REVIEW OF LITERATURE
Ayurvedic system of medicine is widely practised and accepted by an estimated 65% of the population in rural areas in India. The Ayurveda medicine system and medicinal plants help to meet their primary health care needs (Farnsworth et al., 1985; Pattanaik & Reddy 2008). Ayurveda, literally meaning the "Science of Life and Longevity" in ancient Sanskrit, is the one of the oldest healing systems of India, based on lifestyle, diet and herbs (Shah et al., 2010; Gupta et al., 2009). Safe, effective and inexpensive indigenous remedies are gaining popularity among the people of both urban and rural areas in India and China (Meena, 2009).

A large portion of the world population, especially in the developing countries depends on the traditional system of medicine for a variety of diseases. Several hundred genera are used medicinally and plants are vital sources for potent and powerful drugs (Ahmad et al., 1998). Many of the spices and herbs used today have been valued for their antimicrobial effects and medicinal powers in addition to their flavor and fragrance qualities (Ceylan et al., 2004; De, 2004; Davidson et al., 2005).

A large number of medicinal plants have been used for years in daily life to combat diseases, worldwide. Presently, herbs, embodied with due importance in healthcare system, create an herbal renaissance, spread with a greater speed throughout the world. It is therefore, essential to search for the efficacious plants of medicinal value for better manifestations (Panda et al., 2012). According to literature, various solvents are having significant roles in extracting biologically active molecules from various parts of the plants. Of many solvents available, methanol is said to be having extensive capacity in trapping the active compound(s) from the target materials. This might be due to the chemical interactions between the biologically active molecules and methanol.
The methanolic extracts of various phytochemicals and their biological activities have been well established and documented by various researchers, worldwide. The methanol derived phytochemicals and their activities of *Helictres isora*, *Spathodea campanulata*, *Antigonon leptopus* and *Thunbergia grandiflora* have been reported and well documented by various researchers. In this context, methanol could be able to extract alkaloids, phenol, xanthoproteins, carboxylic acid, coumarins and carbohydrates from these plants and exhibit the important activities. While, phenols, saponins, aminoacids, steroids, phytosterols, triterpenoids, tannins, xanthoprotein, carboxylic acid and coumarins were recorded in the methanolic extracts of *A. leptopus*, methanolic extract of *T. grandiflora* was reported to contain alkaloids and phenols only (Johnson *et al.*, 2012).

The antibacterial and antifungal activities of petroleum ether, benzene, chloroform, ethanolic and aqueous extracts of *Myxopyrum serratum* A. W. Hill. leaves were tested using agar diffusion assay. Significant antimicrobial activities were found against seven bacteria viz., *Streptococcus faecalis*, *Bacillus subtilis*, *Bacillus cereus*, *Klebsiella aerogenes*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Proteus vulgaris* and two fungi *Candida albicans* and *Aspergillus flavus* strains by using zone of inhibition. Among all the extracts tested, ethanolic extract showed maximum antimicrobial potential against microorganisms (Gopalakrishnan *et al.*, 2012).

Phytochemical constituents of *Eclipta alba*, *Aphanamixis polystachya* leaves and bark of *Premna integrifolia* in two different solvents showed the presence of alkaloids, tannins, flavonoids and glycosides. Antibacterial activity was tested using disc diffusion method against eight pathogenic bacteria. Kanamycin was used as antibiotic standard and found effective in chloroform and ethyl acetate fractions of tested extracts. The MIC value of chloroform and ethyl acetate extracts possess minimum inhibition (Ripa *et al.*, 2012).
Antonisamy et al., (2012) performed the phytochemical analysis of the methanolic flower extracts of *Helictres isora*, *Spathodea campanulata*, *Antigonon leptopus* and *Thunbergia grandiflora* by using Harborne method. The results revealed the presence of alkaloids, phenolics, tannins, xanthoproteins, carboxylic acid, coumarins and carbohydrates in the methanolic extracts of *H. isora*. The methanolic extracts of *S. campanulata* displayed the presence of alkaloids, phenolics, coumarins and carbohydrates. Phenolics, saponins, aminoacids, steroids, phytosterols, triterpenoids, sapogenins, tannins, xanthoprotein, carboxylic acid and coumarins were present in the methanolic extracts of *A. leptopus*. The methanolic extracts of *T. grandiflora* showed the presence of alkaloids and phenolics only.

Xavier et al., (2012) screened the antibacterial efficacy of various solvent extracts of *Sargassum wightii*, *Chaetomorpha linum* and *Padina gymnospora* against some selected Gram positive and Gram negative human pathogenic bacteria using disc diffusion method and reported that the acetone extracts of marine algae *S. wightii*, *C. linum* and *P. gymnospora* exhibited good antimicrobial activity. But the acetone extracts of *S. wightii* possessed highest antibacterial activity than others.

Shyamala and Thangaraju (2013) revealed the presence of the secondary metabolites viz., alkaloids, carbohydrates, saponins, glycosides, protein, amino acids, phytosterol, Phenolic compound, flavonoids, terpenoids and tannins presence in *C. racemosa*, *S. marginatum* and *H. musciformis* collected from Gulf of Mannar, and also studied the antibacterial activity against several human pathogenic microbes. Among these maximum activity was recorded in methanolic extracts of *H. musciformis* against *B. subtilis* and minimum activity was noted in ethanolic extract of *C. racemosa* against *E. coli* among the two different extracts.

Rabia et al., (2013) identified antibacterial activity of 19 marine algal species (6 Chlorophyta, 8 Phaeophyta and 5 Rhodophyta) collected from the western coast of Libya against patho-genic
bacteria (4 Gram-positive, 4 Gram-negative). The extracts showed a significant antibacterial activity against Gram positive as well as Gram negative bacteria whereas *Cystoseira crinite* exhibited the highest antibacterial activity among tested bacterial species.

Jeyanthi Rebecca *et al.*, (2013) represented the antibacterial and phenolic activity of *G. cortica, E. flexuosa* and *E. clathrata*. Kajal *et al.*, (2013) evaluated the antioxidant activities and total phenolic contents of brown seaweeds belonging to *Turbinaria conoides* and *Turbinaria cornate* collected form gulf of southeastern coast of India. Arunkumar *et al.*, (2013) identified the antibacterial potential of 23 red, 9 brown and 15 green against two plant pathogenic bacteria such as *Xanthomonas axonopodi* var. *citri* and *X. campestris* var. *malvacearum*.

Fruits of *Syzygium cumini* were evaluated for antibacterial activity against some Gram positive and Gram negative bacterial strains by Patel and Rao (2012). Zones of inhibition were observed against all the tested bacterial pathogens except *Micrococcus luteus* by the ethyl acetate fractions of *S. cumini* and *Salmonella paratyphi* by the diethyl ether and ethyl acetate fractions of *S. cumini*. Highest zone of inhibition was obtained against *Bacillus cereus* using diethyl ether extract. Lowest MIC value of 0.25 mg/ml of diethyl ether extract of pre-ripened fruits was effective against *B. cereus*.

