2. REVIEW OF LITERATURE

*Aegle marmelos* (Linn) correa, commonly known as bael (or bel), belonging to the family Rutaceae, is a moderate-sized, slender and aromatic tree. It is indigenous to India and is abundantly found in the Himalayan tract, Bengal, Central and South India. It is extensively planted near Hindu temples for its wood and leaves which are generally used for worship. Its branches are armed with sharp straight spines. The bark is soft, light grey and exfoliating in irregular flakes. The bright green leaves are alternate and trifoliolate (rarely five-foliolate). The flowers are greenish white and sweet-scented, fruits are yellowish grey and globose with woody rind and seeds are numerous, oblong and compressed.

The *Aegle marmelos* tree is an Indian native plant, widely dispersed, naturalised and used throughout Asia; it may grow to a height of 12 m. It is used in Ayurvedic and other traditional medical systems; all plant parts may be used, but generally not together. The uses intended by the NZ sponsors appear to be based on traditional use in the Ayurvedic medical system of India. *A. marmelos* is well known, and from the six monographs consulted there appears to be little probability of confusion with other species leading to potential misidentification. On the other hand, the monographs are not sufficient to adequately characterise all the plant parts that may be used medicinally. A large number (more than 110) of individual chemical constituents have been identified in various parts of *A. marmelos*. Some quantitative data have been published on about two-thirds of these constituents, but there is no uniformly accepted standard for phytochemical characterisation of *A. marmelos* and none of the constituents identified have been proposed as phytochemical markers for the herbal material, in order to distinguish it from lesser quality or contaminated plant materials. The presence of contaminants in Ayurvedic medicines is a serious matter that has recently raised concern both in India and in countries that import the medicines.
2.1 Pharmacological activity of *Aegle marmelos*

The tree *A. marmelos* has been used for millennia in the Indian subcontinent and Indochina as a traditional medicinal herb. Historic mention of Bael fruit (*A. marmelos*) has been traced to Vedic times (2000-800 BC). It has been considered a sacred plant by Hindus, and is commonly grown in temple gardens in India. The Bael tree is an Indian native plant, also naturalised in Burma, Pakistan, Bangladesh, Sri Lanka, Thailand, and various other parts of South-eastern Asia. It was introduced into Europe from India in 1759 (Kumar and Prabhakar 1987). It is also of commercial importance as a source of human food and materials such as essential oil, resin and gum, and wood (although the last is of minor importance, as the timber is not durable). The marketing of *A. marmelos* by NZ sponsors notifying the herb to Medsafe for the purposes of its inclusion in the PIL appears to be based on its medicinal use in the Ayurvedic tradition of India.

It is difficult to describe the Ayurvedic system of medicine adequately in a short review. The paragraph that follows is an attempt to indicate the traditional context of the herb *A. marmelos* without giving a detailed account of the philosophical and medical background to the Ayurvedic system, which dates back more than 4000 years (Kumar and Prabhakar 1987).

The leaves are reported to be useful in treating convulsion, gonorrhoea, heart failure, abdominal pains, oedema and is also used as a purgative (Ogunti *et al.*, 1993).

Several studies have been conducted to provide scientific basis for the efficacy of plants used in herbal medicine. It has been observed that antimicrobial activity of the plants is associated with the presence of some chemical components such as phenols, tannis, saponins, alkaloids, steroids, flavonoids and carbohydrates. The phytochemical components were also investigated as a scientific assessment of the claim of therapeutic potency (Akinsinde *et al.*, 1995).
Ibrahim and Osman (1995) reported that the ethanolic extract of *Cassia alata* leaves was investigated for its antimicrobial activities on several microorganisms including bacteria, yeast, dermatophytic fungi and non-dermatophytic fungi. *In vitro*, the extract exhibited high activity against various species of dermatophytic fungi but low activity against non-dermatophytic fungi. The inhibition can be observed on the macroconidia of *Microsporium gypseum*, which resulted in structural degeneration beyond repair. The mechanism of inhibition can be related to the cell leakage as observed by irregular, wrinkle shape and loss in rigidity of the macroconidia.

Sakharkar and Pati (1998) investigated the in vitro antimicrobial activity of *Cassia alata* extracts has been against *S. aureus*, *S. aureus* coagulase positive, *B. subtilis*, *B. cereus*, *B. stearothermophilus*, *E. coli*, *V. cholerae*, *S. typhi*, *S. dysenteriae* and *K. pneumoniae*. The acetone and ethanol (95 percent) extract of *Cassia alata* showed high activity against nearly all test microorganisms. The inhibitory effects of extracts are very close and identical in magnitude and are comparable with that of standard antibiotics used.

