Review of Literature

2.1. General

A careful and thorough literature review is essential for research at any level. Review of literature is a survey, is a fact-finding and fact-checking mission, which reveals the past work done in the particular field and it also estimates, encapsulates, compares and contrasts, and correlates various methods adopted and fruitfulness of the findings of the problem under research. The present work is intended to evaluate pharmacological, biological activities and also to isolate compounds from ethanol extract of K. foetidissima. So literature search comprising of basic analysis of phytochemical, proximate analysis, biological, pharmacological evaluation of Kedrostis, especially on the antibacterial, antifungal, antioxidant, wound healing, antidiabetic, anticancer activity of extracts, biosynthesis of nanosilver, nanogold and their activity as anticancer agents has been carried out and systematically documented in the following pages.

2.2. Botanical aspects

2.2.1. Family Description

The Cucurbitaceae family includes 700 species and 90 genera. They mainly include decorative reclining or climbing annuals. These genuses usually possess five-angled stems and curled up tendrils. They have alternate, palmated leaf pattern with five-lobes. The flowers are actinomorphic and usually unisexual. The perianth of the flower has a short to prolonged epigynous section with 3-6 segmented calyx, 3-6 lobed corolla and 3-6 petals. The androecium is highly variable, consisting of basically 5 distinct to completely connate stamens that frequently are twisted, folded or reduced in number. The gynoecium consists of a single compound pistil of 2-5 carpels, generally with one style and as many style branches or major stigma lobes as carpels, and an inferior ovary with one locule and usually numerous ovules on 2-5
parietal placentae or 3 locules with numerous ovules on axile placentae. The fruit is a type of berry called a pepo. (Gerald Carr). ([http://www.Zip code Zoo.com](http://www.Zip code Zoo.com)).

### 2.2.2. *Kedrostis foetidissima* (Jacq.)Cogn

*Kedrostis* (*Cucurbitaceae*) occurs in Africa and Madagascar and comprises four out of five species in Asia. Of these, two species are found in India and Sri Lanka and two out of three species in western Malaysia. *Kedrostis Medik* is an Old World genus occurring in Africa and Madagascar with c.20 species and in SE Asia with 5 species. In Asia the distribution is restricted to two separate areas: 2 species (of which *K. foetidissima* also in Africa) in S India and Sri Lanka and three in West Malaysia. *Kedrostis bennettii* is offensively smelling when crushed, similar as is known for the Indian *K. foetidissima* (Jacq.)Cogn. ([DeWilde and Duyfjes, 2004](#)).

### 2.2.3. Ethno-medicinal practices and traditional use of Kedrostis

Traditional herbal medicine (THM) is practiced in several parts of the world, especially in Australia, Africa, Bangladesh, Brazil, China, Caribbean States, Europe, Spain, North and South America, Russia, Pacific islands where large ethnic community still live in. History has revealed that most of the people of the world have been using plants, animals, micro-organisms and minerals for treating their illness. Traditional herbal medicines in last one decade have gained importance in various developed countries. One-third of the American adults, seventy four percent population of United Kingdom, sixty percent population of the Netherlands and Belgium are now utilizing alternative herbal medicinal therapies ([WHO, 1996](#)). Herbal medicines build up the body system specifically and selectively without any side effects. Usage of medicinal herbs for treating various ailments is extensive among *Paliyan tribes* of Tamilnadu. Ancient literatures like, Unani, Siddha and Ayurveda mention the utilization of medicinal plants for particular ailments by *Sirumalai Paliyan tribes* ([Ganesan *et al*, 2004; Rajendran and Gunasekaran, 2004; Ayyanar and Ignacimuthu, 2005](#)). Five drops of leaf juice of Kedrostis are given orally in the treatment of common cold in children ([Karuppusamy, 2007](#)). The leaves of this plant are used as an effective medicine against cough, cold, asthma and other respiratory ailments in infants and adults ([Kavitha *et al*, 2014](#)).
People of Ngai and Otwal sub countries consume the crushed root of Kedrostis with water once in a day for treating measles (Kamatenesi et al, 2011). Multiple plant extract of Mangifera indica, Eucla natalensis, Carissa edulis, Psidium guajava, Penisetum purpureum, Cymbopogon citratus, Punica granatum, Musa sp, Withania somnifera, Acacia robusta, Eucalyptus sp, Ximenia caffra, Clerodendrum myrcoides and Dichrostachys cinerea along with Kedrostis foetidissima was used in treating opportunistic infection (Otieno et al, 2008). An ethno diagnostic study reveals that people of Kenya fed the cattle suffering from pasture bloat and frothy bloat with the leaves of Kedrostis foetidissima (Ole-Miaron, 2003). The medicinal use of Kedrostis foetidissima with Tarenna asiatica, Theriophonum fischeri, and Exacum pedunculatum Linn. are being reported for the first time. (Kirtikar and Basu, 1935; Chopra et al, 1956; Agarwal, 1986; Ambasta et al, 1986; Bhattacharjee, 2001; Pullaiah, 2006). Xhosa culture, in South Africa, traditionally use the tuber infusion as a ritual wash to bring luck and also have the practice of keeping a piece under the tongue when problem arises (Cocks and Dold, 2006).

