CHAPTER I

General Introduction
1. GENERAL INTRODUCTION

1.1 Origin of the study

Nature is the chief source of novel & active chemotypes for valuable drug development. The world of the plants and all natural sources represents a virtually untapped reservoir of valuable drugs. Much of the nature still remains to be explored, awaiting discovery from terrestrial and marine sources. Phytochemicals known for medicinal activities are rich in secondary metabolites, which are latent source of the drugs. Despite the great successes already achieved in natural products chemistry and drug development, we have barely begun to tap the potential of their molecular diversity. Only 5% to 15% of the 250,000 species of higher plants have been chemically and pharmacologically investigated in a systematic way. Thus there is a desperate need to expand the exploration of natural source for novel active agents, which can serve as the leads and scaffolds for elaboration into efficacious drugs for a multitude of diseases.

The Indian Materia Medica, together with the common household remedies, currently includes nearly 2,000 different drugs. Among this, nearly 200 are of mineral origin; 200 of animal origin and the remaining of plant origin. The study of native drugs, therefore, means the study of Indian medicinal plants used for healing of wide variety of diseases. India abounds in all kinds of food plants, spices, perfumes, timber, fibers, gums, etc., which have been known all over the world from ancient times. It is not surprising, therefore, that plants containing active and medicinal principles also grow abundantly. More than 2,000 plants, out of a total of about 11,000 species found in India, are contend to have medicinal properties of some description or other. The families to which the large number of medicinal plants belongs include Leguminoseae, Composite Labiateae,
Kuphorbiaceae, Rubiaceae, Rosaceae, Liliaceae, Rutaceae, Ranunculaceae, Umbelliferae, Cucurbitaceae, Solanaceae, Apocynaceae and Malvaceae (Chopra & Chopra, 1955).

1.2 Ethnopharmacological approach in bioprospecting

The ethnopharmacological information may be used to provide search for new drugs in three levels: (i) general indicator of non-specific bioactivity suitable for broad screens; (ii) indicator of specific bioactivity suitable for high-resolution bioassays; and (iii) indicator of pharmacological activity for which mechanism-based bioassays have yet to be developed.

1.2.1 The selection process- a vital and basic step

1.2.1.1 Plant material

The criteria used for selecting plants for investigation are based on: (i) traditional medicinal information (ethnopharmacological knowledge); (ii) chemical composition of the plant species and (iii) literature reports on plant extract pharmacology and ethnomedical claims. The selection of the plant material for the screening of biological activity is based on a random selection or ethnopharmacology, whereas existing knowledge of the particular healing properties has been handed down from generation to generation, especially among traditional practitioners. Additional mechanism for the identification of the plants for the study of its chemical constituents is based on chemotaxonomy, the science focusing on the correlation between related plant species and the occurrence of secondary metabolites. Rutaceae, family of flowering plants belonging to the order Sapindales is valuable as a source of edible fruit and as ornamentals. Despite the extensive traditional uses of *Feronia limonia* Linn, it is
remarkable that this species is indigenous to India and has not much been the subject of pharmacological and extensive phytochemical studies. State of the efficacy of the plant in its traditional usage therefore requires validation and accurate documentation. For this reason, we have initiated the present study as a basic step for scientific validation pertaining to its traditional use.

Different approaches may be employed in the process of bioprospecting. Cotton (1996) outlined three main approaches to the collection of plants for screening: the random method, where every species in a given area is included; phylogenetic targeting, where a particular taxon (such as a family) is targeted, because it is already known to be a good source of pharmacologically active metabolites; and the ethno-directed sampling, which is guided by traditional plant usage. The later approach is based on the concept that the initial screening and selection has already been conducted effectively by the owners of the traditional knowledge. The ethno-directed approach for identifying plants with biological activity has been shown in a number of studies to be more efficient than the random method at identifying plants with promising pharmacological activity.

1.2.1.2 Biological activity/ assays

The origin and design of a screening process incorporates knowledge attained in ethnomedicine, traditional uses of the plants, pharmacognostic & phytochemical evaluation and correlation to specific biological targets together with the use of natural product libraries and general/ targeted literature review. The selection of the screening assays for the evaluation of biological activity is a complex process where a number of factors require careful consideration. Ethnobotanicals may possess a number of biological activities, which must be evaluated for their respective applications. This is possible only
through detailed understanding and implementation of basic assays designed to target the biological activity. An insight of physiology of the processes and the chemical composition of the specific extracts is hence crucial. Stable standardized crude extracts are prepared and assayed for the known or claimed activities for which the particular plant species is traditionally used, as well as for activities documented for related species both indigenous and exotic species. The present study, therefore, focused on antimicrobial, anti-inflammatory, anti-oxidant and anticancer activities.

