong life because of their health-promoting properties. Thousands of secondary metabolites are isolated from plants, and many of them have powerful physiological effects in humans and are used as medicines. It is only since the late twentieth century that secondary metabolites have been clearly recognized as having important functions in plants (Doughari, 2012). Secondary metabolites are often colored, fragrant or flavored compounds, and they typically mediate the interaction of plants with other organisms. Such interactions include those of plant-
pollinators, plant-pathogens, and plant-herbivores. Recent studies are involved in the identification and isolation of new therapeutic compounds of medicinal importance from the plants for specific diseases. The secondary metabolites present in the plants, such as alkaloids, tannins, saponins, sterols, triterpenoids, flavonoids etc., are noted to have a major role in the nutrition, physiology and the control of diseases (Gadhvi et al., 2013). The role of different phytochemicals and their bioactivity are listed in Table 1.

Table 1. Role of phytochemicals and their bioactivity

<table>
<thead>
<tr>
<th>Phytochemicals</th>
<th>Bioactivity</th>
<th>References</th>
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<tbody>
<tr>
<td>Phenolics</td>
<td>Ubiquitously found across the plant kingdom, and synthesized from phenylalanine via the action of phenylalanine ammonia lyase (PAL). They are important to plants in defense against pathogens. They represent a host of natural antioxidants, used as nutraceuticals with an ability to combat cancer and to prevent heart ailments.</td>
<td>Puupponen-Pimia et al., 2008</td>
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<td>Tannins</td>
<td>The word tannin comes from French word ‘tan’ meaning bark of the Holm oak and other trees used in tanning. They are more abundant in new leaves and flowers. Tannins are well known for their antioxidant, antimicrobial, antiseptic, anti-inflammatory properties as well as for soothing, relief and skin regeneration. In Ayurvedic formulations, it is used for the treatment of diseases like leucorrhoea, rhinnorhoea and diarrhoea.</td>
<td>Schofield et al., 2001 Frutos et al., 2004 Mensah et al., 2013</td>
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<tr>
<td>Saponins</td>
<td>The word “saponins” is derived from Latin word “sapo” which refers to the formation of stable soap-like foam in aqueous solution. The word is derived from Saponaria vaccaria, a plant which was once used as soap. Approximately 60 families of plants produce saponins, including Araliaceae, Apiceae, Fabaceae, Sapotaceae, Theaceae etc. Plant saponins help to fight fungal infections, combat microbes and viruses, boost the effectiveness of certain vaccines.</td>
<td>Melzig et al., 2001 Poornima and Ravishankar, 2009 Thakur et al., 2011 Doughari, 2012</td>
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<td>Flavonoids</td>
<td>Flavonoids are widely distributed among the plant flora. The compounds are derived from parent compounds known as flavans. Over four thousand flavonoids are known to exist and some of them are pigments in higher plants. Quercetin, kaempferol and rutin are common flavonoids present in nearly 70% of plants. A number of trials of acceptable quality with flavonoid-rich foods provide evidence for beneficial effect on flow-mediated dilation, blood pressure, and lipid profile, which are relevant indicators of cardiovascular health.</td>
<td>Geleijnse and Hollman, 2008 Doughari, 2012</td>
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<td>Anthraquinones</td>
