1. INTRODUCTION

The earth is a home to a rich and diverse array of living organisms, whose genetic diversity and relationships with one another and with their physical environment constitutes biodiversity. This biodiversity is the natural biological capital of the earth. Man’s survival has been dependent on his innate curiosity, his desire to examine by trial and error all aspects of his environment, and to conclude which materials are remedial, which ones are harmful, and which give him the greatest nourishment. Nature by its very design provides a remedy for nearly any disease that may afflict a human being. “We come on this earth as guests of plant” is a monumental ancient aphorism. In his long struggle to achieve mastery over the powerful forces of nature, man has always turned to plants for help.

Long before the earliest record that is available today, it seems many different people and cultures discovered that some plants are good for food, some are poisonous, and some produce bodily changes such as increased perspiration, bowel movement, urination, relief of pain, hallucination and healing power. In fact, from the start of life to the last breath, almost every aspect of human life is deeply associated with plants. This is especially so, when he was struck with ailments, both physical and mental. In the past, almost all the medicines were from the plants, the plants being man’s only chemist for ages. Slowly by trial and error, some tried and trusted herbal remedies were amassed resulting in a corpus of information about the medicinal plants.

The traditional definition of medicinal plants is in Ashtaanga Hrdaya (600 AD) ‘jagatyevam anoushhadham na kinchit vidyate dravyam vashaannaarthayagayoh’ (Sutra Stha Ch. 9 – verse 10). This means “There is nothing in this universe, which is non-medicinal, which cannot be made use of for many purposes and by many modes” (Raveendra Retnam and Martin, 2006). The widespread use of plant remedies and healthcare preparations, as those described in ancient texts such as the Vedas and the Bible, and obtained from commonly used traditional herbs and medicinal plants, has been traced to the occurrence of natural products with medicinal properties. The scientific
studies of medicinal plants were carried out all over India since Vedic times 3000 BC to 1000 BC. Ayurveda, written probably between 2500 and 900 BC, established the real foundation of ancient medical sciences. Initially, the medicinal plants formed the bulk of folk or ethno-medicine, practiced in India and some other parts of the World like China, the Middle East, Africa and South America. Later, a considerable part of this indigenous knowledge was formulated, documented and eventually passed into the organized systems of medicine, such as Ayurveda, Siddha, Unani, Homoeopathy and Amachi (Sane, 2002). It is indeed very interesting to note that our ancestors were well equipped with a vast knowledge regarding drugs of natural origin, but unfortunately, they possessed scanty knowledge and idea to isolate and obtain pure chemical compounds having prominent biological activity.

Plants had been priced for their medicinal, flavouring and aromatic qualities for centuries but the synthetic products of the modern age surpassed their importance for a while. Though, the synthetic drugs have swapped herbal healing at a certain level, renaissance and awareness on herbal medication is coming back. Moreover, medicinal plants are still the mainstay of healthcare in the lives of rural people. Even now, in an age dominated by scientific and technological marvels, by miracle drugs and miracle cures, botanicals or their synthetically derived equivalents account for a majority of prescriptions or even non-prescription medicines (Bhandari, 2009). Further, drugs of natural origin are gaining greater acceptance from the public and the medical profession due to greater advances in understanding the mechanism of action by which medicinal plants can positively influence the health and quality of life.

India in general and the hills in particular, always held a high place as the supplier of plant drugs and aromatic plants used for a variety of pharmaceutical purposes. It is because of the fact that climatic conditions varying from the torrid to the frigid zones exist in India, embraces vast tracts of tropical, subtropical plateau, temperate hills and the valleys, dry alpine areas and irrigated soils, etc. The country has in fact been described as an epitome of climates, seasons and soils of the world. India is well known as ‘Emporium of Medicinal plants’ growing up to 75% of the plant drugs mentioned in the pharmacopoeias of different countries. In addition to the medicinal plants, aromatic and
essential oil-bearing plants constitute an important group of Indian flora and a large number of them are used in the indigenous systems of medicine, including some traditional drugs used by the rural, semi-rural and the tribal population. The World Health Organization has listed 20,000 medicinal plants globally (Gupta and Chadha, 1995), especially, India’s contribution being about 15-20% (Singh, 2000). Out of the 17,500 species of the flowering plants, scientists know about 3000 species, but the tribal populations have known about 10,000 of them. Of these, they have recorded 5200 having medicinal use, 3500 edible use, 500 fibre use, 325 pesticidal use, and about 475 used as gum, resins and dyes (Raveendra Retnam and Martin, 2006). According to the World Health Organization estimates, about 80% of the population in the developing countries depends directly on plants for its medicinal values (Pareek, 1996). In India, about 2000 drugs used are of plant origin (Dikshit, 1999).