2.2.4. Kedrostis - Wild edible plant as a food source

People in the rain forests of Africa and South America utilize wild edible plants as a food source (Friedman et al, 1993; Bussman et al, 2006; Grivetti and Ogle, 2000; Medley and Kalibo, 2007). They also eat wild edible plants as snacks and at times of food scarcity (Campbell, 1987; Zinyama et al, 1990; Johns and Kokwaro, 1991; Asfaw and Tadesse, 2001; Addis and Urga, 2005; Addis, 2009). Kara and Kwego people have the habit of consuming wild edible plants as their food source; they consume the leaf of Kedrostis in boiled form (Teklehaymanot and Giday, 2010).

2.3. Phytochemicals present in Kedrostis

The characteristic features of a plant are mainly decided by its secondary metabolites. Secondary metabolites like alkaloids, terpenoids, sterols, phenolic compounds, tannins, glycosides etc, play a vital role in plant defense. These metabolites, not essential for plant growth, were once considered as unwanted materials. These compounds help human to treat various ailments.
Preliminary phytochemical analysis on *Kedrostis foetidissima* divulges the presence of terpenoids, sterols and amino acids. Some non-protein amino acids were first isolated from members of *Cucurbitaceae* (Fowden, 1964). The amino acid fraction separated from the aqueous ethanol soluble compounds from ethanol extract (75%(v/v)) of the seed of *Kedrostis foetidissima* with the help of the cation exchange resin, by adsorption, shows a mild chromatographic spot in the presence of amino acid, citrulline(l) and traces of m-carboxy phenyl alanine (Patricia et al, 1965). Cucurbitacins, the tetracyclic triterpenoids derived from the plants belongs to the family *cucurbitaece*. Cucurbitacin A to Cucurbitacin R may be present in different plants of *cucurbitaece* family. Literature study reveals Cucurbitacins B, D, E and I to be present in *K. foetidissima* (Miro, 1995). Qualitative phytochemical assay of Kedrostis reveals the methanol leaf and stem extract to be rich in flavonoids, steroids, alkaloids, saponins, tannins, glycosides, triterpenoids and cardiac glycosides. Leaf and stem chloroform extracts show high amount of alkaloids and moderate amount of triterpenoids, tannins, phenols, flavonoids and sterols. Acetone leaf extract show high degree of saponins and moderate amount of triterpenoids, tannins, phenols, flavonoids and sterols whereas stem extracts show the presence of moderate amount of flavonoids, tannins and sterols. Quantitative examination discloses the maximum amount of phenols, tannins and flavonoids in methanol leaf extracts, phenols and tannins in stem and tuber methanol extracts and steroids in chloroform leaf extract (Vasantha et al, 2012). Methanol extract of the whole plant shows the presence of alkaloids, saponins, steroids, cardiac glycosides, flavonoids, aminoacids and monosaccharides whereas acetone extract give positive results for the presence of terpenoids and carbohydrates (Sharly et al, 2014). Qualitative phytochemical analysis of the crude leaf extract showed the presence of flavonoids, alkaloids and nitrogen and crude proteins in higher quantity, while phenols and lipids were present in lower quantity. GC-MS evaluation of the methanolic leaf extract of *K.foetidissima* shows the presence of 59 compounds including Phytol, Squalene, Stigmasta-7,25(27)-dien-3-ol, Beta-amyrin, Palmitic acid etc. (Pavithra and Vadivukkarasi, 2012). The structures of few such compounds are given below:

