The use of the medicinal herbs for curing disease has been documented in history of all civilizations. Before the onset of synthetic era, man was completely dependent on medicinal herbs for prevention and treatment of various ailments. With the introduction of scientific procedure, the researchers comprehend toxic principles present in the green flora. Scientists isolate active constituents of the medicinal herbs or fractionate portions which are therapeutically active.

1.1. Medicinal herbs

Medicinal herbs have been of immense use in the prevention and curing of many diseases. Documents reveal use of medicinal plants more than 60,000 years ago (Solecki, 1975). They has been an invaluable boon to maintain and develop good health in almost all civilizations. Enormous and rapid development in the field of synthetic organic chemistry has totally modified the therapeutical methods. The purity, abundance in structural modification, fast recovering effect, simplicity in utilization, easy availability and economic feasibility of synthetic drugs has pushed back the old and traditional herbal practices. In spite of the fast development of the synthetic drugs, the lurking evil is the problem of various side effects. This situation makes us to look back the positive sides of the traditional herbal medicines.

Worldwide over 80% of the people depend on medicinal plant species to meet their day-to-day health care (WHO, 2002). Medicinal plants used as sources for extracts or pure products for therapeutic use, represent a rapidly expanding area of health science (Chopra et al, 1956). Higher plants, as sources of medicinal compounds have continued to play a dominant role in the maintenance of human health since ancient times. It is reported that over 50% of all modern clinical drugs are of natural product origin and natural products play an important role in drug development programs in pharmaceutical industry (Onorato et al, 1999). Nature has been a source of medicinal
agents for thousands of years and an impressive number of modern drugs have been isolated from natural sources (Cragg and Newmann, 2001).

Plants are nature’s “Chemical factories” providing the richest source of organic chemicals on earth (Palombo and Semple, 2001). Our globe is blessed with a great variety of natural plants; most of them are used in traditional medicine to cure various ailments (Rachuonyo et al, 2016; Attanayake and Jayatilaka, 2016; Lam et al, 2016). With introduction of scientific procedures the researchers are able to isolate active constituents of the herbs. Some of the constituents thus isolated were found to be therapeutically active. Many plants have been sources of medicines since ancient times (Hughes, 1952; Madhumitha and Saral, 2009). India is a land of rich biodiversity with more than 45,000 species (Jain, 1994). More than 61% of 877 small-molecule drugs introduced worldwide between 1981 and 2002 were derived from natural products (Prasad and Tyagi, 2015). Envisaging the importance of medicinal plants in the treatment of ailments, an endangered medicinal plant has been taken up for study.

1.1.1. Kedrostis foetidissima (Jacq.) Cogn

The plant Kedrostis foetidissima (Jacq.) Cogn., (Fig-1) belongs to the Cucurbitaceae family. This traditional medicinal plant is locally known as Appakovai, in Tamilnadu. This species is also found in Sri Lanka, Kenya, Ethiopia, Uganda and Western Malaysia.
Fig-1. *Kedrostis foetidissima Cogn.*, (Jacq.).

An ethnobotanical survey on the use of *Kedrostis foetidissima* reveals water extracts of the aerial parts of this plant to have been used for centuries by Kenyans, as an effective remedy for complications arising from the measles virus infection in children. The study shows that this extract is encouragingly active against a number of bacterial species: *Klebsiella pneumoniae*, *Escherichia coli*, *Streptococcus aureus*, *Pseudomonas aeruginosa*, *Shigela flexneri*, *Vibrio comma*, *Salmonella typhi*, *Streptococcus pneumoniae* and *Enterobacter aeruginosa*. The extract is also active against the measles virus *Leishmania donovani*, the visceral *Leishmania parasite*, as well as *Trypanosoma brucei* (Otieno and Odero, 1988). Medicinal practices of the Zay people of Ethiopia, revealed that the whole plant of *Kedrostis foetidissima (Jacq.) Cogn.*, locally named as holobido(Or.) is taken orally for curing chest pain and its leaves are used as a traditional veterinary medicine in the treatment of ALOYE - a cattle disease (Giday, 2001). Medicinal plant records of Bulamogi in Uganda reveal *Kedrostis foetidissima*, to be used in treatment of diarrhoea and measles. Leaf infusion is used in treating diarrhoea and leaf decoction is taken orally in the treatment of measles (Tabuti et al, 2003). The medicinal herbs *viz. Kedrostis foetidissima (Jacq.) Cogn.* and *P.vogelii* are recommended for further pharmacological tests in HIV cases (Otieno et al, 2007). Opportunistic infections are treated with multi-plant extracts including *Kedrostis foetidissima* (Otieno et al, 2008).