Population rise, inadequate supply of drugs, prohibitive cost of treatments, side effects of several allopathic drugs and development of resistance to currently used drugs for infectious diseases have led to increased emphasis on the use of plant materials as a source of medicines for a wide variety of human ailments. Several diseases like cancer, AIDS, rheumatoid arthritis, hepatitis and infectious diseases still lack satisfactory solution. The Allopathic system of medicine has adopted a number of plant-derived drugs which form an important segment of the modern pharmacopoeia. Approximately one-third of all pharmaceuticals are of plant origin, wherein fungi and bacteria are also included. Over 60% of all pharmaceuticals are plant-based. The drugs are derived either from the whole plant or from different organs, like leaves, stem, bark, root, flower, seed, etc. Some drugs are prepared from excretory plant product such as gum, resins and latex. In the commercial market, medicinal plants are used as raw drugs, extracts or tinctures (Fugh-Berman, 2000).

Medicinal plants are an integral part of research and development in the pharmaceutical industry with a research focus on isolation and direct use of active chemical constituents. The biodiversity of plant species coupled with the chemical diversity found within each plant, leads one to the conclusion that plants are perhaps the most valuable source of new bioactive chemical entities. There are two types of plant
chemicals, one of which is the primary metabolites such as common sugars, carbohydrates, proteins, amino acids and chlorophyll. These are universally present in all kinds of plants whether medicinal or non-medicinal. The other types of chemicals called secondary metabolites include alkaloids, terpenoids, phenolics, etc., which do not have an essential role in plant metabolism and vary in their distribution from plant to plant. Secondary metabolites are mostly accumulated by plant cells in smaller quantities than primary metabolites. They are synthesized in specialized cells at particular developmental stage which makes their extraction and purification difficult. The secondary metabolites exert a profound physiological effect on the mammalian system and thus are known as the active principles of that plant (Padma, 2009). The physiological effect of these active principles is used for curing ailments.

In the 19th century, scientists started works on the active compounds in plants that gave a way to the research on molecular level. The importance of medicinal plants lies in their biological active principles, which are the real healers in the process of medication. Therefore, the screening of plants for their biologically active principles is done on the basis of ethno-botanical knowledge for a particular disease. Chemotaxonomic investigations also involve the use of biomolecules. Identification of the action of a particular compound against a specific disease is a challenging and long process (Ahmed, 2010). Subsequently, with the advance in techniques of molecular biology, phytochemistry and pharmacology, a number of active principles of medicinal plants were isolated and introduced as valuable drugs in modern medicine. Thus, the new medical science is affirming much of the old herbal lore and extending horizons to botanical medicines (Trivedi, 2006).

Oxygen is a double-edged sword. The organisms cannot live without oxygen but at the same time, human beings are continuously exposed to oxygen toxicity. However, molecular oxygen is neither very reactive nor very toxic. The apparent toxicity of oxygen is actually due to free oxygen radicals formed by partial reduction of molecular oxygen. During the process of oxygen utilization in normal physiological and metabolic processes approximately 5% of oxygen gets univalently reduced to oxygen derived free radicals (Halliwell and Gutteridge, 1988; Yu, 1994) like superoxide, hydrogen peroxide, hydroxyl
and nitric oxide radicals. All these free radicals known as reactive oxygen species (ROS) are neutral, short lived, unstable and highly reactive to pair up the odd electron and finally achieve stable configuration. They are capable of attacking the healthy cells of the body, causing them to lose their structure and function. The reactive oxygen species exert oxidative stress towards the cells of human body rendering each cell to face about 10000 oxidative hits per second (Lata and Ahuja, 2003).

A normal cell may control or prevent such adverse reactions by physically separating oxygen from susceptible molecules by providing molecules that effectively compete for oxygen losing, inactivating or removing damaged molecules or by rapidly repairing damaged molecules. Humans have evolved a highly sophisticated and complex antioxidant protection system, that functions interactively and synergistically to neutralize free radicals (Temple, 2000). There are many enzymatic and non enzymatic antioxidant defense systems in the body that remove these toxic species (Clark et al., 1985). The amount of antioxidant principles present under pathological conditions may be insufficient to neutralize free radicals generated. When generation of ROS overtakes the antioxidant defense of the cells, the free radicals start attacking the cell proteins, lipids and carbohydrates (Yu et al., 1992; Campbell and Abdulla, 1995 and Cotran et al., 1999). The therapeutic benefit of plants is often attributed to their antioxidant properties (Hertog et al., 1993; Zhang et al., 2001; Dixon et al., 2005). Therefore, it is obvious to enrich our diet with antioxidants that are capable of stabilizing or deactivating free radicals before they attack cells (Beris, 1991). Hence there has been an increased interest in preventive medicine in the development of “Natural antioxidants” from plant materials.