<td>Anthraquinones are compounds which occur naturally in some plants, fungi, lichens and insects, where they serve as a basic skeleton for their pigments. Anthraquinones are group of functionally diverse aromatic chemicals, structurally related to anthracene. Anthraquinones are used as laxatives and also used in the treatment of skin diseases. Plant extracts containing anthraquinones are being used for cosmetics, food, dye and pharmaceuticals due to their wide therapeutic and pharmacological properties.</td>
<td>Alves et al., 2004 Li et al., 2004</td>
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<tr>
<td>Terpenoids</td>
<td>Terpenoids constitute one of the largest families of natural products accounting for more than 40,000 individual compounds of both primary and secondary metabolisms. Terpenoids are medicinally used as anti-inflammatory, analgesic, antipyretic, antioxidant, antimicrobial, hepatoprotective, antiviral, antiallergic, antipruritic, antiangiogenic and spasmylytic activity. They are also known to exhibit cytotoxicity against a variety of cancer cells without manifesting any toxicity in normal cells.</td>
<td>Shah et al., 2009 Goto et al., 2010</td>
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<tr>
<td><strong>Alkaloids</strong></td>
<td>Alkaloids are structurally diverse group of over 12,000 cyclic nitrogen-containing compounds that are found in over 20% of plant species. These have contributed to a majority of poisons, neurotoxins and traditional psychedelics (e.g. atropine, scopolamine, and hyoscyamine, from the plant <em>Atropa belladonna</em>) and social drugs (e.g. nicotine, caffeine and cocaine) consumed by humans. Alkaloids have many other pharmacological activities including antihypertensive effects, antiarrhythmic effects, antimalarial activity (quinine) and anticancer actions (dimericindoles, vincristine, and vinblastine).</td>
<td>Zulak et al., 2006.</td>
</tr>
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<td><strong>Reducing Sugars</strong></td>
<td>Reducing sugars contain either an aldehyde group or is capable of forming one in solution through isomerism. The aldehydes function group allows the sugar to act as a reducing agent. Sugar signaling might also be of great importance in plant (defense) responses under biotic and abiotic stresses. Therefore sugars from microbial or plant origin might play crucial roles in host pathogen interactions.</td>
<td>Morkunas et al., 2005 Bolouri-Moghaddam et al., 2010</td>
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<td><strong>Cardiac Glycosides</strong></td>
<td>Cardiac glycosides are secondary metabolites scattered in several unrelated angiosperm families e.g. Apocynaceae, Asclepiadaceae, Convallariaceae, Fabaceae, Hyacynthaceae, Ranunculaceae and Scrophulariaceae. Plants create cardiac glycosides as a strategy for protection against being eaten by other creatures. Some plants like <em>Asclepias</em> species (milkweeds), <em>Convallariamajalis</em> (Lily of the valley), <em>Digitalis</em> species (foxglove), <em>Nerium oleander</em> (oleander), and <em>Urginea maritime</em> (squill) contain cardiac glycosides.</td>
<td>Neuhuber, 2000 Firn, 2010</td>
</tr>
<tr>
<td><strong>Phlobatannins</strong></td>
<td>The name phlobaphen comes from the Greek roots (Phloios) meaning bark and baphe meaning dye. Phlobaphenes are reddish, alcohol soluble and water insoluble phenolic substances. Phlobatannins have astringent properties, and has been recorded in the leaves of <em>Peperomia pellucida</em>.</td>
<td>Mensah et al., 2013</td>
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</table>
Steroids