In India, five drops of juice of the leaves of *Kedrostis foetidissima*, is given orally to treat common cold in children (Karuppusamy, 2007). The chloroform extract of leaf and stem of *Kedrostis foetidissima* showed significant antibacterial activity against bacteria like *Streptococcus aureus*, *Escherichia coli*, *Pseudomonus aeruginosa*, *Klebsiella pneumoniae*, *Serratia marcescens* (Priyavardhini et al, 2008). Nutritional and anti-nutritional evaluation on proximate composition of the edible tubers consumed by tribal Valaiyans of Madurai, reveal tubers of *Kedrostis foetidissima* to have more crude protein, higher vitamin, niacin content and more starch content (Mohan and Kalidas, 2010). In my home town, this plant is used for curing various ailments such as cough, common cold, measles, in healing wounds and treating bloats in cattle. This
traditional practice is the impetus behind choosing this plant for my research work.

Several of non-protein amino acids were isolated first from members of *Cucurbitaceae* (Jeffery, 1962, Jeffery, 1964). *Kedrostis foetidissima*, shows presence of the amino acid Citrulline(I) and traces of m-Carboxyphenylalanine and Ninhydrin (Patricia et al, 1965). GC-MS analysis of the methanolic leaf extract of *K. foetidissima* reveals the presence of 59 compounds including Phytol, Squalene and Palmitic acid (Pavithra and Vadivukkarasi, 2012). Hydro-alcoholic extract of Kedrostis shows better anti-anaemic effect (Saravanan and Manoharan, 2012). In Nigeria, leaf and stem of Kedrostis are used in treating tumours. The crude extracts of Kedrostis are reported to exhibit apoptosis in breast cancer cell lines MCF-7 and YMB-1 (Choene and Motadi, 2012). Contemplating on the traditional global medicinal practices using *Kedrostis foetidissima*, it was intended to explore the medicinal efficacy of *Kedrostis foetidissima* through phytochemical, biological and pharmacological evaluation.

The present research entitled “Phytochemical, Biological, Pharmacological Evaluation of *Kedrostis foetidissima* (Jacq.) Cogn. and Plant-Mediated Synthesis of metal nanoparticles” was performed in different phases as mentioned below:

- **PHASE - I**
  - Solvent Extraction – Different methods of extraction
  - Phytochemical analysis – Analysis of various phytochemicals
  - Proximate analysis – Analyzing the quality of the plant.
  - Isolation – Open column chromatographic isolation of compounds from ethanol extract.

- **PHASE - II**
  - Plant-Mediated synthesis of nanoparticles – Synthesis of silver and gold nanoparticles using plant extracts.

- **PHASE - III**
Biological, Pharmacological evaluation of selected solvent extracts, isolated compounds and metal nanoparticles.

- Antimicrobial activity – Bacteria and fungi
- Antimicrobial activity of face mask fabricated with extracts
- Antioxidant activity – *In vitro* DPPH radical scavenging assay and *In vitro* ferric reducing power assay.
- Wound healing activity – *In vivo* wound healing assay
- Antidiabetic activity – *In vitro* alpha amylase inhibition of extracts and selected isolated compounds.
- Anticancer activity.
  i) *In silico* molecular docking of selected ligands with Lung cancer protein (Gamma–enolase 1TE6).
  ii) *In vitro* cell viability study of extracts.
  iii) *In vitro* anticancer efficacy of plant-mediated synthesised nanoparticles – MTT assay of nanoparticles on Human Lung cancer (A-549) and Human Osteosarcoma (MG-63) cell lines