The indiscriminate use of synthetic drugs against microbial pathogens has resulted in mutation of strains making them insensitive to these chemical agents leading to the global hazard of drug resistance. Considerable progress has been made from the past two centuries when the chemists and biologists accepted the challenge of combating the dreadful diseases by synthesizing a wide plethora of organic compounds having capacity to combat various pathogens. The scientists of the 21st century are generally reviving our traditional knowledge and are screening various parts of plants scientifically used in the folklore medicine in search of newer lead compounds having antimicrobial efficacy. This
has influenced many of the pharmaceutical companies to produce new antimicrobial formulations extracted from plants or herbs. Therefore, plants are often considered to be harmless compared with western medicines (Hseih et al., 2008).

There is renewing interest in phytomedicine during the last decade and nowadays many medicinal plant species are being screened for pharmacological activities (Gautam et al., 2007). It is high time the hidden wonders of plant molecules were revived with the modern tools of target-based screening to develop newer advanced generation of antioxidants and antimicrobials with novel modes of action. A systematic approach through experimental and clinical validation of efficacy is required for a plant identified for traditional medicine, as is done in modern medicine. Animal toxicity studies are also required to establish the potential adverse effects.

Plants of the family Elaeocarpaceae have been reported to be used in traditional medicines particularly in India. A noteworthy chemical feature of Elaeocarpaceae is their ability to elaborate a series of oxygenated steroids or cucurbitacins and ellagic acid derivatives which abound in this family, hold some potential as a source of cytotoxic agents (Fang et al., 1984; Ito et al., 2002; Rodriguez et al., 2003). Other principles of interest in Elaeocarpaceae are indolizidine alkaloids, which have attracted a great deal of interest on account of their ability to inhibit the enzymatic activity of glucosidases because of a structural similarity with glucose; hence there is some potential to explore it further in the treatment of Human Immunodeficiency Virus, diabetes and cancer. A small number of indolizidine alkaloids have emerged that have therapeutic indices favouring their introduction into clinical practice (Wiart, 2006). All these pharmacological events together lend considerable support to the view that Elaeocarpaceae plants would be worthy screening thoroughly for cytotoxic agents. One can reasonably expect the discovery of molecules of chemotherapeutic value in this large family.

_Elaeocarpus_, a genus with about 360 species of the family Elaeocarpaceae, are reported from different parts of Asia, including Nepal, Bhutan, Sikkim, Tibet, Java, Indonesia, foothills of the Himalayas and various parts of India, 25 are found in India. _Elaeocarpus_ species contain hard and highly ornamental stony endocarp of fruit (nut)
commonly known as ‘Rudraksh’. The stony endocarp is used as religious jewellery in the form of beads throughout India and Southeast Asia. Rudraksha beads are dielectric as they store electrical energy and they have permanent magnetic properties. The bead boosts the concentration and will power of the wearer. The complete list of all the properties found inherent in the Rudraksha beads includes electromagnetism, paramagnetism, diamagnetism and dynamic polarity or the ability to change polarity. Wearing of Rudraksha controls heart beat and has a positive effect on blood pressure, stress, anxiety, depression, palpitations and lack of concentration. Rudraksha beads users have repeatedly confirmed the medicinal properties (Bhuyan et al., 2002).

With this in mind, this research was undertaken to evaluate the antioxidative, antimicrobial, anti-inflammatory and anti-ulcer potentials of *Elaeocarpus serratus* L. and *Elaeocarpus tuberculatus* Roxb. Both the species are distributed in the Kodaikanal Forest Division. This Forest Division contains 36740 ha of Reserve Forest and 4000 ha of Reserve Land. This division is located in Dindigul Revenue District and lies within 10° 6' and 10° 21' North latitudes and 77° 16' and 77° 42' East longitudes and is surrounded by Kerala Forest Division on the North and East and Theni Revenue District in South. This area is also known as Upper Palani Hills of Western Ghats. The altitude varies from 300 metres (Ganguvarpatty) to 2654 metres (Vandaravu Peak). The minimum temperature of Kodikanal varies between 8°C to 13°C and the maximum temperature varies between 16°C to 22°C. The type of forests in this Division varies from Dry Mixed Deciduous Forests to Montane Wet Temperate Forests which is commonly known as “Shola” and “Grassland” Vegetation. The Shola forests exhibit high bio-diversity and the rarest type in the world especially, the Kukkal Shola of the Upper Palani Reserve Forest which has some unique features. It is now fenced in and under the care of the Tamil Nadu Forest Department. Very rare single fern trees, jamun and rudraksha trees, 26 species of cinnamon and the Shenbaga tree highlight the plant biodiversity (Soma, 2004). The Rudraksha is found in the second storey of the Shola forests, which are characterized by three tier forest structure.