The chemical constituents of the volatile oil of the stems and leaves of *Pogostemon cablin* collected from Leizhou County have been analysed by means of GC-MS. The main constituents are patchouli alcohol, delta-guaiene, alpha-guaiene, seychellene, alpha-patchoulene, aciphyllene, trans-caryophyllene (Feng et al., 1999).

The essential oil in Michelia leaves was extracted by steam distillation. The oil obtained was dried with anhydrous magnesium sulfate. The chemical constituents were analyzed by GC-MS. Thirty three peaks were separated by GC, and 27 of them were identified by MS with NBS mass spectral data and Wiley/NBS registry of mass spectral data. The structure of linalool was further verified by GC/FTIR. The identified constituents represent 97% of the peak area of the essential oil on FID. The major chemical constituent of them are linalool, trans-caryophyllene and diethyl-o-phthalate (Qin et al., 1999).
Monoterpene compounds of leaf pairs and flowers of *Mentha piperita* have been studied by direct headspace sampling using solid-phase microextraction coupled with gas chromatography/mass spectrometry (SPME-GC/MS). The content of peppermint-characteristic compounds such as menthol, menthyl acetate, and neomenthol increased in a basipetal direction (older plant parts), whereas menthone and isomenthone showed higher levels in the acropetal direction (younger plant parts). Higher levels of menthofuran were found in peppermint flowers in contrast to the leaves. SPME sampling resulted in relatively higher amounts of high-volatile monoterpenes and lower detection of less volatile compounds such as menthol and menthone, compared to solvent-based samples from essential oil distillation (Rohloff, 1999).

Three simple coumarins; scoparone, limettin and psoralen have been isolated as major components from the leaves of *Euodia borbonica* var. borbonica (Rutaceae) together with xanthoxylin, a common phenolic compound in Rutaceae family. Their structures were elucidated through GC/MS and NMR studies. A minor furocoumarin, bergapten, was also detected in the extracts. Preliminary biological tests on ethanolic leaf extracts did not show any activity (Valenciennes *et al*., 1999).

The antiulcer activity of *Maytenus aquifolium* spray dried extract in rats was studied by Bersani-Amado *et al*., (2000). Ulcers were induced by means of three experimental models: acidified-ethanol, indomethacin and acute stress. The extract was found to have significant antiulcer activity against all the models studied. These results show that preparation of the extract by means of the spray dried technique does not alter the biological activity of *Maytenus aquifolium*.

Pandit *et al*., (2000) investigated the anti-peptic ulcer effect of *Shankha bhasma* (conch shell ash) in rats. Gastric ulcers were induced in rats by indomethacin and cold restraint stress, and the effect of two different doses of *Shankha bhasma* was studied. The response of the bhasma on ulcer index, lipid peroxidation (thiobarbituric
acid reacting substances TBARS) in gastric tissue and serum calcium was determined. Shankha bhasma caused significant reduction in ulcer index (P<0.001) in both the indomethacin and cold restraint models. TBARS of stomach in indomethacin treated rat was also reduced (P<0.001) by Shankha bhasma but serum calcium level was not altered. Shankha bhasma induced dose dependent protection against experimental gastric ulcers.

The essential oil was extracted from Biota orientalis (L) Endl by using steam distillery, analyzed with SE-54(30 m x 0.25 mm I.d) fused silica capillary column. The optimum separate and analytical conditions were researched. The amount of the components from the essential oil was determined by monoliration method. The separated components were identified by GC-MS. There are 33 components which are make up 80% of the total essential oil were separated and identified by Liu et al., (2000).

Chronic Helicobacter pylori disease is reduced with Allium vegetable intake. This study was designed to assess the in vivo anti-\emph{H. pylori} potential of a variety of garlic substances. The garlic materials all showed substantial but widely differing anti-\emph{H. pylori} effects against all strains and isolates tested. Antimicrobial activity of the diallyl sulfides increased with the number of sulfur atoms. Time course viability studies and microscopy showed dose-dependent anti-\emph{H. pylori} effects with undiluted GO, GP, allicin, and diallyl trisulfide after a lag phase of ca. 1 to 2 h. Substantial in vitro anti-\emph{H. pylori} effects of pure GO and GP and their diallyl sulfur components exist, suggesting their potential for in vivo clinical use against \emph{H. pylori} infections (O'Gara et al., 2000).