1.3 Role of traditional medicine: Benefits and challenges.

Since the ancient time, humans used the plants and their products for curing ailments, though they were not known about the components of the particular plant to be used in a specific disease. Despite many achievements in human health care in the twentieth century many of the world’s population in developing countries lack regular access to affordable vital drugs. For such community, modern medicine is never likely to be a realistic treatment option. Traditional medicine is generally cheaper than modern medicine and affordable to most people. It is important for primary health care delivery and its use is widespread in developing countries (Zhang, 2000). The cost of modern medicine is increasing by the use of modern health technology and in many cases is unsuitable to the immediate needs of the people in developing countries. Sometimes traditional medicine is the only reasonable source of health care especially for the world’s poorest patients (Tabuti, 2004). Herbal medicines used for treating malaria are considerably cheaper and may sometimes even be paid for in kind (WHO, 2002).

Due to the widespread use of traditional and complementary medicines (TCM) for primary health care and rich medicinal plant tradition, it is recently captured the attention
of the pharmaceutical industry and the medical research community, both of which have sought to capitalize on the knowledge contained therein (Vos, 2010). Natural products used in TCM have been the primary source of early drug discovery and still continues to provide new therapeutic chemical entities against various pharmacological targets including malaria, Alzheimer’s disease, cancer, inflammation and other microbial infections. As analyzed by Fabricant and Farnsworth (2001), the origin of the drugs developed between 1981 and 2001 showed that 80% out of the 122 plant derived drugs, were related to their original ethno pharmacological purposes. Between 2000 and 2005, about 5 medicinal plant based drugs were introduced in the US market and other such few currently are in clinical trials around the world (Chin et al., 2006).

With the human refinement, screening of the bioactive compounds from the plants lead to the discovery of new medicinal drugs having cost-effective protection and treatment roles against both communicable and non-communicable diseases. Presently, synthetic drugs are available against almost all the diseases, but they have adverse effect on the body physiology of the patient. To overcome these side effects research is going on to isolate different plant compounds in the pure form and the efforts are going on to develop new drug formulations to combat the pathogenic diseases and drug resistance evoked in pathogens. Encouragingly, many of the plant compounds have been fruitfully isolated and tested against the disease causing pathogens, however, these are less effective against certain viral diseases. Secondary metabolites isolated from plants such as tannins, terpenes, flavonoids, alkaloids, sterols and coumarins play a vital role in serving the man as a life saver and reliever by functioning as antimicrobial, anti-diabetic, anticancer, anti-inflammatory, analgesic, and antipyretic activities. Few of them are used
as drug templates and are of wide commercial value. Phytochemical studies may be directed towards characterizing the chemical composition of complex essential oils or plant extracts. Phytochemical screening can assist the taxonomic classification whilst the bioassay guided studies which can be targeted to identify biologically active compounds in complex plant extracts.

Apart from the advantages of traditional medicine many problems must be tackled to maximize the potential of traditional medicine as a source of health care. Perhaps one of the greatest arguments against traditional medicine today is the lack of scientific proof of its efficacy. There is no thorough scientific investigation on most of the claims made by the traditional medicine practitioners. In addition to a problem of efficacy traditional medicine has a problem of safety. People think that herbs are ‘safe’ and ‘harmless’ since they are natural and are not invented in the laboratory. But utilization of herbs may possibly expose the patient to unknown dangers. For example aristolochic acid and other components within herbs can cause adverse renal effects and renal toxicity (Wojcikowski et al., 2004). There is also possible adverse reaction between herbal therapy and biomedical medications. Unfortunately most patients do not inform their health care provider that they are using herbal therapy, this may result in adverse reactions which can be serious and fatal.

1.4 Traditional medicine and drug discovery

Although it is these traditional medicines that provided the link between medicine and natural products, but it was in 19th century that active compounds were isolated and principles of medicinal plants were identified. Regardless of the discovery of natural products from higher plants, the attention of chemists, pharmaceutical researchers and
pharmacologists turned to the production of synthetic compounds. It was in the late 19th century, study was directed towards modification of natural products, with an effort to boost biological activity, to enhance selectivity, decrease toxicity and side effects. One such example is Aspirin, the first modified natural product. In recent years, nevertheless, industry has once again turned its interests to natural product research (Phillipson, 2001).