Ishnava *et al.*, (2012) evaluated the *in vitro* antibacterial potential of chloroform, ethyl acetate, hexane, methanolic and aqueous extracts of *Calotropis gigantea* (L.) R. Br. latex against five carcinogenic bacteria viz., *Actinomyces viscosus, Lactobacillus acidophilus, Lactobacillus casei, Streptococcus mitis* and *Streptococcus mutans* using agar well diffusion method. The chloroform extract fraction of latex showed inhibitory effect against *S. mutans* and *L. acidophilus* with MIC value of 0.032 and 0.52 mg/mL respectively. Qualitative investigation such as IR, GC-MS and NMR revealed the presence of methyl nonanoate, a saturated fatty acid in *C. gigantea*. 
Kamalakannan et al., (2012) performed phytochemical, antibacterial and antifungal activity on methanolic and aqueous extracts of *Elephantopus scaber* L. against six bacterial pathogens viz., *Escherichia coli, Staphylococcus aureus, Streptococcus pyogenes, Pseudomonas aeruginosa, Leuconostoc lactis* and *Salmonella typhi* and four fungal strains viz., *Aspergillus niger, Aspergillus flavus, Rhizopus indicus* and *Mucor indicus*. Maximum inhibition zone (28 mm) was recorded from 200 mg of methanolic extract and minimum (18 mm) was found at 50 mg of methanolic extract of *E. scaber* against *S. pyogenes*. The methanolic extract of *E. scaber* showed the maximum antifungal activity (32 mm) from 200 mg of extract against *M. indicus* and minimum (14 mm) by 50 mg of extract against *R. indicus*. Phytochemical analysis revealed the presence of alkaloids, flavonoids, saponins, tannins, phenolics, proteins and carbohydrates.

Janakiraman et al., (2012) analyzed the phytochemical and antibacterial efficacy of ethanolic, acetone and chloroform extracts of *Peristrophe bicalyculata* (Retz.) Nees. Preliminary phytochemical screening revealed the presence of various secondary metabolites like steroids, alkaloids, phenolics, flavonoids, saponins and tannins. The antibacterial efficacy was tested against the pathogens viz., *Bacillus cereus, Enterococcus aerogenes, Escherichia coli, Salmonella typhi* and *Staphylococcus aureus* by disc diffusion method. Ethanolic extract of *P. bicalyculata* was most effective against *E. coli, B. cereus* and *S. typhi*. Maximum zone of inhibition (18 mm) was observed against *E. coli*.

Ruban and Gajalakshmi (2012) tested the *in vitro* antibacterial activity of *Hibiscus rosasinensis* flower extract against the human pathogens using disc and agar diffusion methods. The results showed that the cold extraction exhibited a maximum zone of inhibition against *Bacillus subtilis* and *Escherichia coli* followed by hot extraction against *E. coli* and *Salmonella* sp. The crude protein from flower shows a maximum inhibition against *Salmonella* sp. and *E. coli*. 
Malar et al., (2012) determined the bio-efficacy of the leaf extracts of *Hyptis suaveolens* (L.) Poit against the fish pathogens isolated from diseased Tilapia (*Oreochromis niloticus*). Petroleum ether, ethanolic, ethyl acetate, chloroform and aqueous extracts of *H. suaveolens* were tested against the pathogens viz., *Aeromonas formicans*, *Aeromonas hydrophila*, *Bacillus subtilis*, *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* by agar well diffusion method. The results illustrated the widest spectrum activities with the maximum zone of inhibition (23 mm) for *A. formicans*.

The methanolic extract of the leaves of *Rauwolfia serpentina* was studied for its anti-diarrhoeal properties in experimental diarrhoea induced by castor oil in mice. Oral dosing of 100, 200 and 400 mg/kg methanolic leaf extracts of *R. serpentina* showed significant and dose-dependent anti-diarrhoeal activity. All doses of the extract and the reference drug atropine sulphate produced a dose-dependent reduction in intestinal weight and fluid volume. The methanolic leaf extracts of *R. serpentina* significantly reduced the intestinal transit in charcoal meal test when compared to diphenoxylate HCl (Ezeigbo et al., 2012).

Sasmal et al., (2012) evaluated the acetone extract of the seeds of *Saraca asoca* (Ashoka) for acute toxicity and antipyretic activity using Brewer’s yeast induced pyrexia in Wister rats at oral doses of 300 mg/kg and 500 mg/kg. It showed the presence of saponins, tannins and flavonoids which inhibit pyrexia. The therapeutic efficacy achieved at both the dose levels and standard drug aspirin (100 mg/kg) showed significant antipyretic activity when compared to the control group. The highly significant antipyretic effect exhibited at the dose of 500 mg/kg was also found to be sustainable in nature.

Kumbhare et al., (2012) assessed the phytochemical constituents; total phenolic content and in vitro antioxidant activity of *Moringa oleifera* stem bark extracts. DPPH and nitric oxide radical scavenging activity were used to demonstrate antioxidant activity. Phytochemical analy-
sis revealed the presence of tannins, flavonoids, steroids and alkaloids. The (lethal concentration) LC_{50} values were obtained for extracts as 850 µg/mL for petroleum ether extract, 800 µg/mL for chloroform extract and 900 µg/mL for methanolic extract. The total phenolic content of the methanolic extract was 50.72% w/w equivalent to gallic acid. Methanolic extract was found to be good scavenger of DPPH radical with an (Inhibition concentration) IC_{50} of 54.34 µg/mL. Ethyl acetate soluble fraction was found to be good scavenger of nitric oxide radical with an IC_{50} of 54.83 µg/mL.

Janakiraman et al., (2012) determined the chemical constituents of *Peristrophe bicalyculata* (Retz.) Nees. using GC-MS. The results provided different peaks determining the presence of seven different phytoconstituents viz., propane,1,1-diethoxy (68.89%), (6Z)-nonen-1-ol (24.00%), 4-methyl-2,4-bis(4',trimethylsilyloxyphenyl) pentene-1 (3.56%), cyclooctyl alcohol (1.78%), oxirane, butyl- (0.89%), (2H)pyrrole-2-carbonitrile,5-amino-3,4-dihydro- (0.44%) and ethaneperoxoic acid,1-cyano-1-(2-(2-phenyl-1,3-dioxolan-2-yl)ethyl) pentyl ester (0.44%).

Satani and Mishra (2012) studied the morphological, histological, quantitative microscopic and chromatographic studies of the leaves of *Heterophragma quadriloculare* (Bignoniaceae). Diagnostic features are compound leaves, odd-pinnate, dorsiventral, asymmetric at base with unicellular non-covering and glandular trichomes having unicellular stalk and bicellular head, actinocytic stomata and rhombus calcium oxalate crystals. HPTLC studies revealed that the solvent system toluene: ethyl acetate (9:1) was ideal and gave well resolved sample peaks.

Kiruba et al., (2012) performed the phytochemical analysis to determine the secondary metabolites present in the pericarp of *Crataeva magna*. The phytochemical screening proved the presence of phenolics, saponins and tannins. The findings prove that the pericarp of *C. magna*
has potential antimicrobial compounds that may be useful for developing plant based drugs for various ailments.

Saad et al., (2012) investigated the antimicrobial properties of mangrove Sonneratia alba for their ability to inhibit the growth of pathogenic bacteria and fungi using disc diffusion and microdilution methods against six microorganisms. Soxhlet apparatus was used for extraction with a series of solvents viz., n-hexane, ethyl acetate and methanol in sequence of increasing polarity. Methanolic extract appears to be the most effective while n-hexane extract showed no activity. The antimicrobial activities were observed against the Gram positive bacteria Staphylococcus aureus and Bacillus cereus, the Gram negative Escherichia coli and the yeast Cryptococcus neoformans. Pseudomonas aeruginosa and Candida albicans were resistant to the concentrations tested since no inhibition zone was observed. E. coli appears to be the most sensitive strain followed by S. aureus and B. cereus.