2.4. Nutritional and anti-nutritional values


2.4.1. Proximate analysis of Kedrostis foetidissima

Evaluation of proximate composition of the edible parts of 23 plants utilized by tribal Valaiyans of Madurai, reveals that the tubers of K. foetidissima possess more crude protein, starch, vitamin, niacin content than other herbs. Moreover, all the 23 medicinal herbs including K.foetidissima, have a higher level of iron content compared to Recommended Dietary Allowances (RDA) of NRC/NAS(1980) for infants and adults (Mohan and Kalidas, 2010).
2.5. Plant-mediated synthesis of metal nanoparticles

Development of nanotechnology provides new opportunities to develop nanomaterials of improved properties. Nanomaterials find wide range of applications in medicine, energy production, catalysis, environmental remediation etc. Recently, researchers concentrate more in the synthesis of plant-mediated metal nanoparticles and analyse their efficacy against various disease conditions.

2.5.1. Plant-mediated synthesis of Silver nanoparticles (AgNps)

Evolution of Green technology pave a path way for the innumerable attempts in the biosynthesis of silver nanoparticles from plant sources like Alovera (Chandran et al, 2006), leaf extract of Datura metel (Kesharwani et al, 2009); Papaya fruit extract (Jain et al, 2009); Eucalyptus hybrid (Dubey et al, 2009); leaf extract of Seuvious portulacastrum (Nabikhan et al, 2010); Banana peel (Bankar et al, 2010); Mango stem and leaf (Veerasamy et al, 2010); Acalypha indica leaf extract (Krishnaraj et al, 2010); Eclipta prostrate leaf (Rajakumar and Abdul, 2011); Vintex negundo (Zargar et al, 2011); Lemon grass (Masurkar et al, 2011); Nelumbo nucifera leaf (Santhoshkumar et al, 2011); Allium sativum leaf (Ahamed et al, 2011); Citrus sinensis peel (Kaviya et al, 2011); Memecylon edule leaf (Elavazhagan and Arunachalam, 2011); Mahogany leaf (Mondal et al, 2011); Moringa oleifera (Prasad et al, 2011); Aqueous extract of Portulaca oleracea (Firdhouse and Lalitha, 2012); Trachyspermum ammand Papaver somniferum (Vijayaraghavan et al, 2012); Thevetiya peruviana latex (Rupiasih et al, 2013); Acorous calamus rhizome (Nakkala et al, 2014); Rosa indica petals (Manikandan et al, 2014); Cocos nucifera (Mariselvam et al, 2014); Symbopogan citrates (Geetha et al, 2014); Argyreia nervosa (Thombre et al, 2014); Psoralea corylifolia seed extracts (Sunita et al, 2014); leaf extract of Brassica rapa (Narayanana et al, 2014); Meliadubin leaf (Kathiravan et al, 2014); Ziziphora tenuior (Sadeghi and Gholamho seinpoor, 2015); Ficus carica (Ulug
et al., 2015); *Pistacia atlontica* (Sadeghi et al., 2015) and *Terminalia chebula* (Bupesh et al., 2016).