In drug discovery, the major secondary metabolites (terpenoids, phenolics, and alkaloids) are of potential medicinal interest. Secondary metabolites are synthesized by the plant during development and are time, tissue and organ specific. They can be induced by biotic and abiotic factors. In contrast to primary metabolites, they are not present in all plant cells and not essential to sustain growth. Functions of secondary metabolites are: deterrence against predators and pathogens, attraction and prevention against pollinators, allelopathic action, attraction of symbionts, food for pollinators, symbionts, herbivores, pathogens and decomposers.

The study of the plants used in the traditional medicine requires the effective integration of information on chemical constitution of the plant extracts and pharmacological activities of the isolated compounds. The means of isolating and identifying the lead compounds from a complex mixture requires a number of resources, including comprehensive knowledge, specialized equipment and skills. The need for the discovery of new agents is a consequence of indecipherable factors that come into play, includes the emergence of new killer diseases, antimicrobial drug-resistance, ineffectiveness of synthetic drug and the high cost in bringing them to the market. A swing towards natural product research is further driven by significant advances in plant technology, biotechnology and analytical chemistry. There is a great need and ethical
obligation to accurately document on medicinal plants. This aids in the proper preservation and conservation of traditional knowledge, thereby preventing the further disappearance of indigenous systems of medicine, which may potentially benefit the society in general.

The methodology for the drug development from plant resources depends on the aim of the study. Different strategies will result in an herbal medicine or in an isolated active compound. The selection of a suitable plant for pharmacological study is a very important step and there are several ways including traditional use, toxicity, chemical content and randomized selection. It is also sometimes inevitable to use a combination of several criteria. Also, searching databanks and scientific literature is crucial in finding active and/or toxic compound that have already been recognized and is used as a criteria for choosing plants, for example if the purpose is to find a new source (Rates, 2001). The long-term success of the ‘herbal renaissance’ currently experienced in most of the industrialized world undoubtedly depends on the scientific foundation of traditional uses.

The discovery process is compiled of a number of stages. The first stage is the use of a naturally occurring material for some purpose reported already, which is related to a medicinal use. Consideration of the cultural practice associated with it is important in deciding possible bases of the reputed activity. If there is an indication of valid effect, then the material should be identified and characterized based on scientific nomenclature. It is then collected for experimental studies, involving few tests for determining the biological activity, further linked with isolation and structure determination of phytochemicals present responsible for the observed activity. Figure 1.1 represents
conceptual scheme of modern approach in development of plant based healthcare products.

According to the above scheme, the plant products are selected as medicine for the study based on any one or all of the following criteria viz.; ethnomedicinal knowledge, taxonomical relation to well studied therapeutically important plants and the current scientific knowledge available about plants. After selection, through bioactivity evaluation / validation are made by conducting various analysis and bioassay guided fractionation. Finally, identification of active fraction and chemical characterization including structure elucidation has to be done. When the chemistry of the active principle is established, the standard drug screening protocol may be followed to validate the results that include animal studies and various clinical trials. On successful completion of these scientific methodologies, a standard plant based product can be formulated for disease prevention, cure or management.

Today, high-throughput screening is made to test thousands of potential targets with various diverse chemical compounds in order to identify promising lead compounds. The other method for the rational drug design involves the design and synthesis of the compounds based on the known structure of either a specific target or one of its natural ligands. The outcome of the Human Genome Project and Human Pathogen Genome projects will provide many new potential drug targets. Thus, target identification must be followed by target validation, which validates the likelihood of interfering with the target protein which will impact on the disease. The development of a new therapeutic drug is a complex, long and expensive process. It takes about 10-15 years and 50 crores $ to bring a drug from model to market. This consists of 2-4 years pre-clinical development, 3-6
years clinical development and extra time for dealing with the regulatory authorities according to Abrantes et al., (2004).