Kalaivani et al., (2012) analyzed the preliminary phytochemical constituents of Andrographis paniculata (Burm.f.) Wall. ex Nees and confirmed the presence of various secondary metabolites like steroids, alkaloids, phenolics, catechines, flavonoids, saponins and tannins. GC-MS analysis determined the presence of 13 different phytochemical compounds viz., 1,1,3-triethoxy-propane, tetradecanoic acid, 3,7,11,15-tetramethy-2-hexadecen-1-ol, n-hexadecanoic acid, 9,12-octadecadienoyl chloride, (Z,Z)-, phytol, 9,12-octadecadienoic acid(Z,Z), 9,12,15-octadecatrienoic acid (Z,Z,Z), 1,2-benzenedicarboxylic acid diisooyctyl ester, squalene, retinoic acid methyl ester, androstan-17-one,3-ethyl-3-hydroxy-(5α) and β-sitosterol.

Prabhadevi et al., (2012) explored the phytochemical constituents present in Allamanda cathartica L. using GC-MS. The results determined the presence of 28 different phytochemical compounds in the ethanolic leaf extract of A. cathartica. The major phytoconstituents were 9, 12, 15-octadecatrienoic acid (Z,Z,Z), n-hexadecanoic acid, 3-O-methyl-d-glucose and 9, 12, 15-
octadecatrienoic acid ethyl ester (Z,Z,Z). The ethanolic stem extract of *A. cathartica* showed the presence of 26 different bioactive compounds and the major ones are 3-O-methyl-d-glucose, 2-furancarboxaldehyde 5-(hydroxymethyl) n-hexadecanoic acid and 9,12,15-octadecatrienoic acid (Z,Z,Z).

Sahaya Sathish *et al.*, (2012) determined the bioactive constituents present in different leaf extracts of *Vitex altissima* L. using UV-Vis, FT-IR and GC-MS. The UV-Vis profile showed different peaks ranging from 400-700 nm with different absorption respectively. FTIR spectrum confirmed the presence of alcohols, phenols, alkanes, alkynes, alkyl halides, aldehydes, carboxylic acids, aromatics, nitro compounds and amines in different extracts. GC-MS analysis provides different peaks determining the presence of 21 phytochemical compounds with different therapeutic activities. The major phytoconstituents were n-hexadecanoic acid, 9, 12-octadecadienoic acid (Z,Z) and squalene.

Bakkour *et al.*, (2011) identified eight major chemicals from the essential oils of *Punica granatum*, *Vitis vinifera* and *Cucurbita maxima* using GC-MS. Three of the identified chemicals (Farnesene, Docosane and Tetracosane) were found in all three samples, but in varying proportions. Trans-Squalene was found in *C. maxima and P. granatum* only. The remaining four compounds (Octanoate ethyl ester, Doconoate ethyl ester, Palmiate ethyl ester and Linoleic acid ethyl ester) were found exclusively in *V. vinifera* seed oil.

Gayathri Gunalan *et al.*, (2012) developed the finger print of medicinally and economically important leaves of *Bauhinia variegata* Linn. The HPTLC fingerprinting of the ethanol extract has shown several peaks with different Rf values. The ethanolic extract of *Bauhinia variegata*’s leaves showed 11 spots. Devaki *et al.*, (2012) studied the HPTLC analysis of *Passiflora edulis* and *Bauhinia tomentosa* and the results authenticate the presence of phenols, flavonoids, tannin and cardiac glycosides.
The phytochemical constituents of the leaves of *Rhinacanthus nasutus* was analysed in order to understand the nature of the principle component responsible for its medicinal property. Preliminary absorbance survey scan of the methanolic extracts of *R. nasutus* evidenced the presence of multiple components in the extract. Two peaks observed in the HPLC spectrum showed the presence of two compounds in the extract. GC-MS profile revealed that the active components present in the leaf extract might be alkaloids or polyphenols. The results of IR spectrum revealed that band 1 possesses compounds of polyphenolic nature and band 2 possesses compounds that are having hydroxyl and carbonyl groups (Nirmaladevi et al., 2010).

Alkaloids from the aerial parts of *Vinca minor* L. were isolated and purified using different chromatographic methods. The structures of these alkaloids were determined on the basis of their physical and spectroscopic data. The concentration of vincamine was determined by high performance liquid chromatography using Tracer Excel 120 ODS AC18 column. Five indole alkaloids including vincaminorine, vincaminoreine, minovine, minovincine, and vincamine were isolated from the aerial parts of *V. minor*. Vincamine was found to be the dominant alkaloid in this plant with the content of 0.057% of the dried plant mass (Farahanikia et al., 2011).

The phytochemical and toxicity analysis of the ethanolic extract of *Rourea induta* Planch. (Connaraceae) was studied using the leaves. A long chain hydrocarbon, n-tetracosane and four flavonoids were identified: quercetin, and three glycosylated derivates, quercetin-3-O-α-arabinofuranoside, quercetin-3-O-β-xyloside and quercetin-3-O-β-galactoside. The structures were elucidated by $^{13}$C NMR, $^1$H NMR, UV and IR spectroscopy. The toxicity evaluation of extracts was performed by the brine shrimp method and determination of hemolytic activity. The samples demonstrated no toxic potential by the analyzed methods (Kalegari et al., 2011).

The methanolic leaf extract of *Callistemon lanceolatus* was screened for anti-inflammatory activity on carrageenan-induced paw edema in rat at doses of 200 and 400 mg/kg.
orally. The detailed pharmacognostic study of the *C. lanceolatus* leaf was carried out to lay down the standards which could be useful in future experimental studies. *C. lanceolatus* methanolic leaf extract showed significant (P<0.05) anti-inflammatory activity at doses of 200 mg/kg and 400 mg/kg. The pharmacognostic profile of the *C. lanceolatus* leaf is helpful in standardization for quality, purity and sample identification. The methanolic extract at a dose of 400 mg/kg shows a significant anti-inflammatory activity in comparison with the standard drug diclofenac sodium (Kumar et al., 2010).

*Rhinacanthus nasutus* contains a wide range of chemical compounds, mainly flavonoids, benzenoids, coumarin, anthraquinone, quinone, glycosides, carbohydrate, triterpenes, sterols, anthraquinones and naphthoquinones. Different parts of the plant have been used in folk medicine for treating liver disorders, skin diseases, peptic ulcers, helminthiasis, scurvy, inflammation and obesity. The naphthoquinones known as rhinacanthin-C and rhinacanthin-D extracted from *R. nasutus* are reported to have anti-inflammatory and analgesic activity. The promising alkaloid, Rhinacanthin isolated from *R. nasutus* is having antibacterial and antihelmintic activity. *R. nasutus* shows several other characteristic pharmacological effects like platelet aggregation inhibition, antidiabetic, antituberculosis and anticancer which are consistent with the reported uses of the plant extracts in the indigenous system of medicine (Bukke et al., 2011).