### 2.5.1.1. Plant-mediated synthesis of Silver nanoparticles (AgNps) using an aqueous extract of *K. foetidissima*

Silver nanoparticles synthesised from aqueous extract by sonication method show excellent crystalline, uniform, spherical–shaped crystals of size ranging from 5 to 90 nm. Nanoparticles with size less than 100 nm provide more surface area and excellent biological activity (Jannathul and Lalitha, 2015).

### 2.5.2. Plant-mediated synthesis of Gold nanoparticles (AuNps)

Synthesis of Gold nanoparticles from plant source become prominent in this decade since it is safe and green. Plant-mediated syntheses of gold nanoparticles have a wide range of applications. Gold nanoparticles synthesized from various plant sources like Coriander leaf (Narayanan et al., 2008 b); *Ocimum sanctum* leaf (Philip and Unni, 2011); *Amaranthus spinosus* leaf (Das et al., 2012); Olive leaf extract (Khalil et al., 2012); *Gymnocladus assamicus* (Tamuly et al., 2013); *Cacumen Platycladi* (Wu et al., 2013); *Euphorbia hirta* leaf (Annamalai et al., 2013); *Terminalia arjuna* (Mohan Kumar et al., 2013); *Couroupita guianensis* flower (Kirubha and Alagumuthu, 2014); *Sesbania grandiflora* (Das and Velusamy, 2014); stem of *Hibiscus nnnabinus* (Bindhu et al., 2014); *Azadirachta indica* leaf (Bindhani and Panigrahi, 2014); *Morinda citrifolia* root (Suman et al., 2014); Pea nut (Raju et al., 2014); Mango peel (Yang et al., 2014); Leaf of *Pogestemon benghalensis* (Paul et al., 2015); *Nerium oleander* (Tahir et al., 2015); *Butea monosperma* (Patra et al., 2015); bark of *Eucommia ulmoides* (Guo et al., 2015); *Zizyphus mauritia* (Sadeghi, 2015); *Argemone Mexicana* leaf (Selvaraj et al., 2015); *Nepenthes khasiana* leaf (Bhau et al., 2015); *tamarindus indica* leaf (Correa et al., 2016) yield particles in size ranging from 20-200nm.

### 2.6. Medicinal plants a potent source of antimicrobial agents

Traditional medicinal plants have a greater antimicrobial potential against microorganisms; they may be used in treating infectious affliction provoked by resistant microbes. The synergistic effect of herbal plant extracts against resistant microbes leads to new choices of drugs for the treatment of infectious diseases. The surge of

2.6.1. Kedrostis–Antimicrobial agent

Various extracts of K. foetidissima were screened for its anti-microbial activity against different microbes. Water extract of the aerial parts is active against the measles virus *Leishmania denovani*, the visceral *Leishmania Parasite*, *Trypanosoma brucei* (Otieno and Odero, 1988). Chloroform leaf and stem extract showed effective antibacterial activity against *Pseudomonas aeruginosa* (Priyavardhini et al, 2008; Elavazhagan and Balakrishnan, 2013). Fresh juice of Kedrostis, collected from Gobichettipalayam shows better antimicrobial activity than that from Namakkal (Mekala et al, 2011). Among various extracts of leaf, stem and tubers of K. foetidissima, analysed for its antimicrobial efficacy against various microbes at different concentrations reveals, methanol leaf extract to be more effective against *S. marcesense* and gram positive bacteria *S. aureus* at 100% concentration (Vasantha et al, 2012). Leaf methanol extracts inhibit the fungi *C. albicans* and *C. tropicalis* more effective than other extracts of stem and tubers (Priyavardhini et al, 2012). Methanol leaf extracts exhibit better antibacterial activity on *Klebsiella pneumoniae* (Kavitha et al, 2014; Sharly et al, 2014). Methanol leaf extracts show higher inhibition against the pathogen *E. coli* isolated from clinical and subclinical bovine mastitis milk samples (Jagadeeswari et al, 2014).