1.5 Global standpoint of traditional medicine

Recent trends in the use of traditional and complementary medicine is increasing gradually in many developed, developing and under developed countries. It was estimated that about 42.5 million of patients were made to visit the herbalists in 1990 in USA, on contrary to 388 million patients were made to visit to the primary health care centers. About 20 million of patients in Germany have used homeopathy, acupuncture, chiropractic and herbal treatment in the year 1992. About 60% of the population of Australia are using the complementary medicine, whereas 17,000 herbal products have already been registered and a total of US $650 million was spent on the complementary medicine in the year 1998 (WHO, 2000).

The use of the traditional medicine in countries like Africa, Asia and America accounts to 80% of the population and government in these regions have incorporated traditional medicine practices to meet the primary health care needs of the common people. In industrialized countries, half the population now use the traditional medicine for their healthcare (United States, 42%; Australia, 48%; France, 49%; Canada, 70%), and a significant practice exists in the developing countries (China, 40%; India, 70%; Chile, 71%; Colombia, 40%; up to 80% in African countries) (Bodeker and Kronenberg 2002; WHO, 2002; Unnikrishnan, 2009). Heavy burden of the communicable diseases like malaria, HIV and other parasitic diseases like pneumonia, diarrhea, tuberculosis, together with chronic diseases such as diabetes, ischemic heart diseases etc., steadily bother the lives of the common people in these countries. Fast demographic changes and
urbanization, environmental changes and related epidemics, elevated maternal and child mortality, fruitless health support systems for the poor population, relocation of medical experts, increase in the privatization of health services are among the major public health problems.

Traditional herbal medicine still occupies a prominent role in China in the approach to treat severe acute respiratory syndrome (SARS). The use of the herbal medicine in Africa is around 80%, and the worldwide annual market for the herbal products, it has reached US$ 60 billion market (Jon and Ted, 2008). China, India, Nigeria and the United States of America (USA) together with the aid of WHO have made considerable research investments in the herbal medicines. Investment from the industry rises to millions of US dollars in search for the promising herbal products. It is comparatively a reserved investment in the overall pharmaceutical industry.

### 1.6 Plant products as prophylactic agents

Plant drugs have no noticeable detrimental action at the optimum concentration. Majority of the compounds in the nature belong to this group and are known to act as prophylactic agents. Prophylaxis is defined as the treatment given or action taken to protect the body from several degenerative diseases, especially oxidative stress in consequence to the metabolism. The antioxidant hypothesis evolved with the proposal that high intake of dietary antioxidants will prevent the oxidation of plasma and thereby leading to oxidative stress (Gey, 1987). In recent times, attention has been given to the plant phenolic antioxidants like flavonoids which have a protective role against the damage caused from oxidative stress (Frankel and German, 2006). Prophylactic activities of phytochemicals are thus attributed to the antioxidant/radical scavenging activities to
retard oxidative stress. Free radicals are reactive chemical entities produced in the body during the metabolic activity but often they are overproduced and cause damage to the biomolecules like DNA, protein, fatty acids and others, leading to the degenerative process & aging. Hence, it forms the basis for the onset of various diseases.

1.7 *Feronia limonia* Linn

1.7.1 Rutaceae- citrus or rue family

Rutaceae, the family of flowering plants belongs to the order Sapindales, is valuable as a source of edible fruits and ornamentals. The Rutaceae includes woody herbs, shrubs, and trees with glandular punctate, commonly strong smelling herbage comprising about 160 genera and 1,600 species distributed all over the world, chiefly in warm temperate and tropical regions. Majority are found in Africa and Australia, often in semiarid woodlands. The leaves are alternate or opposite, simple or palmately/ pinnately compound; stipules are absent. The flowers are often sweet-scented, bisexual, and are actinomorphic or sometimes zygomorphic. The flowers are generally perfect (containing both male and female reproductive organs in the same flower) and rarely unisexual. The flowers are prominent for their fragrance, colour and nectar.

There are various types of fruits family, for example, capsules (genus *Ruta*), follicles (*Zanthoxylum*), drupes (*Amyris*), berries (*Triphasia*), samaras (hop tree), and schizocarps (*Helietta*). A citrus fruit is actually a modified berry. The family contains economically important Citrus species including the lemon (*Citrus limon*), sour orange (*C. aurantium*), sweet orange (*C. sinensis*), lime (*C. aurantifolia*), tangerine and mandarin orange (*C. reticulata*), grapefruit (*C. paradisi*), and citron (*C. medica*). Other important fruits are the kumquat (*Fortunella*), bael (*A. mermelos*),

### 1.7.2 Taxonomy

- **Kingdom**: Plantae
- **Sub-kingdom**: Tracheobionta
- **Superdivision**: Spermatophyta
- **Division**: Magnoliophyta
- **Class**: Magnoliospida
- **Subclass**: Rosidae
- **Order**: Sapindales
- **Family**: Rutaceae
- **Genus**: Limonia L.
- **Species**: *Feronia limonia* Linn.