1.2. Extraction of plant materials

Extracts are the crude drugs which include the phytoconstituents which are soluble in the solvents utilized in the preparation of extract. Extraction of natural products from the biomass is the foremost step before the isolation and purification of the active constituents. The active constituents of plants are always present in the plant cells. During extraction, the solvent disseminates into the cells, dissolves the phytoconstituents and flows out of the cell-wall in reverse direction, establishing equilibrium with the constituents present inside the cell. Extraction of the biomass may be carried out by maceration, ultrasonic-assisted solvent extraction, percolation, Soxhlet extraction, pressurized solvent extraction, supercritical fluid extraction etc. (Samuelsson, 2004; Satyajit *et al*, 2005).
The leaves and stem of *K. foetidissima* contain 90% moisture and hence drying may result in appreciable weight loss. This necessitates a suitable extraction method for the extraction of *K. foetidissima*. **Hence, it is attempted to try various extraction methods such as reflux, sonication and ultrasonic homogenization to choose a suitable extraction method for *K. foetidissima*.**

### 1.3. Phytochemical screening

Medicinal plants contain some active metabolites which possess specific physiological action on the human body and these bioactive compounds comprises of alkaloids, flavonoids, tannins, terpenoids, steroids and carbohydrates (Mann, 1978). Phytochemical screening provides information regarding the metabolites present in the extracts, which aids in selecting suitable isolation method. **Therefore, it is aimed to screen the solvent extracts of leaf and stem of *K. foetidissima* for the presence of phytochemicals.**

### 1.4. Proximate Analysis

Plants house several significant metabolites and nutrients whose concentration may vary depending on region, soil, climate etc. Owing to the considerable dependence of mankind on natural products and increasing demand in medicine, adulteration of plant species is a cropping problem. Hence Ayurveda and other traditional system of medicine seek in establishing the quality of plant parts before use in formulations. Proximate analysis ensures maintaining quality and establishing the nutrient content of plants. This also provides a method to screen plants for its medicinal properties based on its nutrient content before enduring thorough investigation. **So, it is intended to examine the proximate parameters of leaf and stem of *K. foetidissima*.**

### 1.5. Isolation of compounds

Isolation techniques include open column chromatography (CC), Thin layer chromatography (TLC), High Performance Liquid Chromatography (HPLC) etc. TLC and HPLC techniques are costly to perform and only small amounts of compounds can be purified. Open column chromatographic technique is a cheap and appropriate method for the isolation of more number of compounds from the extract (Tesso, 2005). **Literature review revealed sparse work on isolation of compounds from**
K.foetidissima. Hence open column chromatographic isolation has been attempted in this research work.

1.6. Plant–mediated synthesis of metal nanoparticles

The exploitation of nanotechnology for designing nanoscale products is a fast growing research field (Albrecht et al, 2006). Nanoparticles possess exclusive properties based on their size, morphology and distribution. Silver particles are used as antimicrobial agents against infections caused by microorganisms (Becker and Spadaro, 1978). Nanoparticles have been synthesised traditionally by physical and chemical methods, which incorporate solvothermal synthesis, sputtering, sol-gel method and reduction. Chemical methods include electrochemical methods (Rodríguez et al, 2000), chemical reduction (Guzmán et al, 2009) and reduction using phytochemicals (Sharma et al, 2009). Plant-mediated synthesis of nanoparticles is safer, easy, quick, requires low temperature and eco-friendly (Goodsel, 2004). Plant-mediated synthesis of gold and silver nanoparticles using Kedrostis foetidissima has hence been attempted in this research work.

1.7. Biological and Pharmacological evaluation of plant extracts

Detailed biological assessment of plant extracts is essential to ensure their potential uses. Natural-product chemists, ethanopharmacologists, microbiologists and botanists are probing the globe for bioactive compounds active against various diseases (Tanaka et al, 2006).

1.7.1. Antimicrobial activity

Many medicinal plants possess antimicrobial property. These antimicrobial activities have been proved by researchers through their thorough investigation of the plant, their extracts and isolated compounds (Tanaka et al, 2006).

1.7.1.1. Antimicrobial activity of plant extracts

The evolution and development of bacterial pathogens which possess multidrug-resistance (MDR) have extensively endangered the prevailing antibacterial therapy. Infections caused by this multidrug-resistant pathogens lead to death, prolonged stay in
clinic and treatment with higher costs (Boucher et al, 2009; Giamarellou, 2010). This necessitates alternative drugs which may be effective in treating multidrug-resistant bacterial infections. Plants, their extracts and isolated compounds have been recognized to be promising drugs since ancient times in various traditions in curing bacterial infections and other diseases. WHO suggests the inclusion of traditional medicines into National health care systems, as they are found to be effective and safe (WHO, 2002) in treating various ailments.