Antifungal activity of silver nanoparticles synthesised using aqueous extract by agar well diffusion method shows moderate zone of inhibition against *C. albicans* (8 mm) and excellent activity against *S. cerevisiae* (14 mm) when compared with that of standard Fluconazole (*C. albicans* -12 mm ; *S. cerevisiae* - 10 mm) (Jannathul and Lalitha, 2015).
2.6.2. Antimicrobial Textiles

Awareness in health care and protective aspects plays a significant role in the development of antimicrobial textiles. Textiles when fabricated with commercially available antimicrobial chemicals are costly, create environmental issues and also have side effects. This leads to the development of antimicrobials of natural origin. Researchers work with various plant extracts in the identification of plant-based antimicrobial for cost effective development of antimicrobial fabric.

Grafting of woven and non-woven 100% cotton fabric with aqueous neem extract analysed for their antimicrobial efficacy against *E. coli*, *P. aeruginosa*, *S. aureus*, *C. albicans* and *B. subtilis*, show effective inhibition (Patel and Desai, 2014). Methanolic extract of *Ricinus communis*, *Senna auriculata* and *Euphorbia hirta* coated denim fabric shows potent antimicrobial activity against *Staphylococcus aureus* and *Escherichia coli* (Sumithra and Vasugi, 2014). Bleached cotton fabric treated with *Aloe vera* gel and Neem extract are reported to possess significant antimicrobial activity against selected microbes (Khurshid et al, 2015).

2.7. Antioxidant Activity of medicinal plants

In the flow of analyzing the specific medicinal properties of herbal plants, around the World, many medicinal plants were screened for its antioxidant efficacy. Scientists examined various medicinal plants for its antioxidant efficacy. Almost all the medicinal plants tested show prominent antioxidant activity (Lie-Fen et al, 2005; Katalinic et al, 2006; Nooman et al, 2008; Prakash et al, 2009; Maryam et al, 2009; Maria et al, 2010; Vinay et al, 2010; Nithya and Balakrishnan, 2011; Yu-Ling et al, 2012; Jayachitra et al, 2012; Berłowski et al, 2013; Kaur and Mondal et al, 2014; Jayathilake et al, 2016).

2.7.1. Antioxidant activity of *K. foetidissima*

The ethanol leaf extract of *K. foetidissima* was analysed for their free radical, superoxide, hydroxyl and nitric oxide scavenging potency and compared with standard drugs ascorbic acid, BHT (2, 6-di-ter-butyl-p-hydroxytoluene) and copper sulphate. Ethanol extract shows moderate antioxidant efficacy with standard antioxidants (Gopi et al, 2012). Free radical scavenging efficacy of different solvent extracts such as
aqueous, methanolic, chloroform, acetone and petroleum ether extracts of *K. foetidissima* leaves examined and compared reveal the methanolic leaf extract to show effectual DPPH, hydroxyl, superoxide, hydrogen peroxide and nitric oxide scavenging efficacy. This was attributed due to high precipitation of flavonoids, phenols and tannins in methanolic extract (Sasikumar and Kalaisezhiyen, 2014). DPPH, hydroxyl radical scavenging, metal chelating and reducing power ability of aqueous, methanolic, chloroform, acetone and petroleum ether extracts of *K. foetidissima* leaves were analysed for their antioxidant efficacy, methanolic extracts show excellent free radical scavenging activity, metal chelating and reducing power ability than other extracts (Pavithra and Vadivukkarasi, 2015).

### 2.8. Medicinal plants as wound healers

From time immemorial, medicinal herbs have been used for curing various skin disorders like cuts, wounds and burns (Kumar, 2007). Developing countries rely on traditional herbs to maintain their day-to-day health care (Survase and Raut, 2011). Wound healing rate may be enhanced by proper care and providing best suitable environment. In addition to this, application of suitable herbs possessing antimicrobial, antiseptic, astringent and anti-inflammatory properties, supply essential phytoconstituents responsible for enhancing wound healing without side effects (Jaiswal et al, 2004). Tissue healing effect of medicinal herbs without side effects and side effect caused by the modern medicines intended researchers to move towards Siddha and Ayurvedha in identification of herbal based drugs.