**Current name**: *Feronia limonia* Linn (synonyms. *Feronia elephantum; Limonia acidissima; Limonia elephantum; Schinus limonia; Hesperethusa crenulata*).

### 1.7.3 Common names

- **English**: Wood Apple, Elephant Apple, Monkey Fruit or Curd Fruit
- **Kannada**: Belada / Byalada Hannu
- **Telugu**: Vellaga Pandu
- **Tamil**: Vilam Palam
- **Malayalam**: Vilam Kai
- **Hindi**: Kaitha or Kath Bel
- **Marathi**: Kavath
- **Sanskrit**: Kapittha, Dadhistha, Kapipriya, Dadhi, Puspaphala
1.7.4 Origin and Distribution

*Feronia limonia* Linn is the only species of its genus belonging to the family Rutaceae. It is native to India, China, Indonesia and Sri Lanka. The wood-apple is common in the wild and dry plains of India and Ceylon. It is cultivated along the roads and edges of the fields and rarely in the orchards. In India, the fruit was called "poor man's food" traditionally due to its high nutritional contents; until the processing techniques were developed in the mid-1950's.

1.7.5 Ecology and botanical description

The *Feronia limonia* Linn is native and found commonly in dry plains of India. It prefers a monsoon climate with a distinct dry season. The tree grows up to an elevation of 450 m. It is apparently drought tolerant and best adapted to light soils. It is a large tree growing to 9 meters tall, with spiny rough bark. The leaves have 5-7 leaflets which are pinnate; each leaflet is 25–35 mm long and 10–20 mm broad, with a citrus-scent when crushed. Dull-red or greenish flowers (1.25 cm) wide found in a loose, small, terminal having lateral panicles & they are bisexual. The fruit is round to oval, 5-12.5 cm wide having a hard, woody, gray scurfy rind. The fruit pulp is brown, odorous, astringent, resinous, acid or sweetish, with several small, white seeds spread throughout. The fruit looks similar in appearance to fruit of Bael (*Aegle marmelos)*.

1.7.6 Nutritional value

100 grams of wood apple pulp contains 140kcal. The fruit contains large amount of carbohydrates and proteins. It is also rich in beta carotene, vitamin B, vitamin C, thiamin and riboflavin. Wood apple fruits that grow in the wild tend to have more tannin than those cultivated for commercial purposes.
1.7.7 Medicinal Uses

The literature survey reveals that *Feronia limonia* Linn was known as a medicinal plant already in ancient Greek and Roman times and one of the most important plant of ‘Ayurveda’ as well as of traditional Indian medicines to treat various ailments. In ancient literature of indigenous systems of medicine this plant has various medicinal properties viz., vasodilator, anti-microbial, laxative, purgative, astringent and anti-hypertensive. In India, the ripe fruit is used as a liver and cardio-tonic and unripe as an astringent for halting diarrhea and dysentery, hiccough, sore throat and disorders of the gums (Khare and Khare, 2011). The fruit pulp and powdered rind is poulticed onto the bites and stings of venomous insects. Juice of leaves is mixed with milk and sugar and taken as a remedy for biliousness and intestinal troubles (Faysal et al., 2015). The gum is mixed with honey to overcome dysentery and diarrhea. Oil from the crushed leaves is applied on itch. Leaf decoction provides as an aid to digestion. Roots, Leaves, bark and fruit pulp are all used against snakebite. The unripe fruits contain 0.015% stigmasterol, leaves contain stigmasterol (0.012%) and bergapten (0.01%), the stem bark contains 0.016% marmesen, root bark contains isopimpinellin, aurapten, bergapten and other coumarins (Pratima and Rekha, 2014).

1.7.8 Other Uses

The pulp is eaten raw with or without sugar; or is mixed with coconut milk and palm-sugar syrup and drunk as a beverage or frozen as ice cream. It can also be used for making chutneys jelly and jam. Bottled nectar is made by diluting the fruit pulp with water, passing through a filter to remove seeds, further diluting, straining, and pasteurizing. A clear juice for blending with other fruit juices has been obtained by
clarifying the nectar with Pectinol R-10. The pulp represents 36% of the whole fruit which can be sweetened with syrup of cane or palm sugar, nowadays, it has also been canned and sterilized. The seeds contain non-bitter oil, high in unsaturated fatty acids.