The chemical constituents of *Solanum torvum* were isolated by silica gel, Sephadex LH-20, and Rp-C18 column chromatography. Their structures were elucidated on the basis of spectral analysis of ESI-MS and NMR. Nine known compounds including neochlorogenin 6-O-ß-D-quinovopyranoside, neochlorogenin 6-O-ß-D-xylpyranosyl-ß-D-quinovopyranoside, neochlorogenin 6-O-ß-D-quinovopyranoside, solagenin 6-O-ß-D-quinovopyranoside, isoquercetin, rutin, kaempferol and quercetin were isolated from *S. torvum* (Yuan-Yuan et al., 2011).
The phytochemical profile and antimicrobial activity of *Andrographis paniculata* were obtained by extraction in chloroform and chloroform + HCl and further subjected to GC-MS analysis. The chloroform extract showed better antimicrobial activity against all the nine pathogenic bacterial strains (Gram negative *E.coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Salmonella typhimurium, Enterobacter cloacae* and four Gram positive bacteria *S. aureus, B. subtilis, Enterobacter faecalis, S. epidermidis*) tested and found to be active against the opportunistic and Gram-negative pathogenic bacteria, indicating its potential application related to noscomial infections. GC-MS results revealed the presence of phenols, aromatic carboxylic acids and esters in the chloroform extract and these molecules are responsible for the antimicrobial activity of *A. paniculata* (Roy et al., 2010).

Alkaloids profile for the medicinally important plant *Albizia lebbeck* has been studied using HPTLC. The ethyl acetate-methanol-water (100: 13.5: 10) was employed as mobile phase for alkaloids. Petroleum ether extracts of *A. lebbeck* leaves displayed the presence of 10 types of alkaloids with 10 different Rf values ranging from 0.02 to 0.85. Ethyl acetate extract of *A. lebbeck* leaves illustrated the presence of 5 different types of alkaloids with 5 different Rf values ranging from 0.09 to 0.84. Methanolic extract of *A. lebbeck* leaves demonstrated the presence of 4 different types of alkaloids with 4 different Rf values ranging from 0.02 to 0.79. This profile can be used for the identification of the medicinally important plants from the adulterants (Bobby et al., 2012).

The phytochemical constituents of petroleum ether, chloroform, ethanol and aqueous extracts of four medicinally important plants viz., *Mimusops elengi* L., *Cinnamomum verum* J. Presl, *Kigelia africana* (Lam.) and *Canthium dicoccum* Gaertn. Merr were studied using Harborne method. The result analysis revealed the presence of steroids, coumarin, anthroquinoline, proteins and sugars in different extracts of *M. elengi*. The extracts of *C. verum*
contain steroids, coumarins, tannins, anthroquinoline, phenols, proteins and sugars. The presence of steroids, coumarin, anthroquinoline, phenols, proteins and sugars were found in the extracts of *K. africana*. The extracts of *C. dicoccum* showed the presence of steroids, coumarin, tannins, anthroquinoline, phenols, proteins and sugars (Kala *et al.*, 2011).

Paola *et al.*, (2013) identified antioxidant and trace element content (vitamin C, total polyphenols, zinc, iron, cooper, selenium, cadmium and lead) of eight macroalgae species, three red (*Hypnea spinella, Gracilaria textorii* and *G. vermiculophyla*), four green (*Caulerpa sertularioides, Codiumsimulans, C. amplivesiculatum* and *Ulva lactuca*) and one brown (*Dictyota flabellata*) macroalgae.

Vijayabaskar and Vaseela (2012) studied the physico-chemical characteristics, total antioxidant capacity (TAC), reducing power and the free radical scavenging potentials (DPPH radical, ABTS, H2O2 radical) of sulfated polysaccharide from marine brown algae *Sargassum tenerrimum* and characterized the sulfated polysaccharide FT-IR spectrum showing the presence of carboxyl, hydroxyl and sulfate groups. Lakshmana *et al.*, (2013) evaluated α-amylase inhibitory activity, antioxidant activity and toxic effects of ten seaweeds viz., *S. duplicatum, S. wightii, S. tenerrimum, T. conoids, T. ornate* and *P. gymnospora* (brown seaweed), *G. gracilis, C. hornemanni, G. edulis* (red seaweed) and *C. racemosa* (green seaweed) from the southeast coastal area of India. Corpuz *et al.*, (2013) identified the total phenolic (TPC) and flavonoid contents (TFC) of methanolic extract of *S. siliquosum* to prevent the initiation of free radicals to cause cellular damage.

Leonel *et al.*, (2013) identified variety of polysaccharides present in *K. alvarezii, C. jubata, and C.crispus* - Gigartinales, Rhodophyta; *G.corneum*and *P. capillacea* -Gelidiales, Rhodophyta; *L.obtuse* - Ceramiales, Rhodophyta; *H.elongata, U.pinnatifida, S. polyschides, S.vulgare*, and *P. pavonica* - Phaeophyceae, Ochrophyta) using FTIR-ATR, FT-Raman analysis and spectroscopic techniques.
Vijayabaskar and Shiyamala (2012) studied the TLC, FTIR and antioxidant activity in *T. ornata* collected from Mandapam coastal region of Gulf of Mannar and revealed that the high polyphenol content of *T. ornata* represented higher antioxidant activity. Selvaraju *et al.*, (2012) studied the *in vitro* antioxidant activity of *Sargassum wightii* and *Ulva lactuca*. The functional groups of the two seaweeds were analysed by Fourier transform infrared spectroscopy (FTIR). These results show that *S. wightii* has higher antioxidant capacity than *U. lactuca*.

Selvamaleswaran *et al.*, (2013) studied the HPTLC alkaloid profile of *Clitoria ternatea* seeds, stems and leaves using the mobile phase ethyl acetate-methanol-water (100: 13.5: 10). It showed the presence of 26 different types of alkaloids with 21 R<sub>f</sub> values ranges from 0.02 to 0.93. Maximum number (10) of alkaloids has been observed in seeds followed by leaves (9). Among the ten different alkaloids of seeds, seven (0.15, 0.23, 0.41, 0.52, 0.62, 0.67 and 0.79 are unique to the seeds and they are not present in the vegetative parts of the plant.

The bio-efficacy of methanolic flower extracts of *Peltophorum pterocarpum* (DC.) Baker ex Heyne was tested through well diffusion method against the bacteria *Salmonella typhi*, *Staphylococcus aureus*, *Proteus mirabilis*, *Bacillus subtilis* and *Escherichia coli* isolated from human infections. The maximum zone of inhibition was observed against *P. mirabilis* followed by *S. typhi*. Preliminary phytochemical studies on methanolic flower extract of *P. pterocarpum* revealed the presence of glycosides, flavonoids, phenolics, saponins, catechins and alkaloids. The HPTLC separation was achieved using ethyl acetate-methanol-ethanol-water (8.1: 1.1: 0.4: 0.8) as the mobile phase. It showed four different Rf values 0.16, 0.31, 0.77 and 0.82 which indicated various glycosides present in the flower extract (Nathan *et al.*, 2012).

The leaves of *Coccinia indica* are reported to have good medicinal values in traditional system of medicine. Oral administration of ethanolic extract of *C. indica* leaves for 45 days to diabetic rats decreased the concentrations of blood glucose, lipids and fatty acids viz., palmitic
acid, stearic acid, oleic acid, linolenic acid, arachidonic acid and plasma insulin (Paril and Venkateshwaran, 2003).

Chromatographic finger print analysis of *Rumex vesicarius* L. was carried out using HPTLC technique. Toluene: Ethylacetate (7:3) was employed as mobile phase. HPTLC fingerprinting of the extracts showed several peaks with different Rf values. Chloroform and ethanol extracts showed 9 peaks in 5 µL concentration and 10 peaks in 10 µL concentration while aqueous extract showed only 2 peaks in both concentrations. This HPTLC fingerprint profile can act as biochemical marker in pharma industry and plant systematic studies (Hariprasad and Ramakrishnan, 2012).