Review shows plant-based ointments to be efficient in healing incision and excision wounds in wistar rats. Pounded whole plant of *Agrimonia pilosa Ledeb*; bark paste of *Betula alnoides*, whole plant poultice of *Boschniakia himalaica*; bark paste of *Buxus wallichiana*; wood paste of *Caryopteris odorata*; latex of *Euphorbia pilosa* (Gaur et al, 1992), leaf paste with albumin of *Dodonaea viscosa Linn* (Sudersanam, 1995), leaf of *Adhatoda zeylanica*; bark juice and paste of *Callicarpa arborea Roxb*; crushed root of *Cirsium sinense*; mashed tuber of *Curcuma domestica*; leaf juice of *Gelsemium elegans* (Bhardwaj and Gakhar, 2005), crushed bark of *Acacia catechu Willd*; latex of *Achyranthes aspera*; fruit powder of *Areca catechu*; leaves and latex of *Argemone*
Mexicana; crushed leaves of Barleria prionitis; crushed fruit paste of Brassica juncea; crushed flower of Calendula officinalis; leaf juice of Bryophyllum calycinum; latex and leaves of Calotropis procera; leaves of Cassia alata; leaves and bark of Cassia auriculata (Patil et al, 2009), leaf juice of Cissampelos pareira; stem juice of Commelina benghalensis; stem paste of Cyanotis villosa; whole plant of Dumasia villosa; fresh latex of Euphorbia hirta; flower decoction of Ixora coccinia; seed oil of Pongamia pinnata (Ayyanar and Ignacimuthu, 2009), methanolic leaf extract of Alternanthera brasiliana Kuntz (Barua et al, 2009), methanolic leaf extract of Cassia roxburghii (Srinivas et al, 2011), aqueous extract of Acalypha indica (Kumarasamyraja and Swamivel, 2015), aqueous leaf extracts of Ficus religiosa and Ficus benghalensis (Nidhi et al, 2014) and ethanol leaf extract of Cestrum nocturnum (Hemanth et al, 2016) showed efficient wound healing activity.

2.9. Anti-anaemic activity of Kedrostis

The hydro-alcoholic (ethanol/water 1:1) extract of Kedrostis shows, appreciable elevation in Hb, RBC contents in blood and acts as an effective anti-anaemic drug towards the induced anaemia in Wistar rats (Saravanan and Manoharan, 2012).

2.10. Antidiabetic efficacy

Medicinal plants are traditionally used for treating Diabetes mellitus before the discovery of insulin (Ribnicky et al, 2006). Novel approach for the treatment of diabetes is decreasing the post-prandial hyperglycaemia, by the inhibition of digestive enzyme alpha amylase. Clinically used inhibitors such as acarbose, voglibose and miglitol have side effects. Therefore, it is the need of time to explore and identify the amylase inhibitors from natural sources with lesser side effects. Scientists have proved though their research that many medicinal plants act as efficient antidiabetic agents through the inhibition of α–amylase (Alarcon et al, 1998; Patwardhan et al, 2004; Ali et al, 2006; Du et al, 2006; Giancarlo et al, 2006; Kotowaroo et al, 2006; Cao et al, 2007; Deutschländer et al, 2009; Tundis et al, 2010; Ahmed and Urooj 2010; Al-Aboudi and Afifi, 2011; Bhat et al, 2011; Ghosh et al, 2012; Usune et al, 2012; Rahimzadeh et al, 2014; Elya et al, 2015; Balaji et al, 2015; Agwaya et al, 2016).
2.10.1. Antidiabetic assay of Kedrostis

Methanol and hexane extract of seeds and leaves of Kedrostis examined for its antidiabetic efficacy revealed seeds to be more efficient than the leaf extracts; hexane extract inhibits α-amylase more effectively than methanol extract (Nirmala and Pandian, 2015).