E. coli is a bacterial pathogen generally live in the intestines of human and animals. E. coli can cause intestinal infection, due to which abdominal pain, diarrhoea, fever may occur. Dehydration, bloody diarrhoea even kidney failure may cause in severe cases (http://www.healthline.com).

Staphylococcus is a genus of bacteria liable for number of general infections. They dwell normally on the skin and mucous membranes of human. They are found worldwide as a part of soil microbial flora. Staphylococcus can cause infections like severe cough, skin infections like cellulitis and boils in human through either toxin production or penetration (Madigan et al, 2005).

Klebsiella is a genus of rod-shaped, non-motile bacteria found everywhere in nature (Ryan and Ray, 2004). Klebsiella species commonly exist in human mouth, nose and gastrointestinal tract (Ristuccia et al, 1984). Klebsiella organisms can provoke disease such as, pneumonia, meningitis, urinary tract infections, soft tissue infections, septicemia and diarrhoea (Ristuccia et al, 1984; Podschun and Ullmann 1998).

Pseudomonas aeruginosa is a prototypical "multidrug resistant (MDR) pathogen" perceived for its pervasiveness. Pseudomonas can cause various diseases in humans, plants and animals. Pseudomonas infects urinary tract, airway, wounds, and burns and causes blood infections (Todar, 2004). Pseudomonas rarely cause community–acquired pneumonia (Fine et al, 1996) and ventilator – associated pneumonia (Diekema et al, 1999) in human.

Corynebacterium is an aerobic gram positive bacterial species. Corynebacterium is the causative agent of diphtheria, an upper respiratory tract illness, portrayed by low
grade fever, sore throat, an adherent sheath that grows on the pharynx, tonsils and nose (http://microbewiki.kenyon.edu). Corynebacterium is found generally in nature, in the water, soil and food products (Yassin et al, 2003; Collins et al, 2004).

Aspergillus niger is a most common fungus, common contaminant of food, which causes a disease called black mould (Samson et al, 2001), produces mycotoxin (Abarca et al, 1994) and cause serious lung disease (Handwerk, 2005) and otomycosis in human. Aspergillus fumigatus is saprotrophic in nature and occurs in decaying organic materials. Aspergillus fumigatus is the root cause of immunosuppression infections (Ben-Ami et al, 2010) and chronic pulmonary infections (Segal, 2009). Aspergillus fumigatus initially induces intrusive infection in lung which finally leads to morbidity and mortality (Hohl and Feldmesser, 2007).

Candida tropicalis commonly occurs in tropical and subtropical marine environments. It causes septicaemia in human. Candida albicans is a class of fungi found in intestine and mouth of human. Excessive population can weaken the walls of the intestine, protrude into the blood stream and discharge toxic by products into the body. Aldehydes are the major waste by products produced during cell activity of this microorganism, which are toxic in nature and promotes free radical activity. Candida albicans can cause oral thrush, headaches, nausea and vaginal infection in human (http://www.thecandidadiet.com).


Hence the present study is attempted to examine the antimicrobial property of leaf and stem extracts of K. foetidissima against Escherichia coli, Staphylococcus sp, Klebsiella sp, Pseudomonas aeruginosa and
Corynebacterium, Aspergillus niger, Aspergillus fumigatus, Candida tropicalis Candida albicans.

1.7.1.2. Antimicrobial activity of the facemask impregnated with extracts of K.foetidissima

Recent developments in apparel technology has increased the interest in the development of apparels with specified functions such as wrinkle free, fade resistant, water repelling and microbial resistant etc. Since, fabrics are in direct contact with human body while wearing, it is essential to develop apparels which are microbial resistant (Sathianarayanan et al, 2010).

Microbial growth in cotton fabric is predominant. Awareness on hygienic lifestyle of the consumers and need of antimicrobial medical textiles increase the demand for microbial resistant apparels globally. Antimicrobial agents such as quarternary ammonium salts, triclosan and nanosilver are used in the manufacture of microbial resistant apparels (Thilagavathi and Kannaian, 2010). Synthetic antimicrobial agents are costly and create environmental problems; therefore, it is necessary to develop antimicrobial agents of plant origin. The natural antimicrobial agents are cost-effective and eco-friendly. Antimicrobial activity of various plant extracts have been analysed by researchers (Liolios et al, 2007; Jasso et al, 2007; Pereira et al, 2007).