The fruit shell or rind is fashioned into snuffboxes and other containers. The trunk and branches secrete a white, transparent gum which is used in making artists watercolors, ink, dyes and varnish and as a substitute for gum arabic. It has 35.5% arabinose and xylose, 42.7% $d$-galactose, and traces of rhamnose and glucuronic acid (Morton, 1987). The wood is yellow-gray to whitish, heavy, hard, durable and is used for fuel, construction, agricultural implements, pattern-making, rollers for mills, carving, rulers, and other products.

1.7.9 Scientific investigations on *Feronia limonia* Linn

1.7.9.1 Phytochemical profiling

The preliminary phytochemical analysis of *Feronia limonia* Linn plant parts have been studied by many researchers, it is indicated the presence of alkaloids, flavonoids, phenols, terpenoids, tannins, fats steroids, saponins, glycosides, gum, mucilage and fixed oils (Panda et al., 2013; Vijayvargia et al., 2014; Thomas and Ponnammal, 2005). The unripe fruits contain stigmasterol whereas fruit pulp contains large quantity of citric acid and other fruit acids, mucilage and minerals. Alkaloids, coumarins, fatty acids and sterols have been detected in the pericarp. Leaves contain stigmasterol, psoralen, bergapten, orientin, vitedin, saponarin, tannins and an essential oil (Pandavadra and Chanda, 2014). Marmesin, feronolide and feronone have been isolated from the bark. Seeds contain fixed oil, carbohydrates, proteins and amino acids. Roots contain feronia lactone, geranylum
belliferone, bargapten, osthol, isopimpinellin, marmesin and marmin (Intekhab and Aslam, 2009).

1.7 OBJECTIVES OF THE STUDY

1. To investigate the morphological, physico-chemical and organoleptic characteristics of *Feronia limonia* Linn fruits to establish the pharmacognostical standards of the plants.

2. To carry out preliminary phytochemical analysis of various extracts of fruits of *Feronia limonia* Linn to establish the different classes of compounds present in various organic solvent extracts.

3. To evaluate the extracts of *Feronia limonia* Linn for antibacterial and antifungal activity against common pathogenic gram positive and gram negative bacteria and common pathogenic fungi.

4. To evaluate the extracts of *Feronia limonia* Linn for antioxidant activity by different radical scavenging methods and protective activity against carbon tetrachloride induced liver and testes damage in rats.

5. To evaluate the extracts of *Feronia limonia* Linn for acute toxicity potential and to establish their margin of therapeutic safety.

6. To evaluate the anti-inflammatory activity of extracts of *Feronia limonia* Linn against carrageenan induced paw edema in rats and membrane stabilization method.

7. To isolate individual phytoconstituents by chromatographic and separation techniques and characterize them by spectrophotometric and physicochemical methods.
8. To evaluate the anticancer activity of isolated compound in different test systems.

1.8 SIGNIFICANCE OF THE STUDY

Phytochemical screenings are now seen as the first step towards the discovery of useful drugs. The successive solvent extraction, Chromatography separation and spectroscopy method are used to determine the chemical constituents and bioactivities of the plant to produce a beneficial value in medical. In order to understand the plant-derived remedies completely, and for the plant to reach the apt role in contributing to affordable healthcare, these plants must be assessed from a scientific viewpoint to ensure chemical consistency, therapeutic benefits and safety. Keeping these in point of view, the plant was subjected to biological evaluation such as antimicrobial, antioxidant and anti-inflammatory activity. We were interested in screening *Feronia limonia* Linn for the presence of chemical compounds that has high medicinal value. Finally, cytoxicity study was carried out by using pure isolated compound. The result of the study reveals that the compound luteolin 2-(3,4-dihydroxyphenyl)-5,7-dihydroxy-4H-chromen-4-one which is isolated from *Feronia limonia* Linn is essential for development into a potential herbal medicine to be used as antioxidant and cytotoxic agent.

The research work embodied in this thesis is thus an attempt to explore the untapped bio-therapeutic nature of *Feronia limonia* Linn for the development of drugs used in the treatment of multitude of human diseases.