2.11. Anticancer activity

Medicinal plants are nature’s gift. Medicinal plants were the origin of the traditional medicinal system around the world. For decades together, these herbs provide remedies for human in treating various ailments. Traditional medicinal plants and plant derived compounds have anti-tumour activity and are more effective against cancer cells. Researchers examined various plants extracts for its anticancer efficacy on different cancers cell lines (Chabner, 1991; Harvey, 1999; Cragg and Newman, 1999; 2000; 2002; Mann, 2002; Cochrane et al, 2008; Sherine et al, 2010; Subhadradevi, 2011; Nonkululeko et al, 2012; Pauli et al, 2013; Widowati et al, 2013; Elisha et al, 2014; Shruti et al, 2015; Gayathri et al, 2016; Murganatham et al, 2016).

2.11.1. Molecular docking and anticancer studies

Cancer is a deadly disease, which is the foremost cause of death worldwide. It is due to continual, comparatively independent and unusual expansion of cells. The death rate imposes the urge in the development of new drugs (Ferlay et al, 2010). Molecular docking now becomes a key tool in computer-assisted drug designing. It effectively indicates the protein-ligand interactions which aids in identifying potent inhibitors (Srinivasan et al, 2011). Literature show researchers use this computational technology for docking Bcl-2 protein(202F) an apoptosis regulator with paclitaxel chemotherapeutic drug and its 84 analogues (Shinha et al, 2010), Cdk1_yeast (cell cycle control) protein has been docked with bioactive compounds of Azadiractica indica for the identification of suitable protein inhibitor (Krishnamoorthy and Balakrishnan, 2014) and PTEN tumour suppressor gene, docked with thymoquinone for its anticancer activity (Nithya et al, 2015).
2.11.2. Anti proliferative effect of plant extracts against Human Lung cancer cell lines A-549.


Isolates from medicinal plants shows prominent anticancer activity against Human lung cancer cells (A-549). Etoposide isolated from Podophyllum peltatum and the wild chervil Podophyllum emodi (Stähelin et al, 1973), Salidroside, a phenylpropanoid glycoside isolated from Rhodiola rosea (Jun et al, 2014), Myricanone, diarylheptanoids, isolated from the bark of Myrica (Dai et al, 2014) were effective in inhibiting Human Lung Cancer cell lines.

2.11.2.1. Anticancer activity of Kedrostis species on Human Lung cancer Cell line A-549

Aqueous extract of K. hirtella was examined for its anticancer activity on dose dependent and time dependent manner, shows appreciable reduction in cell growth
There are no reports on the use of K. foetidissima in treating lung cancer.

2.11.3. Anti tumour activity of herbal extracts against breast cancer cell lines MCF-7 and YMB-1

A malignant tumour that grows in breast tissue is breast cancer. This tissue growth starts in lobules or ducts. Breast cancer is the second-leading cancer, causing cancerous death in women globally (Parkin et al., 1999). A review of American National Cancer Institute reveals this type of cancer to be a postmenopausal problem. The average age of women suffering from breast cancer was 61 years and no woman below the age of 20 was reported to have this disease (Altekruse et al., 2009). Incessant practice of taking oral contraceptives and exposure to radiation may be the reason for breast cancer in women (Ronckers et al., 2005; Urban et al., 2012). With the increased interest in the identification of herbal-based drugs for breast cancer, many medicinal plant extracts were analysed and proved to be potent against the breast cancer cell lines MCF-7 and YMB-1 (Abu-Dahab and Affiridi, 2007), Garcinia mangostana extract (Agustina et al., 2014); Piper c obeba extract (Graidist et al, 2005) and hydromethanol extracts of Farsetia aegyptia, Lactuca serriola, and Santolina chamaecyparissus (Elsharkawy and Algohar, 2016) are reported to be effective against breast cancer cell lines.