All available natural antimicrobial agents have not been explored for their antimicrobial activity on apparels; it requires extensive research in the preparation of antimicrobial textiles especially for medical textiles. Upper respiratory tract illness and Oral thrush may develop in persons wearing face mask all along the day, due to the Corynebacterium and Candida albicans. This motivated us to fabricate a herbal facemask with ethanol leaf and stem extracts of K.foetidissima and analyse its antimicrobial efficacy against Corynebacterium and Candida albicans.

1.7.2. Antioxidant activity

Oxidative stress is the foremost among various factors responsible for the generation of chronic and degenerative diseases such as ageing, cancer, immune suppression, Diabetes mellitus and others (Young and Woodside, 2001). Innumerable plants posses phytochemical which exhibit antioxidant properties (Halliwell, 1994).
Plant-based antioxidants are considered to be the prominent source of therapeutic agents due to their cheaper cost, easy availability and lack of side effects compared to modern drugs (Agbor and Ngogang, 2005). Antioxidants are capable of preventing oxidative damage provoked by free radicals. Antioxidants impede the oxidation process by reacting with the free radicals or by acting as oxygen scavengers (Shahidi and Wanasundara, 1992; Buyukokuroglu et al, 2001).

1.7.2.1. DPPH Radical Scavenging Assay

2, 2-diphenyl-1-picrylhydrazil (DPPH) assay is an easy and susceptible method of analysing antioxidant activity of natural products. This assay is based on the speculation that the phytochemicals present in natural products serve as hydrogen donors, acts as antioxidants. DPPH accepts hydrogen atom from the donors. The antioxidant efficacy was measured by analysing the absorption of DPPH at 517 nm using UV spectrophotometer. Upon the absorption of hydrogen atom from the test sample, the colour of DPPH changes from purple to yellow and the UV absorption decreases. The antioxidant efficacy of the sample can be calculated from the UV absorption values.

Reactive Oxygen Species (ROS) like hydroxyl radical, hydrogen peroxide and superoxide anion are the root cause in the augmentation of diseases such as asthma, carcinoma, arthritis, Mongolism, Parkinson’s disease and dementia. Free radical generation in human body may be from external sources or by aerobic respiration (Halliwell and Gutteridge, 1990). Some free radicals generated in the body are responsible for energy production, cell growth and damages to human cells. Free radicals react with biomolecules such as carbohydrates, proteins, lipids etc. present in the body resulting in antioxidants and oxidants imbalance. Even though human body, as its own, possesses antioxidant defense mechanism, there is a consistent need of antioxidants from external sources (Rimbach et al, 2005). Plant-based phenolic compounds are potent antioxidants and protect the cells from oxidative damage provoked by free radicals (Kahkonen et al, 1999). They are also efficient radical scavengers, reducing agents, metal chelators, singlet oxygen quenchers and hydrogen donors (Proestos et al, 2006). Antioxidants of plant origin wrap up the free radicals and protect our body from various ailments (Lai et al, 2001).
1.7.2.2. Ferric Reducing Power Assay

Antioxidant potency of a phytochemical is mainly due to its reducing ability, which can play a subsequent role in neutralising free radicals, absorbing, quenching singlet or triplet oxygen and decomposing peroxides (Duh et al, 1999). Tanaka et al, 1998 identified a direct relationship between the reducing ability and antioxidant potency of some plant extracts. The reducing ability is usually due to the existence of reductones. The reductones present in the extract bring about Fe$^{3+}$-Fe$^{2+}$ transformation (Osawa, 1994). Reductones show their antioxidant activity by donating H-atom and terminating the free radical chain (Gordon, 1990).

Antioxidant activity of ethanolic leaf extract of K. foetidissima (Gopi et al, 2012), various leaf extracts (Sasikumar and Kalaisezhiyen, 2014; Pavithra and Vadivukkarasi, 2015) are reported. There are no reports on the antioxidant activity of stem extracts of K. foetidissima. Hence it was attempted to validate the DPPH radical scavenging activity and Ferric reducing ability of various solvent extracts of leaf and stem of K. foetidissima.