The use of Ayurveda and other traditional medicines has expanded globally and gained wide popularity. Hexane extract obtained by Soxhlet extractor of leaves of *Ehretia laevis* is examined using GC-MS and eleven compounds are identified. Identification of compounds is based on similarity index of NIST and WILEY libraries (Torane et al., 2011).

The leaves of *Vitex negundo* were studied to evaluate the phytochemicals, total phenols, total flavonoids and antioxidant activity. Total phenol evaluations were carried out by Folin Ciocalteu method and the phenolic content was 27.72 mg/100 of gallic acid equivalent (GE). Antioxidant activity was evaluated by DPPH method and the leaves of *V. negundo* showed 23.21 mg/100 of Ascorbic acid Equivalent Antioxidant Capacity (AEAC). GC-MS study showed the presence of phytochemicals like 4H-Pyran-4-one, 2,3-dihydro-3,5-dihydroxy-6-methyl-, Phytol and Vitamin E (Kumar et al., 2010).

The major chemical constituents in *Canthium dicoccum* are Spathulenol (20.76%), Caryophyllene oxide (19.25%), Cedren-13-ol (10.62%), Ledene oxide (5.24 %), m-mentho-4, 8-diene (6.41%) and 2-furancarboxaldehyde (4.51%). The extract of *C. dicoccum* was characterized by substantial levels of sesquiterpenoids (55.87 %), nitrogenous compounds (12.93 %), al-
dehydes (8.7%), terpinolene (6.41%) and phenols (4.26%). The presence of these phytoconstituents in the plant extract provides scientific evidences for antimicrobial, anti-tumor, immune modulatory and antioxidant properties (Raja Rajeswari et al., 2011).

GC-MS analysis of the vacuum liquid chromatographic (VLC) fractions of the dichloromethane (DCM) extract of the bulbs of Ornithogalum cuspidatum leads to the identification of a number of steroidal compounds. The free radical scavenging activity of the DCM extract was assessed by the 2,2-diphenyl-1-picryl hydrazyl (DPPH) assay and found to be much weaker than that of the positive control Trolox (Nazifi et al., 2008).

The bioactive compounds of Indigofera aspalathoides have been evaluated using GC-MS. The chemical compositions of the whole plant methanolic extract of I. aspalathoides were investigated using Clarus 500 Perkin-Elmer (Auto system XL) GC-MS which revealed the existence of the two major compounds Tetradecanoic acid and 2 Methoxy-4α-methylandrost-2-en-17-one 5β (Abirami and Rajendran, 2011).

The steam distillation of Thymus serphyllum yielded 0.48% of the essential oil. GC-MS spectroscopic analysis resolved the oil into 39 constituents. Out of which, 28 components comprising 80% of the oil were tentatively identified and Thymol (53.33%) was the most abundant constituent of the oil. The antimicrobial activity of the essential oil was determined by using zone of inhibition method. The activity was found against seven Gram positive and three Gram negative test organisms. The minimum inhibitory concentration (MIC) for the tested microorganisms was found to be highly significant. All these values were indicative as bactericidal and not as bacteriostatic (Ahmad et al., 2006).

The stem bark extracts of Nyctanthes arboristis L. belonging to the family Oleaceae were tested for in vitro antimicrobial activity by cup plate method. The test organisms were Staphylococcus aureus, Micrococcus luteus, Bacillus subtilis, Escherichia coli, Pseudomonas
aeruginosa, Candida albicans and Aspergillus niger. The zone of inhibition and minimum inhibitory concentration (MIC) of the extracts were determined and compared with the standard drugs ciprofloxacin and fluconazole. Chloroform extract was found to have both antibacterial and antifungal activity whereas the petroleum ether and ethanol extracts exhibited only antibacterial activity (Manisha et al., 2009).

The stem and leaves of Malva parviflora L. have been tested for the presence of phytochemical compounds, total phenols and antioxidant activity. The results of the phytochemical screening showed the presence of flavonoids, tannins, phenols, saponins, alkaloids and resins in both the parts of M. parviflora. The total phenolic content was found at higher levels (40 mg/mL) in the stems and leaves of M. parviflora. The DPPH test demonstrated higher antioxidant potential at 4 mg/mL and H₂O₂ test showed maximal antioxidant activity at 2.5 mg/mL of M. parviflora (Farhan et al., 2012).

Antifungal activity of acetone and chloroform extracts of Pseuoclitocybe cyathiformis against Fusarium species (Fusarium culmorum and Fusarium moniliforme) was assessed using disc diffusion technique. The antifungal effects of P. cyathiformis were found against both Fusarium spp. tested. The zone of clearance was clearly observed around the mushroom extracts. The results were compared with commercial antibiotics amoxycillin and erythromycin (Guler et al., 2012).

Infection with HIV leads to immunosuppression and up to 90% of HIV infected individuals contract fungal infections of which 10 - 20% die as a direct consequence of these infections. Venda traditional healers used 76 extracts from 30 plants for the treatment of fungal related ailments. They were tested for their antifungal activities against clinical isolates of Candida albicans, Candida krusei and Cryptococcus neoformans using the agar diffusion and the microdilution methods. The minimum fungicidal concentrations as well as the time kill curves of
the most active plants were also determined. Extracts from 25 plants (83.3%) were active against *C. albicans*, *C. krusei* or *C. neoformans*. 32 extracts were active against *C. neoformans*, while 15 were active against *C. albicans* and 12 were active against *C. krusei* (Samie et al., 2010).

Evaluation of endophytes has been carried out for their possible antimicrobial activity from various parts of medicinal plants belonging to Jalgaon, Maharashtra (India). A total of 78 bacterial endophytes and 142 fungal endophytes were isolated from the aerial and underground parts of selected medicinal plants. 15 positive endophytic bacterial isolates and 14 positive endophytic fungal isolates possess antibacterial and antifungal activity respectively. Bacterial isolates from the roots of *Pongamia glabra*, from the stem of *Eucalyptus globulus* and rhizomes of *Curcuma longa* have strong antifungal activity. Endophytic fungi from the roots of *Aloe vera* possess strong antibacterial activity against *S. typhi* in dual culture assay (Jalgaonwala et al., 2010).

The evolution and spread of antibiotic resistance, as well as the evolution of new strains of disease causing agents are of great concern to the global health community. The ability to effectively treat disease is dependent on the development of new pharmaceuticals and one potential source of novel drugs is from traditional medicine. The extracts from Haudenosaunee medicinal plants would be more effective against moderately virulent bacteria than less virulent bacteria. Antibacterial activity against mostly avirulent (*E.coli, S. lactis*) and moderately virulent (*S. typhimurium, S. aureus*) microbes was inferred through replicate disc diffusion assays. Statistically predicted MIC values were determined through replicate serial dilution assays. In particular, four plant species exhibited antimicrobial properties as expected (*Achillea millefolium, Ipomoea pandurata, Hieracium pilosella* and *Solidago canadensis*), with particularly strong effectiveness against *S. typhimurium* (Frey and Meyers, 2010).
The methanolic leaf extracts of *Acacia nilotica*, *Sida cordifolia*, *Tinospora cordifolia*, *Withania somnifera* and *Ziziphus mauritiana* showed significant antibacterial activity against *B. subtilis*, *E. coli*, *P. fluorescens*, *S. aureus* and *Xanthomonas axonopodis* var. *malvacearum* and antifungal activity against *A. flavus*, *Dreschlera turcica* and * Fusarium verticillioides* when compared to root/bark extracts. *A. nilotica* and *S. cordifolia* leaf extract showed highest antibacterial activity against *B. subtilis* and *Z. mauritiana* leaf extract showed significant activity against *X. axonopodis* var. *malvacearum*. Root and leaf extracts of *S. cordifolia* recorded significant activity against all the tested bacteria. *A. nilotica* bark and leaf extract showed significant antifungal activity against *A. flavus*, *Z. mauritiana* and *T. cordifolia* recorded significant antifungal activity against *D. turcica*. The methanol extract of *S. cordifolia* exhibited significant antifungal activity against *F. verticillioides* (Mahesh and Satish, 2008).