The antibacterial and antifungal activities, along with a phytotoxicity test of the newly isolated diterpene bondenolide of a methanol extract, ethylacetate fraction and water-soluble part of the methanol extract of medicinal plants were assayed by Simin et al., (2001).
Two alkaloids, N-2-hydroxy-2-(4-methoxyphenyl)-ethylcinnamamide (aegeline) and 4,7,8-trimethoxy-furoquinoline (skimmianine) were isolated from Aegle marmelos. The structure of the compounds were confirmed by spectroscopic analysis and by comparison with the data reported previously. The bioassays of the isolated compounds against some microbes and cancer cell lines were also carried out by Riyanto et al. (2001).

Marone et al. (2001) evaluated the antibacterial activity of mastic gum, a resin obtained from the Pistacia lentiscus tree, against clinical isolates of Helicobacter pylori. The minimal bactericidal concentrations (MBCs) were obtained by a microdilution assay. Mastic gum killed 50% of the strains tested at a concentration of 125 microg/ml and 90% at a concentration of 500 µg/ml. The influence of sub-MBCs of mastic gum on the morphologies of H. pylori was evaluated by transmission electron microscopy. The lentiscus resin induced blebbing, morphological abnormalities and cellular fragmentation in H. pylori cells.

The chemical components of tarbush (Flourensia cernua) leaves were fractionated by extracting successively with hexanes, diethyl ether, and ethanol. Volatile profiles of each fraction were identified by using GC-MS. The hexanes fraction contained mostly monoterpenoids, while the ethanol fraction volatiles were primarily sesquiterpenoids. Crude fractions were tested for activity against fungi, algae, and termites. Application of as little as 1 microg of the essential oil from the hexanes fraction was sufficient to provide visible antifungal activity in bioautography assays. The diethyl ether fraction showed selective activity against the cyanobacterium responsible for the 2-methylisoborneol-induced off-flavor sometimes associated with catfish farming operations. All three fractions exhibited a high degree of antitermite activity (Tellez et al., 2001).

The essential oils of Piper cernuum and Piper regnellii leaves were analyzed by gas chromatography-mass spectrometry (GC-MS) and the results were compared to
that obtained by means of a program designed to analyse (13)C-NMR data of complex mixtures. Bicyclogermacrene (21.88 %)/beta-caryophyllene (20.69 %) and myrcene (52.60 %)/linalool (15.89 %) were the major constituents in essential oil from leaves of *P. cernuum* and *P. regnellii*, respectively. Both essential oils presented growth inhibitory activities against *Staphylococcus aureus* and *Candida albicans* (Costantin *et al.* 2001).

Monoterpenes (alpha- and beta-pinene, delta-3-carene, camphene, alpha-phellandrene and limonene) were determined by Gas Chromatography-Mass Spectrometry in fresh needles of *Picea abies* situated in three ecologically different regions of Moravia. Through the use of cryogenic grinding for critical sample homogenisation, solvent extraction with cold n-hexane, followed by GC analysis with mass detection, very low quantities of sample (0.1-0.3 g needles) could be processed, thus permitting a comparison of amounts of monoterpenes in needles of different ages and a determination of changes in concentrations of monoterpenes in needles at different locations on the tree. The amount of alpha-phellandrene decreased with the age of the needles, and the content of delta-3-carene was higher in apical branches compared to lateral ones (Holubova *et al.*, 2001).

The effects of the dried stem powder of *Opuntia ficus-indica* var. saboten (OF-s) on gastric lesion and ulcer models in rats were investigated by Lee *et al.*, (2002). It showed significant inhibition in HCl ethanol-induced gastric lesion at the doses of 200 and 600 mg/kg p.o. and in HCl.aspirin-induced gastric lesion at 600 mg/kg p.o. OF-s also showed significant inhibition in indomethacin-induced gastric lesion at the doses of 200 and 600 mg/kg, p.o. However, it did not affect both the aspirin-induced and Shay ulcers in rats. It also did not affect gastric juice secretion, acid output and pH. These data indicate that OF-s only possesses pronounced inhibitory action on gastric lesion without antiulcer activity in rats.
Garcinia cambogia extract is a herbal preparation that has been suggested as useful drugs in the treatment of gastrointestinal disorders. Mahendran et al. (2002) studied that the drug was tested for its antiulcerogenic effect. Oral pretreatment with Garcinia cambogia fruit extract (1 g/kg body wt/day) for 5, 10 or 15 days protected the gastric mucosa against the damage induced by indomethacin (20 mg/kg body wt). The volume and acidity of the gastric juice decreased in the pretreated rats. The glycoprotein levels of the gastric contents which were decreased in the untreated rats, maintained near normal levels in the pretreated rats. Protein which was elevated in the gastric juice of untreated rats, showed near normal levels in the pretreated rats. Garcinia cambogia was able to decrease the acidity and to increase the mucosal defence in the gastric areas, thereby justifying its use as an antiulcerogenic agent.