1.7.3. In vivo Wound Healing Activity

A wound may be described as “a break in the continuity of tissue, from violence or trauma”. Wound healing is a biological process during which repair and regeneration of damaged tissues take place (Taber, 1965). It takes place through a complex tissue repair and remodeling process with respect to the injury (Diegelmann and Evans, 2004). Medicinal plants have been used in healing wounds over the years traditionally. Various phytochemicals present in the medicinal herbs induce blood clotting and accelerate wound healing efficacy. Small animals offer a multitude of replica for human wound situation (Thakur et al, 2011). Among various drugs used in the curative effect of wound antibiotics like penicillin and streptomycin play a significant role in modern medicine (Gyang, 1986). These antibiotics have specific ability to inhibit the growth of pathogenic organisms and leave behind the tissues unaffected (Brander et al, 1992). In vivo studies incorporating small animals can be done by incision, excision, dead space and burnt wound models to analyse the wound healing efficacy (Kiran and Asad, 2008).
K. *foetidissima* possess antimicrobial and antioxidant efficacy. The leaves and stem of *K. foetidissima* possess high wax content as obviously seen from the glossy appearance of its leaves. All these properties prompted us to anticipate wound healing activity for this plant. **To give scientific validation to the folkloric use of *K. foetidissima* in healing wounds, an herbal formulation has been attempted and examined for its wound healing efficacy through incision wound model studies.**

### 1.7.4. Antidiabetic activity

Diabetes is a group of metabolic syndrome portrayed by hyperglycemia arising out of imperfect secretion of insulin. Genetic aspects and food practices are liable for diabetes. Urbanisation doubled the rate of diabetes in India (*Mitra, 2007*). According to the National Urban Diabetic Survey, in India the incidence may raise from 19 million to 57 million in 2025. Among these, 80% are of Type-2 diabetes (*Mitra, 2008*). Clinical approach in treating Type-2 diabetes is to reduce the postprandial hyperglycemia. Contemporary drugs such as sulfonylureas, biguanides and thiazolidinediones, have undesirable side effects with their use (*Fowler, 2007*).

Alternatively, plant-based drugs are feasible in treating diabetes. Herbal drugs are safe and cost effective over modern drugs (*Valiathan, 1998*). Phytochemicals present in the herbal drugs inhibit the carbohydrate hydrolysis by inhibiting the pancreatic amylase and decelerate glucose absorption. The inhibition of this enzyme prolongs the carbohydrate digestion, decrease glucose absorption and consequently diminishes postprandial plasma glucose level. Certain medicinal plants are efficient in inhibiting alpha amylase enzyme activity (*Prashanth et al, 2001*).

Methanol seed extract of Kedrostis shows better inhibition towards alpha amylase (*Nirmala and Pandian, 2015*). There are no reports on the antidiabetic activity of *K. foetidissima*. **It is intended to explore the antidiabetic activity of various solvent extracts of leaf, stem and selected isolated compounds for their alpha amylase inhibition efficacy. Amylase inhibition assay also provides a facile method for screening medicinal plants for their antidiabetic effect.**
1.7.5. Anticancer activity

Cancer is a carcinogenic syndrome and affects ample population worldwide (Xu et al, 2011). Development of bio-medical science in the last century has conquered many diseases except cancer, which is a thriving health crisis worldwide. It is the second most common cause of death after cardiovascular diseases. Tumour is the abnormal growth of tissues owing to rampant cell growth (Kumar et al, 2005). The risk of cancer can be reduced by avoiding cancer-causing physical, chemical and biological agents and regular utilization of foods with cancer protection (Alberts et al, 2002). Several scientific findings have concentrated on the pharmacological activity of plant derived bio-active compounds as anticancer agents (Amin et al, 2009). Epidemiological studies recommend regular consumption of specified phytochemicals for curtailing cancers (Russo et al, 2010).