Three native Turkish medicinal and aromatic plants (*Artemisia absinthum*, *Artemisia santonicum* and *Saponaria officinalis*) were investigated to analyze their antioxidant activity, total phenolic content and antimicrobial activity. Total antioxidant activity was determined by using a β-carotene bleaching assay and their antimicrobial activity was determined by utilizing an agar disc diffusion assay. The methanol extracts of the three species showed high antioxidant activity and among them *A. absinthum* possessed the highest quantity (71.78%). The total phenolic content (Folin-Ciocalteu assay) was shown to be between 6.57 µg GAE/mg (*S. officinalis*) and 8.86 µg GAE/mg on dry weight basis (*A. absinthum*). Aqueous and methanol extracts of the aerial parts of the species showed antibacterial activities against a number of microorganisms. The methanol extracts were found to inhibit the growth of microorganisms more than the aqueous extracts. These exhibited properties propose that such plant extracts can possibly be used as natural preservatives in the food and pharmaceutical industries (Sengul *et al*., 2011).
Many bacteria among the Enterobacteriaceae family are involved in infectious diseases and diarrhoea. Natural substances seem to be an alternative to this problem. Therefore, in vitro antibacterial activity of the methanol and aqueous-methanol extracts of Sida rhombifolia (Malvaceae) against seven pathogenic bacteria involved in diarrhoea was studied. Acute toxicity of the most active extract was determined and major bioactive components were screened. The agar disc diffusion and the agar dilution method were used for the determination of inhibition diameters and the minimum inhibitory concentration (MICs) respectively. The aqueous-methanol extract was most active with diameters of inhibition zones. The MICs of the aqueous-methanol extract varied from 49.40 to 78.30 µg/ml. Salmonella dysenteriae was the most sensitive. For acute toxicity study, no deaths of rats were recorded. However, significant increase of some biochemical parameters such as aspartate amino-transferase (AST), alanine amino-transferase (ALT), alkaline phosphatase (ALP) and creatinine (CRT) were found. The phytochemical analysis of the aqueous methanol extract indicated the presence of tannins, polyphenols, alkaloids, glycosides, flavonoids and saponins (Assam et al., 2010).

The wound healing efficacy of the root extract of Ixora coccinea L. was studied in five groups of animals. Two wound models including incision and excision models were used and compared with standard Nitrofurazone (NFZ) ointment (0.2% w/w). Six extracts (ethanol, aqueous, petroleum ether, benzene, chloroform and ethyl acetate) of I. coccinea were screened for in vitro growth inhibiting activity against different bacterial strains viz., S. aureus, B. pumilius, E. faecalis, E. coli, S. typhi and P. aeruginosa and fungi C. albicans and A. niger were compared with the standard drugs ciprofloxacin and chloramphenicol for antibacterial and griseofulvin for antifungal screening. The serial dilution and well plate methods were used for the antimicrobial study and MIC. The ethanolic extract showed significant wound healing activity when compared to standard drug NFZ with respect to normal control group (Selvaraj et al., 2011).
The antibacterial potential of crude ethanolic extracts of five medicinally important plants viz., *Curcuma mangga*, *Ficus racemosa*, *Vitex negundo*, *Ocimum basilicum* and *Etlingera elatior* were determined against the human bacterial pathogens by disc diffusion method. Strains of *K. pneumonia*, *S. aureus*, *S. typhi*, *P. vulgaris* and *P. aeruginosa*, isolated from clinical samples were used in the present work. A wide spectrum of antibacterial activities was observed against all these pathogens tested. The maximum zone of inhibition was observed against *P. vulgaris* followed by *P. aeruginosa* (Renisheya et al., 2011).

Antibacterial activity of clove extracts (*Syzygium aromaticum* L.) was proved against five diarrhoea causing bacteria. This was further confirmed by comparing with commonly used three commercial antibiotics (ciprofloxacin, tetracycline and erythromycin) as a positive control. Clove extracts had significant (P<0.001) activity with the acetone extract demonstrating the highest activity followed by antibiotics and other extracts against tested bacteria. Of all the bacteria tested, *S. typhimurium* was the most susceptible against all of the extracts as well as concentrations of clove, while low MIC (180 mgml\(^{-1}\)) and MBC (680 mgml\(^{-1}\)) of the extracts were observed against *Shigella dysenteriae*. Thus, clove has a significant antidiarrhoeal activity and it could be used as an effective antibacterial agent alternative to the use of antibiotics (Rahman et al., 2011).

*In vitro* antibacterial activities of 46 extracts from dietary spices and medicinal herbs were investigated by agar-well diffusion method against five food borne bacteria viz., *Bacillus cereus*, *Listeria monocytogenes*, *S. aureus*, *E. coli*, and *S. anatum*. The total phenolic contents were estimated using the Folin-Ciocalteu colorimetric method. Many herb and spice extracts contained high levels of phenolics and exhibited antibacterial activity against food borne pathogens. Gram-positive bacteria were generally more sensitive to the tested extracts than Gram-negative ones. *S. aureus* was the most sensitive, while *E. coli* was the most resistant. This sug-
gested that the antibacterial activity of the tested extracts was closely associated with their phenolic constituents (Shan et al., 2007).

Antimicrobial activity of crude powder, aqueous and methanolic extract of the fruit and leaf of *Emblica officinalis* was determined against three commonly encountered respiratory pathogens viz. *S. aureus, K. pneumonia, S. pyogenes* using the agar ditch plate method and the MIC of the extracts were then determined using plate dilution technique. *S. aureus* was the most susceptible organism. Methanolic extract of *E. officinalis* was found to bring about major alterations in the biochemical characteristics of all the three pathogens. Preliminary phytochemical analysis of *E. officinalis* showed the presence of tannins, saponins, flavanoids and phenols of which flavonoids and saponins were found to be the greatest inhibitors towards all the pathogens (Javale and Sabnis, 2010).