2.11.3.1. Anti tumour activity of Kedrostis on breast cancer cell lines (MCF-7 and YMB-1)

A Nigerian report reveals leaf and stem of Kedrostis foetidissima to be used in the treatment of tumours. The crude extracts of K. foetidissima show significant apoptosis in both breast cancer cells (MCF-7 and YMB-1) (Choene and Motadi, 2012).

2.11.4. Antiproliferative effect of plant extracts on Human Osteosarcoma MG-63 cell lines

Osteosarcoma is a type of cancer which occurs in the bones of children and young adult. This type of cancer is due to immature bone or by the formation of osteoid by malignant cells. Trials were registered in the identification of herbal based drugs in the treatment of osteosarcoma. Among various plants parts investigated, water-extracts
of *Scutellaria barbata* (Kim, 2006); Nigerian herbs, *Hunteriaum bellata* leaf, *Cola lepidota* leaf, leaf of *Perseaamericana*, *Perseaamerican* root bark and *Plukenetiaconophora* leaf (Engel et al, 2011); *Psidium guajava* leaf (Sul’ain et al, 2012); *Nephelium lappaceum* peel extract (Emylia et al, 2013); red, brown and green marine algae such as *Caulerpa peltata*, *Gelidiella acerosa*, *Padina gymnospora*, and *Sargassum wighti* (Murugan and Iyer, 2013), Indian tropical fruit residues like, *Carissa carandas* pomace; *Ananas comosus* skin; *Artocarpus lachoocha* pomace; *Litchi sinensis* seeds; *Grewia asiatica* pomace; *Beta vulgaris* pomace and *Artocarpus skin* (Priti et al, 2014); seed of *Capsicum* (Jayanthi et al, 2016); ethanolic leaf extracts of *Alternanthera philoxeroides* and *Alternanthera sessilis* (Sunmathi and Sivakumar, 2016) were effective against Human Osteosarcoma cell lines.

### 2.11.5. Anticancer activity of silver nanoparticles from natural sources

Silver, the noble metal, is traditionally well-known for its medicinal property. Silver nanoparticles, synthesised from natural sources were proved to be effective against cancer cells. Review reveals nanosilver synthesised from aqueous extract of *Gelidiella* to be effective cytotoxicity on Hep-2 (Human laryngeal) cell line (Saraniya et al, 2012), aqueous extract of *Citrullus colocynthis* is effective against human cancer cell lines of colon (HCT-116), breast (MCF-7), liver (Hep-G2) and intestine n(Caco-2) (Alaa et al, 2013), aqueous leaf extract of *Cynodon dactylon* is effective in inhibiting HEpG-2 cells (Supraj and Arumugam, 2016), *Penicillium brevicompactum* is potent against MCF-7 breast cancer cell lines (Majeed et al, 2016) and *Saccharina japonica* extracts show excellent proliferation against HeLa cells (Srekanth et al, 2016).

### 2.11.5. Anticancer activity of gold nanoparticles from natural sources

Noble metal nanoparticles have profound applications in imaging, cosmetics, sensors, cancer therapy, etc. This wide range of application is owing to specific properties such as molecular recognition, optical and electronic properties. They possess high optical field augmentation by virtue of the resonating oscillation of free electrons (Mukherjee et al, 2001; Shankar et al, 2004). Gold and nanogold are more efficient due to their inertness towards oxygen and acids, high stability and coherence (Daniel and Astruc, 2004). Due to these properties, nanogold is used in various
biomedical applications. Literature search concedes, gold nanoparticles synthesised from flowers of C. guianensis to be efficient against HeLa-60 Cell Line (human Caucasian promyelocytic leukemia) (Geetha et al, 2013) from seed of Achyranthes aspera is effective against HeLa (Anand et al, 2014) and from marine bacteria Enterococcus show prominent anticancer activity against Hep-G2 and A-549 cells (Rajeshkumar, 2016).