Plant steroids are one of the most naturally occurring plant phytoconstituents. Plant steroids have found therapeutic applications as arrow poisons or cardiac drugs. Steroids have been observed to promote nitrogen retention in osteoporosis and in animals with wasting illness. Diosgenin and cevadine (from *Veratrum veride*) are examples of plant steroids.

Firn, 2010
Madziga *et al.*, 2010
Doughari, 2012

**Biological activities**

**Antioxidant activity**

In the ancient Indian literature, it is mentioned that every plant on earth is useful for human beings, animals and other plants (Halliwell, 1995). Multiple mechanisms of actions and non-toxic nature of plants, have made plant based antioxidants preferable when compared to the synthetic ones. Good therapeutic efficiency with no side effects, their low price and ability of long-term usage are eminent evidences for the use of natural preparations. These facts have inspired extensive screening of plants for their possible medicinal and antioxidant properties.

Oxygen, an indispensable part of aerobic life under certain circumstances, can seriously affect our well being through the formation of reactive oxygen species (ROS). The ROS represents both free radical and non-free radical species, and their potential deleterious effects include atherosclerosis, ageing, ischaemic heart disease, inflammation, immunosuppression, diabetes, neurodegenerative diseases, cancer and others (Hasan *et al.*, 2009). Frequently encountered free radicals are the hydroxyl radical (HO), the nitric oxide radical (NO), the superoxide radical (O$_2^-$), and the lipid peroxyl radical (LOO) while non-free radical species principally being H$_2$O$_2$ and singlet oxygen (1O$_2$). Proteins, nucleic acids and lipids, react with the free radicals and reactive oxygen metabolites causing changes in genetic material and inactivation of enzymes. Therefore the human health
depends on the efficiency of antioxidant mechanisms. As a result of detrimental influence of peroxidases and oxygen radicals on organisms there is a growing interest in natural antioxidants, especially in polyphenols (Satya et al., 2013). Fruits, vegetables, cereals, leguminous plants, juices, wine, tea and many herbs are reservoirs of antioxidants. Many herbs and spices, usually used to flavor dishes, are an excellent source of phenolic compounds which are known to exhibit good antioxidant activity. The correlation between antioxidant activity and the level of polyphenols or carotenoids exist in plants (Rice-Evans et al., 1996). In the present work, an attempt has been to made to compare the antioxidant capacity of the four Schefflera species selected for the study.

**Hepatoprotective activity**

The liver being the second largest glandular organ of the body, plays a vital role in metabolizing the carbohydrate, proteins, lipids and detoxifying xenobiotics and drugs. The blood flow to the liver is around 20 to 25% of the total cardiac output. Toxins, infectious agents, medications and serum inflammatory mediators result in diverse range of disease processes, leading to loss of normal histological architecture, reduced cell mass and loss of blood flow. About 20,000 deaths are found every year due to liver disorders (Sharma and Sharma, 2010). Exposure to various organic compounds including a number of environmental pollutants and drugs can cause cellular damages through metabolic activation of those compounds to highly reactive substances such as reactive oxygen species (ROS). In the living systems, varieties of antioxidant mechanisms play an important role in combating ROS. The antioxidants act by raising the levels of endogenous defences by up-regulating the expression of genes encoding the enzymes such as catalase (CAT), peroxidase or superoxide dismutase (SOD) (Halliwell, 1990; Aruoma, 1994). Damage to the liver cell membrane leads to the leakage of the cytosolic enzymes into the blood stream. The elevation of these cytosolic enzymes in the blood stream is a needful quantitative marker of the extent of hepatic
damage (Ramaiah, 2007). About 600 commercial herbal formulations with claimed hepatoprotective activity are being sold all over the world. Around 170 phytoconstituents isolated from 110 plants representing to 55 families are reported to possess hepatoprotective activity. In India, more than 93 medicinal plants are used in different combinations in the preparations of 40 patented herbal formulations (Sharma \textit{et al.}, 1991). However, only a small proportion of hepatoprotective plants as well as formulations used in traditional medicine are pharmacologically evaluated for their safety and efficacy (Subramonium and Pushpagandan, 1999). The present study is the first report on the hepatoprotective activity of the selected \textit{Schefflera} species.

\textbf{Antimicrobial activity}

Plants have been a source of inspiration for novel drug compounds since ages, as plant derived medicines have made large contributions to human health and well being. Approximately, 25-50\% of the current pharmaceuticals are derived from plants. Several studies indicate that the medicinal plants contain chemical compounds such as peptides, unsaturated long chain fatty acids, aldehydes, alkaloids, essential oils, tannins, flavonoids, saponins, glycosides and phenols as water or ethanol soluble compounds which are significant in the therapeutic applications against pathogens such as bacteria, fungi and viruses (Parabia \textit{et al.}, 2008). In recent years, the antimicrobial properties of plant extracts have been reported with increasing frequency from different parts of the world. Several laboratory trials have demonstrated that different plant tissues such as roots, leaves, seeds and flowers possess inhibitory properties against microorganisms (Davicino \textit{et al.}, 2007).

The steadily increasing microbial resistance to existing drugs is a serious problem in antimicrobial therapy and necessitates continuing research into new classes of antimicrobials (Woodford, 2003). Many studies have been undertaken with the aim of determining the antimicrobial and phytochemical constituents of medicinal plants and using them for the treatment of both
tropical and systemic microbial infections as possible alternatives to chemical synthetic drugs to which many infectious microorganisms have become resistant (Kumar et al., 2011). Hence, there is an urgent need to evaluate the potentials of plants to manage the microbial infections and identify the secondary metabolites which could be least toxic and cost effective, with minimum side effects. The present study deals with the antimicrobial activity of *Schefflera* species, and is the first report on the antimicrobial activity of *S. wallichiana*, *S. venulosa* and *S. racemosa* as well.