An unusual compound named habenariol was isolated from the freshwater orchid, *Habenaria repens*. Its phenolic structure suggested that habenariol should have substantial antioxidant activity. This possibility was investigated by evaluating the capacity of habenariol to inhibit copper-induced lipid peroxidation of human low density lipoprotein (LDL), a popular experimental model. LDL was incubated with 5 mM cupric chloride in the presence and absence of habenariol or a positive control, viz., α-tocopherol. Both kinetic and end-point spectrophotometric assays were used to determine extent of lipid peroxidation of LDL. In the kinetic assay, the time elapsing before the onset of rapid formation of conjugated lipid hydroperoxides in LDL was prolonged by habenariol, indicative of an antioxidant effect. In the end-point assay, direct colorimetric measurement confirmed habenariol’s ability to inhibit formation of lipid hydroperoxides. However, in both assays, habenariol was less potent than α-tocopherol in inhibiting lipid peroxidation of LDL (Johnson et al., 1999).
Boligon et al., (2009) evaluated the antioxidant activities in the leaves and stem bark fractions of *Scutia buxifolia*. Cerebral lipid peroxidation (TBARS) was induced by Fe(II) and radical-scavenging activity was determined by DPPH method. Folin-Ciocalteu was used to determine phenolic contents. Quercetin, quercitrin, isoquercitrin and rutin were isolated from the leaf ethyl acetate fraction and their levels were measured by HPLC-photodiode array detector. IC$_{50}$ (DPPH) varied from 4.35 ± 1.30 to 29.55 ± 0.54 µg/mL for the stem bark and from 6.50 ± 0.40 to 30.54 ± 1.14 in the leaves. Ethyl acetate and butanolic fractions caused a sharp fall in TBARS production with IC$_{50}$ from 2.93 ± 2.17 to 40.46 ± 2.51 µg/mL for the leaves and 0.66 ± 0.17 to 27.3 ± 1.23 for the stem bark. Results obtained indicated that *S. buxifolia* has a great potential to prevent disease caused by the overproduction of free radicals and also it might be used as a potential source of natural antioxidant agents.

Gursoy et al., (2009) analyzed seven *Morchella* species for their antioxidant activities in different test systems namely β-carotene/linoleic acid, DPPH, reducing power, chelating effect and scavenging effect (%) on the stable ABTS$^+$, besides their heavy metals and total phenolic and flavonoid contents. In β-carotene/linoleic acid system, the most active mushrooms were *M. esculenta* var. *umbrina* and *M. angusticeps*. In the case of DPPH, methanol extract of *M. conica* showed high antioxidant activity. The reducing power of the methanol extracts of mushrooms increased with concentration. Chelating capacity of the extracts was also increased with the concentration. On the other hand, in 40 µg/mL concentration, methanol extract of *M. conica*, exhibited the highest radical scavenging activity (78.66 ± 2.07%) when reacted with the ABTS$^+$ radical. Amounts of seven elements (Cu, Mn, Co, Zn, Fe, Ca, and Mg) and five heavy metals (Ni, Pb, Cd, Cr, and Al) were also determined in all species. *M. conica* was found to have the highest phenolic content among the samples. Flavonoid content of *M. rotunda* was also found superior.
Liyana-Pathirana and Shahidi (2007) studied the effects of milling on the phenolic content and antioxidant capacity of two wheat cultivars, namely *Triticum turgidum* L. var. *durum* and *Triticum aestivum* L. The milling of wheat afforded several fractions, namely bran, flour, shorts and feed flour. In addition, semolina was the end-product of durum wheat milling. Among different milling fractions, the bran had the highest phenolic content while the endosperm possessed the lowest amount and this was also reflected in free radical and reactive oxygen species (ROS) scavenging capacity, reducing power and iron (II) chelation capacity of different milling fractions in the two cultivars.

The *in vitro* antioxidant properties of different extracts (water, alcohol, alcohol: water, hexane or chloroform extract) of *Murraya koenigii* L. were evaluated using various assays. The alcohol: water (1:1) extract of curry leaves showed the highest antioxidant and free radical scavenging activity. It inhibited membrane lipid peroxidation by 76%, at 50 µg/mL, scavenged 93% of super-oxides at 200 µg/3 mL and scavenged approximately 90% of hydroxyl and 1,1-diphenyl-2-picrylhydrazyl radicals at 4-5 fold lower concentrations compared to the other tested extracts. In addition, the alcohol: water extracts reduced cytochrome c and ferric ion levels, chelated ferrous ions and inhibited ferrous sulfate: ascorbate-induced fragmentation and sugar oxidation of DNA (Ningappa et al., 2008).

Lim et al., (2007) analyzed nine tropical fruits for total phenol contents, ascorbic acid contents and antioxidant activities. The antioxidant activities were evaluated based on the ability of the fruit extracts to scavenge 1, 1-diphenyl-2-picrylhydrazyl (DPPH), reduce iron (III) to iron (II) and to bind to iron (II) ions. The results were compared with those of orange. It was found that guava, papaya and star fruit have higher primary antioxidant potential, as measured by scavenging DPPH and iron (III) reducing assays. Banana, star fruit, water apple, langsat and papaya have higher secondary antioxidant potential as measured by the iron (II) chelating experiment.
The ethanolic extracts from 24 plant species commonly found in Thailand were investigated and compared based on their antioxidant activity by ABTS assay. The ethanolic extract from the leaves of *Psidium guajava* showed the highest antioxidant capacity with the TEAC value of 4.908 ± 0.050 mM/mg, followed by the fruit peels of *Nephelium lappaceum* and *Garcinia mangostana* with the TEAC values of 3.074 ± 0.003 and 3.001 ± 0.016 mM/mg, respectively. The further investigation of guava leaves extracts from different solvents viz., n-hexane, ethyl acetate, n-butanol, and methanol was by using ABTS and FRAP assays. The total phenolic content was done by Folin-Ciocalteu reaction. The results indicated that the methanolic fraction possessed the highest antioxidant activity, followed by the butanol and ethyl acetate fractions respectively. The hexane fraction showed the lowest antioxidant activity. The results demonstrated that the mechanism of antioxidant action of guava leaves extracts was by free radical scavenging and by reduction of oxidized intermediates (Tachakittirungrod et al., 2007).

The ungerminated seed embryos of Palmryah (*Borassus flabellifer* L.) were evaluated for nutritional quality with respect to minerals and fiber components, total phenols, and antioxidant properties. It was found to be a good source of carbohydrate, fiber, fat, amino acids, and protein. Analysis of macro and micronutrient composition showed that the palmyarah embryo was a potent source of sodium, potassium, calcium, magnesium, zinc and iron. *In vitro* antioxidant activity was evaluated by different assays, including DPPH radical scavenging, ABTS assay, FRAP assay, phospomolybdenum reduction assay, metal chelating activity, and hydroxyl radical scavenging activity. The results indicated that the seed embryo of Palmyarah possesses micro, macro nutrients, antioxidant properties and nutraceuticals for the treatment of malnutrition (Arunachalam et al., 2011).

Total phenolic contents and antioxidative properties of aerial parts and roots of *Merremia tridentata* were examined in different solvent extracts. The antioxidant activities were evaluated
by measuring the ability of the extracts to scavenge the DPPH, ABTS, and hydroxyl radical scavenging activity. In addition, the reducing power, phosphomolybdenum reduction, Fe$^{2+}$ chelation, antihemolytic activity and inhibition of peroxidation were also assessed. The acetone extract of the roots contained relatively higher levels of total phenolics (35.1 g/100 g extract) and possessed significant free radical scavenging and antioxidant properties whereas the aqueous hot extract of the aerial parts exhibited the maximum iron chelation. The results obtained in the *in vitro* models clearly suggest that *M. tridentata* is a natural source of antioxidants and it validates the folkloric use of the plant (Sowndhararajan *et al.*, 2010).

Leaves and root extracts of *Monochoria vaginalis* were evaluated for their antioxidant and anti-inflammatory properties. Antioxidant property was estimated by using ABTS, metal ion chelating activity, FRAP, superoxide anion, DPPH, nitric oxide, phosphomolybdenum and hydrogen peroxide assays. The leaf ethanolic extract showed the maximum radical scavenging activity in ABTS, superoxide and hydrogen peroxide assays. Meanwhile, the aqueous hot extract of the leaf showed the highest inhibition of free radicals in metal ion chelating assay. *In vivo* anti-inflammatory study in *M. vaginalis* showed appreciable reduction in paw volume after oral administration of 250 and 500 mg/kg doses of methanolic leaf extracts (Chandran *et al.*, 2011), respectively.