*Elaeocarpus serratus* L. (Commonly called Ceylon-olive. Tamil: Karai, Karamaram, Olan karai, Ulang karei, Uttraccham) is a tree that grows up to 18m tall in evergreen to
semi-evergreen forests up to 1600 m. Bark brownish, smooth; blaze orange red. Branchlets terete, glabrous, with scars of fallen leaves. Leaves simple, alternate, spiral, clustered at twig ends; petiole 1.2 – 4 cm long, swollen at both ends, glabrous; lamina elliptic, apex acuminate or obtuse, base acute, margin serrate, glabrous, red when senescent; midrib slightly raised above; secondary nerves 5 – 9 pairs. Inflorescence racemes; flower petals white, laciniate; peduncle to 8 cm long; pedicels 5-8 mm long. Calyx of 5 lobes, free, 5-7 mm long, ovate-lanceolate, reddish, hairy. Petals 5, free. Stamens many, free, filamentous; anthers 2-celled, with tufts of hairs at tips. Fruit drupe, oblong, ellipsoid or ovoid to 2.5 cm long; seeds 3 – 4. Flowering: September-October, Fruiting: January (Gamble, 2005). *E. serratus* is used as diuretic and as a cardiovascular stimulant. The leaves are used in the treatment of rheumatism and as antidote to poison, while the fruits are locally prescribed for the treatment of diarrhea and dysentery. The fruit juice of *E. serratus* is given for stimulating secretions from taste buds thus increasing appetite in patients (Ghani, 1998).

*Elaeocarpus tuberculatus* Roxb. (Tamil: Malampinnai, Ruthtraksham) is a majestic tree to 45 m; crown very extensive with horizontal branch system. Commonly seen on slopes, 600-1800m (clearly low altitude): in ravines, by river banks, etc. Leaves obovate, to 20 x 9 cm, coriaceous, rusty below, base obtuse, margin serrate, apex obtuse; petiole 3 cm. Inflorescence pendulous, massive, rusty. Flowers in peak during April-June. Racemes upto 14 cm, below foliage, 15-flowered; peduncle 2 cm. Flowers 2 cm wide, nodding; pedicel 2 cm. Sepals 5, lanceolate, margin recurved. Petals 5, cream, obovate; apical frills 20. Disk 10-angled. Stamens 60, in 3 whorls. Ovary globose, 2–celled; ovules 8 per cell. Fruits massive, persisting into the next season. Drupe ellipsoid, laterally compressed; seed 1, ellipsoid (Gamble, 2005). Decoction of the bark is used as a remedy for rheumatism, indigestion and biliousness. Rudraksa beads or seeds are used as a treatment for rheumatism, typhoid fever and epilepsy (Pullaiah, 2002).

In this work, the various solvent (acetone, methanol and water) extracts obtained from *Elaeocarpus serratus* and *Elaeocarpus tuberculatus* were evaluated for their *in vitro* antioxidant, antimicrobial and *in vivo* pharmacological activities, which to the best of
contemporary knowledge, has not been reported for these plants so far. The objectives of the present study are:

- To find out the per cent yield of acetone, methanol and water extracts of leaf, stem bark and fruit of *E. serratus* and *E. tuberculatus*.

- To estimate the antioxidant phytoceuticals (total phenols, flavonoids and tannin) in the acetone, methanol and water extracts of leaf, stem bark and fruit of *E. serratus* and *E. tuberculatus*.

- To characterize the distribution of the *in vitro* antioxidants present in the extracts of leaf, stem bark and fruit of *E. serratus* and *E. tuberculatus*. The extracts were examined using eight complementary *in vitro* assays in order to evaluate its natural antioxidant properties.

- To confirm the antimicrobial potentiality of the solvent extracts of *E. serratus* and *E. tuberculatus*.

- To assess the *in vitro* anti-inflammatory activity of the ethanolic extracts of the leaf and stem bark of *E. serratus* and *E. tuberculatus*.

- To investigate the *in vivo* anti-inflammatory and anti-ulcerogenic activities of ethanolic extracts of leaf and stem bark of *E. serratus* and *E. tuberculatus*. 