Extracts of leaves and fruits of Sapindus saponaria L. were orally administered to rats and the parameters of gastric secretion (volume, pH and acidity) after pylorus ligature were evaluated by Meyer Albiero et al. (2002). The inhibitory effect of the extracts on lesions induced by stress was compared to that of cimetidine. The volume and concentration of hydrochloric acid were reduced after oral administration of the extracts. A significant reduction of the lesion index was observed in the acute assays. No significant alteration in body or organ weight was detected in animals treated orally for 30 days with the extracts. These results suggest that S. saponaria fruits have an anti-gastric ulcer potential activity.

The volatile fractions obtained by hydrodistillation of the fresh leaves of Anthemis melampodina and Pluchea dioscoridis were analysed by GC-MS technique. Out of 38 components identified in the volatile oil of A. melampodina, santolinatriene was the major component (27.33%). The oil was characterized by a high percentage of monoterpene hydrocarbons (49.94%) while sesquiterpene hydrocarbons and oxygenated sesquiterpenes represented only 7.41% and 11.43% of the oil. 36 components were identified in the volatile oil of P. dioscoridis. Farnesol was the major component (16.50%) accompanied by a high percentage of sesquiterpene
alcohols. Oxygenated sesquiterpenes (26.43%) and sesquiterpene hydrocarbons (39.43%) represented the main constituents in the oil. *P. dioscoridis* showed a marked mosquito larvicidal activity against *Culex pipiens* (LC(50) 71.86 ppm), while *A. melampodina* was moderately active (LC(50) 139.42 ppm) (Grace, 2002).

The constituents of the volatile oil of *Pogostemon cablin* collected from Wanning city, Hainan province and the influence owing to different collection time were undertaken by GC/MS combination technology. The results showed that main compound was patchouli alcohol in stem oil and leaf oil; its contents were respectively 36.06% and 37.74%; pogostone was poor; its contents in stem oil and leaf oil were respectively 17.08% and 0.85%; the contents of ten compounds were over 1%, which was respectively beta-patchoulene, beta-elemene, transcaryophyllene, delta-guaiene, seychellene, alpha-patchoulene, aciphyllene, alpha-guaiene, patchouli alcohol and pogostone; the contents of volatile oil from June to August were respectively 0.8%, 0.7% and 0.6%; patchouli alcohol, higher in July and June(42.62% and 40.84%), lower in August(31.40%) (Luo *et al.*, 2002).

A new rotenoid, derrisin (1), together with 10 known rotenoids (2-11) were isolated from the roots of *Derris malaccensis* Plain. The structure of 1 was elucidated by spectroscopic analysis. Nine of the isolated rotenoids (3-11) showed antibacterial activity against *Helicobacter pylori* (Takashima *et al.*, 2002).

Iwuoha Odoemena *et al.* (2002) studied that the *Afrofritomia sylvestris* leaf contains alkaloids, flavonoids, cyanogenic glycosides, saponins, tannins, steroids and terpenes. The proximate composition and contents of the leaf showed 24.5% ash, 6.94% crude protein, 2.75% crude fibre and 8.5% carbohydrate while the mineral elements composition revealed high contents of Na\(^+\) (11990mg/100g), Ca\(^++\) (95.8mg/100g), K\(^+\) (69.23mg/100g) and Mg\(^++\) (71.00mg/100g). It also contains low levels of vitamins A and C. The anti-nutritive components of the leaf were very low and negligible except in total and soluble oxalates contents. *A. sylvestris* leaf is a
good source of mineral elements. In the southeastern Nigeria, rural inhabitants supplement their leafy needs with the “hunters weed” which is often added to soup.

Kariba et al. (2002) studied that extracts from Schizzygia coffaeoides showed antimicrobial activity against fungal and bacterial species. Alkaloids isolated using bioassay-guided fractionation were isoschizagaline, schizogynine, and a new indoline alkaloid, 7,8-dehydro-19beta-hydroxyschizozygine, shown to be the most active antifungal compound. The structure of isoschizagaline, the only active antibacterial, is revised on the basis of NMR analyses.