1.7.5.1. In silico molecular docking

Innovative medicines play an intellectual role in increasing human life span. There are certain human diseases that still need drugs for their complete remedy. Clinical studies of new drugs are costly and time consuming. It takes nearly years together or decades for their conformation and utilization (Madeswaran et al, 2012). Recent developments in cheminformatics, availability of protein databases, have successfully incorporated molecular modeling methods in discovering new drugs. It is possible to screen innumerable compounds in one stretch using a computer and select lead compounds in drug designing. This in silico approach not only saves time but also manpower and money. Among the various softwares, Schordinger software is considered to be superior owing to its accuracy. It provides GLIDE scores GLIDE energy which provides resourceful information in selecting lead compounds (Jannathul and Lalitha, 2015).

Gamma-enolase contains 433 amino acid long acidic dimeric protein, comprises of two isoenzymes γγ and αγ, and is also referred as neuron-specific enolase (NSE). Gamma-enolase localizes predominantly in neuronal cells and in neuroendocrine cells, for example in the intestine, lung, thyroid and pituitary gland and
pancreas (Tiainen et al, 2003; Suresh, 2005). Gamma-enolase is used in clinical practice in patients with neuroblastoma and SCLC (Lamerz, 1998; Sturgeon, 2002). Gamma-enolase is used as an auxiliary marker in lung cancer (small cell lung cancer), where biopsy is not possible. Gamma-enolase is also used for survey of treatment in advance, postoperative surveillance of SCLC patients and also in the detection of reoccurrence of disease (Sturgeon, 2002; Stieber et al, 2006). Temporary increase in gamma-enolase serum during chemotherapy, due to cytolysis of tumour cells, disappears in case of regular treatment. But, persistent increase in gamma-enolase level shows the failure of the treatment. However, it is used for the diagnosis of nephroblastoma to neuroblastoma and also for observing disease (Sturgeon, 2002; Suresh, 2005).

With the development of cheminformatics a number of computational methods have been employed to ease the drug designing and analysis of its mechanism. Molecular docking is one of the best tools in analysing the mechanism of action behind the target and the drug designed. The selection of ligands, target molecule plays a vital role in the success of this method. In molecular modelling, the docking scores obtained will provide information regarding the interaction between the target protein and selected ligands, which help in the identification of the best suited ligand. This will help in designing new drugs (Rother et al, 2006; Rask-Andersen et al, 2011; Akhila et al, 2012). Hence, it is aimed to dock selected ligands which have structural similarity with the compounds identified to be present in K.foetidissima with Gamma-enolase protein 1TE6 using Schrödinger software.

1.7.5.2. Human Lung cancer (A-549)

Cancer a non-communicable syndrome causes severe health issues. Now the problem has increased due to intricacy and assortment. Utilisation of alcohol and tobacco are the major causes of cancer. Smoking is the principal pollutant that reinforces the progression of cancer expeditiously. Exposure to tobacco smoke might surge the risk of lung cancer (Massion and Carbone, 2003; Bradshaw et al, 2003). Among 1.4 million cancer deaths worldwide, one fifth is due to lung cancer (Parkin et al, 1999; Pisani et al, 1993; Pauk et al, 2005). Ancient cultural practices reveal natural products of plant origin to be potent in curing cancer (Umadevi et al, 2013). There are
no reports on the anticancer activity of \textit{K.foetidissima}. Hence it is attempted to evaluate the anticancer activity of \textit{K.foetidissima} on A-549 lung cancer cell lines.

1.7.5.3. Human Osteosarcoma (MG-63)

Osteosarcoma is the most prevalent cancerous tumour in bone (Marulanda \textit{et al}, 2008). It is a form of elementary bone cancer common in young adult and in children (Ottaviani and Jaffe, 2009). From time immemorial, medicinal herbs are being used in treating cancerous tumours (Richardson, 2001). Phytoconstituents and their derivatives are effective in treating various cancers (Pezzuto, 1997). There are no reports on the bone cancer activity of \textit{K.foetidissima}. \textit{This intended to analyse the anticancer activity of ethanol extract of \textit{K.foetidissima} on MG-63 human Osteosarcoma cell lines.}