**Characterization of compounds**

Due to the fact that plant extracts usually occur as a combination of various types of bioactive compounds or phytochemicals with different polarities, their separation remains a big challenge for the process of identification and characterization of bioactive compounds. It is a common practice in the isolation of bioactive compounds that a number of different separation techniques such as Thin Layer Chromatography (TLC), column chromatography, flash chromatography, Sephadex chromatography and High Performance Liquid Chromatography (HPLC), should be used to obtain pure compounds. The pure compounds are then used for the determination of structure and biological activity. Besides, non-chromatographic techniques such as immunoassays, which employ monoclonal antibodies (MAbs), phytochemical screening assay, Fourier-transform infrared spectroscopy (FTIR), can also be used to obtain and facilitate the identification of the bioactive compounds (Sasidharan et al., 2011).

**Research on the genus *Schefflera***

The genus *Schefflera* is mainly known as an ornamental plant worldwide. A few species of *Schefflera* have been investigated to address the ecology and distribution. In India, the genus is mainly distributed in the Western Ghats and Nilgiris (Gamble, 1926). The Western Ghats is one among the hotspots of biodiversity and is home for several plant species. They are mountainous ridge running parallel to the west coast of India’s ancient
peninsula, which has a rich and intriguing biodiversity. The *Schefflera* species taken up for the study have been mainly collected from Kodagu district (N12°20′14.97″ and E75°48′24.86″) and Chamundi Hills (N 12°16′21.1368″ and E 76°40′14.3364″), of Mysore district, Karnataka. Kodagu, one of the smallest districts in Karnataka is located in the central part of Western Ghats that has 73% of its landscape under tree cover. The diversity of forested ecosystems and associated biodiversity has contributed to identify Kodagu as a micro hotspot of biodiversity (Khaple *et al.*, 2012). The major phytochemicals isolated and reported from various species of *Schefflera* are mainly saponins and triterpenoid glycosides. Triterpenoid saponins, along with oleanolic acid (Srivastava and Jain, 1989) and a new triterpene (Srivastava, 1992) were reported from *S. impressa* growing in Darjeeling, India. A betulinic acid glycoside was isolated from *S. venulosa* (Purohit *et al.*, 1991). Oleanolic acid, a bidemosidic triterpene saponin, and a trisaccharide were isolated from *S. octophylla* (Sung *et al.*, 1991). *S. leucantha* showed the presence of triterpenoid glycosides (Pancharoen *et al.*, 1994). The leaves of *S. bodinieri* revealed triterpenoids and a triterpene glycoside (Zhu *et al.*, 1996a), while the roots of the plant showed the presence of triterpene glycosides (Zhu *et al.*, 1996b). The aerial parts of *S. divaricata* contained triterpenoid saponins (De Tommasi *et al.*, 1997). *S. bodinieri* has shown receptor binding activities (Zhu and Li, 1999). Antiviral activity has been reported from *S. heptaphylla* (Li *et al.*, 2005). Sabulal *et al.* (2008) have determined the antimicrobial activity of *S. stellata* from the volatile oils of root, stem and leaves. *S. umbellifera* is known to possess antimalarial activity (Mthembo *et al.*, 2010). Cytotoxic saponins have been isolated from *S. fagueti* (Cioffi *et al.*, 2003).

Till date, not much attention has been focused on the phytochemicals and biological activities of the four *Schefflera* species (*S. venulosa*, *S. wallichiana*, *S. racemosa* and *S. stellata*) considered for the present study. Our study is therefore the first report on the phytochemicals, antioxidant activity, hepatoprotective activity, antimicrobial activity and the characterization of bioactive compounds from *S. wallichiana*. Therefore, owing to the available
information on the Schefflera species, the following objectives are proposed for the study:

**Objectives**

1. Comparative phytochemical analysis of *Schefflera* species, from southern Karnataka.

2. Screening of solvent extracts from *Schefflera* species for antioxidant assays and evaluating their hepatoprotective activity.

3. Antibacterial activity of solvent extracts from *Schefflera* species.

4. Characterization of bioactive compounds from *Schefflera* species.