Truiti Mda et al. (2003) reported that ethanolic crude extracts from the leaf of Cassia alata Linn, traditionally used in Brazilian folk medicine, were screened against Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa by using the disk diffusion test technique. The antibacterial property of C. nutans appears to have justified its use for the treatment of wounds, which are contaminated through bacterial infections.

Somchit et al. (2003) tested crude ethanol and water extract of leaves and barks from Cassia alata were tested in vitro against fungi, (Aspergillus fumigatus and Microsporium canis), yeast (Candida albicans) and bacteria (Staphylococcus aereus and Escherichia coli). C. albicans showed concentration-dependent susceptibility towards both the ethanol and water extracts from the barks, but resistant towards the extracts of leaves. The degree of susceptibility varied, the water extract from barks showed bigger inhibition zone than the ethanol extracts (12-16 and 10-14 mm, diameter respectively). All types of the plant extracts did not affect the growth of Aspergillus fumigatus and Microsporium canis. The water extract exhibited higher antibacterial activity than the ethanol extract from leaves (inhibition zones of 11-14 and 9-11 mm, respectively). E. coli showed resistance to all types of extracts. Based on the current findings, it can be concluded that this plant has antimicrobial activity, which is as potent as standard antimicrobial drugs against certain microorganisms.
Ginger root (*Zingiber officinale*) has been used traditionally for the treatment of gastrointestinal ailments such as motion sickness, dyspepsia and hyperemesis gravidarum, and is also reported to have chemopreventative activity in animal models. The gingerols are a group of structurally related polyphenolic compounds isolated from ginger and known to be the active constituents. Since *Helicobacter pylori* (HP) is the primary etiological agent associated with dyspepsia, peptic ulcer disease and the development of gastric and colon cancer, the anti-HP effects of ginger and its constituents were tested in vitro. These data demonstrate that ginger root extracts containing the gingerols inhibit the growth of *H. pylori* CagA+ strains in vitro and this activity may contribute to its chemopreventative effects (Mahady *et al.*, 2003).

Stamatis *et al.* (2003) studied the anti-*Helicobacter pylori* effect of 70 Greek plant extracts and a number of commercially available herbs used traditionally in folk medicine against gastric ailments, peptic ulcer included. The extracts of *Anthemis melanolepis*, *Cerastium candidissimum*, *Chamomilla recutita*, *Conyza albida*, *Dittrichia viscosa*, *Origanum vulgare* and *Stachys alopecuros* have been proved active against one standard strain and 15 clinical isolates of *H. pylori*.

GC-MS analysis of the volatile oil extracted from *Salvadora persica* L. leaves Alali and Al-Lafi (2003) were able to identify benzyl nitrile, eugenol, thymol, isoetumyl, eucalyptol, isoterpinolene, and beta-caryophyllene. Toxicity of the aroma was evaluated using brine shrimp lethality test which gave an LC50 > 1,000 ppm. Using Disc Diffusion Test, it was found that the extract of the leaves has a considerable antibacterial effect on several different oral aerobic bacteria with comparable results to known antibiotics. The extract can be used effectively as a natural tool for teeth cleaning and as a natural analgesic for the disturbing toothache.

The essential oils from leaves, aerial stems and underground organs of *Aristolochia argentina* Gris., a medicinal plant popularly known as "charrúa", were obtained by hydrodistillation and analyzed by GC and GC/MS. Forty-three
components were identified in the oils. All parts of the plant afforded volatile oils characterized by high levels of argentilactone (57-89%) and the presence of undecatriene isomers (0.3-4.0%), these latter compounds providing the essential oils and extracts with an intense particular odour. Terpenes account for the remaining portion of the essential oils (5-29%). Bicyclogermacrene predominates in the aerial parts of the plant, whereas ishwarane is the main terpene of the subterranean organs. Argentilactone, a suspected carcinogenic compound, was also identified in a medicinal commercial tincture of *A. argentina* (Priestap *et al.*, 2003).

*Ocimum basilicum* leaves were dried using a microwave oven at atmospheric pressure or two traditional methods: air-drying at 50°C and freeze-drying. The microwave-drying was carried out at different powers and times on raw basil leaves, while for air and freeze-drying techniques, both raw and blanched leaves were used. The raw and dried basil was analyzed for selected aroma compounds by gas chromatography/mass spectrometry-selected-ion-monitoring, the chlorophyll a and b by HPLC and the colour by a reflected-light colourimeter. Microwave drying allowed a larger retention of chlorophyll pigments than air-drying and freeze-drying (with or without blanching) and preserved the colour of the raw basil. Microwave drying requires a much shorter treatment and implied the simultaneous blanching of the material (Di Cesare *et al.*, 2003).