A systematic record of the relative antioxidant activity in the selected Iranian medicinal plant species was carried out in different extracts. The total phenol varied from 24.1±1 to 289.5±5 mg/g in the extracts. Flavonoid contents were between 25.15 ± 0.8 and 78.3 ± 4.5 mg/g. DPPH free radical scavenging effect of the extracts was determined spectrophotometrically. The highest free radical scavenging effect was observed in *Mellilotus officinalis* with IC$_{50}$ (0.018 mg/ml). The potency of free radical scavenging effect of *M. officinalis* extract was about 4 times greater than that of synthetic antioxidant butylated hydroxy toluene (BHT). The greater amount
of phenolic compounds leads to more potent radical scavenging effect of *M. officinalis* extract (Pourmorad *et al.*, 2006).

The organic solvent extracts of *Adiantum pedatum* were tested for the potential antimicrobial activity against the clinically important standard reference bacterial strains. Acetone and ethyl acetate showed inhibitory activity for *Staphylococcus aureus, Klebsiella pneumonia, Pseudomonas aeruginosa* and *Escherichia coli*. The phytochemical screening of extracts revealed the major derivative of terpenoids, cardiac glycosides and steroids. The antioxidant activities of the extracts of *A. pedatum* were determined by the DPPH and FRAP methods. The ethyl acetate extract of *A. pedatum* had higher activity than that of acetone, ethyl alcohol and hexane extracts. At a concentration of 0.1 mg/ml, the scavenging activity of ethyl acetate extract reached 90%. The FRAP values for all the extracts were significantly lower than those of standard ascorbic acid but higher than those of BHT (Chandran *et al.*, 2011).

Doxorubicin (DOX) is a widely used cancer chemotherapeutic agent. However, it generates free oxygen radicals that result in serious dose-limiting cardiotoxicity. Supplementations with *Gmelina arborea* (Verbenaceae) proved effective in reducing oxidative stress associated with several ailments. The aim of the study was to investigate the potential protective effect of Gmelina arborea (GA) against DOX-induced cardiotoxicity in rats. GA was given orally to rats (250 and 500mg/kg) and DOX (20mg/kg) was administered on the seventh day. GA protected against DOX-induced increased levels of marker enzymes. It significantly inhibited DOX-provoked glutathione (GSH) depletion in cardiac tissues. The reductions of cardiac activities of catalase (CAT), superoxide dismutase (SOD), glutathione peroxidase (GSH-Px) and glutathione reductase (GR) were significantly mitigated. Pretreatment of GA significantly guarded against DOX-induced rise of serum lactate dehydrogenase (LDH). GA alleviated histopathological changes in rat hearts treated with DOX. It is concluded that, GA protects
against DOX-induced cardiotoxicity in rats. The study can be attributed, at least in part, to GA’s antioxidant activity (Vijay et al., 2011).

Kumar et al., (2009) examined the effect of ethanolic extract of aerial parts of *Aerva lanata* at 100 µg/ml in the isolated goat tracheal chain preparation *in vitro* model and 30 & 60mg/kg doses orally *in-vivo* model using clonidine-induced catalepsy, mast cell degranulation in mice. The extract showed significant dose-dependent antiasthmatic activity. Appia Krishnan et al., (2009) evaluated the preliminary phytochemical investigation of *Aerva lanata* Linn and anti-diabetic effect of aerial parts of *A. lanata* in normal and alloxan induced diabetic rats. Oral administrations of *A. lanata* extract to diabetic animals up to four weeks; dose dependently reduced the blood glucose level, which is comparable to standard dose of Metformin. Alcoholic extract of aerial part of *A. lanata* altered other biochemical parameters level. They concluded from the results that the alcoholic extract of *A. lanata* possesses anti-diabetic effect in experimental animals.

Manokaran et al., (2008) evaluated the hepatoprotective activity of hydroalcoholic extract of *Aerva lanata* against paracetamol induced liver damage in rats. They observed that plant extract was effective in protecting the liver against the injury induced by paracetamol in rats. This was evident from significant reduction in serum enzymes alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP) and bilirubin. It was concluded from the result that the hydroalcoholic extract of *A. lanata* possesses hepatoprotective activity against paracetamol induced hepatotoxicity in rats.

Anantha et al., (2010) studied the antiparasitic activity of the seed and leaf extracts of *A. lanata* against a tapeworm and an earthworm, particularly ethanolic extract showing to be better against tapeworms and earthworms than the standard Albendazole, which are used in the treatment of helmentic parasite infections. Deshmukh et al., (2008) examined the antihyperglycaemic activity of alcoholic extract of *A. lanata* leaves (AL-alc) on serum glucose levels, and on the oral
glucose tolerance test (OGTT) in alloxan induced diabetic mice. AL-alc (100, 200 and 400 mg/kg) and glyburide (10 mg/kg) were administered orally in alloxan (70 mg/kg, i.v.) induced diabetic mice. In the OGTT, AL-alc (400 mg/kg) increased the glucose threshold at 60 min after the administration of glucose. The AL-alc (400 mg/kg) showed significantly more antihyperglycaemic activity than AL-alc (100 and 200 mg/kg).

Muthukumaran et al., (2011) evaluated the antioxidative and antimicrobial activities of the methanolic and aqueous extracts of Aerva lanata aerial parts. Both methanolic and aqueous extracts have shown promising antibacterial activity against gram positive bacteria viz. B. subtilis and S. aureus. Both the extracts of this plant showed effective free radical scavenging activity, reducing power and nitric oxide scavenging activity. They observed that antioxidant properties were concentration dependent. Highest antioxidant activity was observed with methanolic extracts that could be attributed due to the presence of flavonoids and saponins.

Arthi et al., (2012) screened the in vivo Antioxidant potential of aqueous extract of Aerva lanata against ethylene glycol induced urolithiatic rats. They revealed that the aqueous extract of A. lanata comprise effective source of natural antioxidant, which might be helpful in preventing the progress of various oxidative stresses and a good source of neutraceuticals. Dulaly et al., (2002) observed the antimicrobial activities in the whole plants ethyl acetate and methanolic extracts of A. lanata and significant cytotoxic properties (petroleum ether, ethyl acetate and methanol extracts).

Shirwaikar et al., (2004) studied the ethanolic extract of the entire plant of Aerva lanata for its nephroprotective activity in cisplatin- and gentamicin-induced acute renal injury in albino rats of either sex. In the curative regimen, the extract at dose levels of 75, 150 and 300 mg/kg showed dose-dependent reduction in the elevated blood urea and serum creatinine and normalized the histopathological changes in the curative regimen. In the gentamicin model the rats in the pre-
ventive regimen also showed good response to the ethanol extract at 300 mg/kg. Their findings suggest that the ethanolic extract of *A. lanata* possesses marked nephroprotective activity with minimal toxicity and could offer a promising role in the treatment of acute renal injury caused by nephrotoxins like cisplatin and gentamicin.

With this knowledge the present study was aimed to reveal the phytochemical profile of the individual parts of *Aerva lanata* using FT-IR, HPTLC and GC-MS and examined their biopotentials.