1.7.5.4. Anticancer activity of plant-mediated synthesised metal nanoparticles

Patients under go very cruel ordeal, when they are put for cancer treatment moreover which leads to many side effects. Sometimes it can lead to death also. Development of nano medicines have revolutionized the cancer treatment procedure. Nanoparticles are rapidly being developed and trailed to overcome several limitations of traditional drug delivery systems and are coming up as a distinct therapeutics for cancer treatment. Silver is a locally used antibacterial agent and our targeting technology may make it possible to use silver nanoparticles in treating infections anywhere in the body. Silver-based nanoparticles have been used with considerable success for diagnostic and therapeutic purposes in the field of medicine since their invention. Gold nanoparticles are also an ideal drug-delivery scaffold because they are known to be non-toxic and non-immunogenic (Connor \textit{et al}, 2005; Male \textit{et al}, 2008). \textit{The nanoparticles synthesised using plant extract as capping agents in the conversion of metal to metal nanoparticles have been evaluated for its anticancer activity on Human lung cancer cell lines and Human Osteosarcoma cell lines.}

1.8. Objectives of the study

Exploring the medicinal efficacy of \textit{Kedrostis foetidissima} is the momentous aspect of this research. The present research entitled “Phytochemical, Biological,
Pharmacological Evaluation of *Kedrostis foetidissima* (Jacq.) Cogn. and Plant-Mediated Synthesis of metal nanoparticles” was performed focusing on the following objectives:

- Plants are the natural bio resources comprising of secondary metabolites possessing significant medicinal properties. Hence it is attempted to extract the leaf and stem of *K. foetidissima* by different traditional and modern solvent extraction methods to arrive at the most suitable method.

- Phytochemicals are useful in understanding the biological efficacy of plant species. Therefore, it is aimed to screen the solvent extracts of leaf and stem of *K. foetidissima* for the presence of phytochemicals.

- Knowledge of proximate parameters reveals the quality of the plant. So, it is intended to examine the proximate parameters of leaf and stem of *K. foetidissima*.

- Compounds from plants always have their own characteristic nature and may be either toxic or possess pharmaceutical and industrial applications. Contemplating on this fact, it is attempted to isolate compounds from ethanol leaf extract of *K. foetidissima* by column chromatography.

- Characterisation reveals complete knowledge regarding the compounds. Hence it is intended to characterise the isolated compounds through their UV, IR, 1D and 2D spectral studies.

- Silver-based nanoparticles have been used with considerable success for diagnostic and therapeutic purposes in the field of medicine since their invention. It is aimed to synthesise silver nanoparticles using leaf and stem extracts of *K. foetidissima* as capping agents.

- Gold nanoparticles are also an ideal drug-delivery scaffold because they are known to be nontoxic and non-immunogenic. This motivated us to attempt to synthesise gold nanoparticles using leaf and stem ethanol extract of *K. foetidissima*.

- To examine the anti microbial property of various leaf and stem extracts of *K. foetidissima* against *Escherichia coli*, *Staphylococcus sp*, *Klebsiella sp*, *Streptococcus sp*,
Pseudomonas aeruginosa and Corynebacterium, Aspergillus niger, Aspergillus fumigatus, Candida tropicalis and Candida albicans.

- To examine the antimicrobial efficacy of column isolates obtained from ethanol leaf extract of K. foetidissima on Corynebacterium and Candida albicans.
- Sweat and Oral thrush may develop in persons wearing face mask all along the day, due to the Corynebacterium and Candida albicans. Hence one of the objectives is to fabricate a herbal facemask with ethanol leaf and stem extracts of K. foetidissima and analyse its antimicrobial efficacy against Corynebacterium and Candida albicans.
- To analyse and compare the antioxidant properties of different leaf and stem extracts of K. foetidissima through radical scavenging and reducing power assays.
- To examine the wound healing efficacy of leaf and stem extracts of K. foetidissima by in vivo analysis.
- To analyse antidiabetic activity of various extracts of K. foetidissima and selected isolated compounds through in vitro assays.
- Molecular docking studies are greener, economical, easier and much useful in designing new drugs. Hence, it is aimed to dock selected ligands with Gamma-enolase protein 1TE6 using Schrödinger software.
- To evaluate the biological effect of leaf and stem ethanol extract of K. foetidissima on Human Lung cancer cell lines A-549.
- To examine the cytotoxicity effect of leaf and stem ethanol extract of K. foetidissima on Human Osteosarcoma cell lines MG-63.
- To study anticancer activity of plant mediated synthesised gold and silver nanoparticles using leaf and stem ethanol extract of K. foetidissima on Human Lung cancer cell lines A-549 and Human Osteosarcoma cell lines MG-63.