Five fractions (F1-F5) isolated from the methanolic leaf extract of *Cissampelos mucronata* rich for antiulcer activities were investigated by Nwafor and Akah, (2003). At the dose of 450 mg/kg, they showed varying degree of protection against ulcer induced by indomethacin; the order of protection being F1>F4>F5>F2>F3. The antiulcer potency of F1 and F2 is comparable with that of cimetidine (100 mg/kg, i.p.). Inhibition of gastric mucosal damage may partly contribute to the antiulcer activity of the fractions.
The effect of *Azadirachta indica* extract on gastric ulceration in albino rats was studied by Raji *et al.* (2004). *Azadirachta indica* extract (100-800 mg/kg p.o., 100-25 mg/kg i.p.) significantly inhibited gastric ulceration induced by indomethacin (40 mg/kg). Administration of 800 mg/kg p.o. and 250 mg/kg i.p. caused 100% cytoprotection against indomethacin (40mg/kg, i.p.)-induced gastric ulceration. This action was accompanied by a dose-dependent decrease in total gastric acidity. In order to investigate the probable mechanism of *Azadirachta indica* antiulcer activity, the effect of the extract alone and in combination with histamine (1mg/kg) and cimetidine (0.12 mg/kg) on gastric acid secretion in situ was studied. *Azadirachta indica* (250 mg/kg) significantly inhibited the basal and histamine-induced gastric acid secretion. Cimetidine seemed to augment *Azadirachta indica* inhibition of gastric acid secretion. The results suggest that the stem bark extract of *Azadirachta indica* possesses antiulcer agents, which probably act via histamine H(2) receptor.

Suba *et al.* (2004) studied the gastric cytoprotective activity of the methanol extract of aerial parts of the plant *Barleria lupulina* Lindl (Acanthaceae) in albino rats using various models of ulcers such as drug induced ulcers, restraint ulcers, duodenal ulcers and pylorus ligated ulcers. The effect of the extract on gastric secretion and lipid peroxidation (thiobarbituric acid reacting substances TBARS) was also studied in rats. The extract at the tested dose of 200 mg/kg significantly reduced the volume of gastric juice, total acidity and the ulcer index in pylorus ligated rats. It also afforded significant protection against alcohol and indomethacin induced ulcer as well as stress induced ulceration. TBARS in the stomach of indomethacin treated rats was also reduced. In addition, it gave protection against duodenal ulcers. The study suggests that the methanol extract of aerial parts of *Barleria lupulina* Lindl has a protective effect against experimental gastric and duodenal ulcers.

Upadhya *et al.* (2004) evaluated the hypoglycemic and antioxidant effect of aqueous extract of *Aegle marmelos* leaves (AML) on diabetic rats. Glucose, urea and glutathione-S-transferase (GST) in plasma, glutathione (GSH) and malondialdehyde
(MDA) levels in erythrocytes were estimated in all the groups at the end of four weeks. There was a decrease in blood glucose at the end of four weeks in group III animals compared with group II, however it did not reach the control levels. There was an increase in erythrocyte GSH and a decrease in MDA in group III as compared to group II. The plasma GST levels were raised in diabetic rats when compared to controls. In the group III animals, there was a decrease in GST as compared to group II. Owing to hypoglycemic and antioxidant properties, AML may be useful in the long-term management of diabetes.

Oxidative stress induced by alloxan has been shown to damage pancreatic beta-cell and produce hyperglycemia in rats. *Aegle marmelos* leaf extract is being used in Ayurveda as a medicine for diabetes. Sabu and Kuttan (2004) reported the action of *Aegle marmelos* against experimental diabetes as well as the antioxidant potential of the drug. A methanolic extract of *Aegle marmelos* was found to reduce blood sugar in alloxan diabetic rats. Reduction in blood sugar could be seen from 6th day after continuous administration of the extract and on 12th day sugar levels were found to be reduced by 54%. Oxidative stress produced by alloxan was found to be significantly lowered by the administration of *Aegle marmelos* extract. This was evident from a significant decrease in lipid peroxidation, conjugated diene and hydroperoxide levels in serum as well as in liver induced by alloxan. Catalase and glutathione peroxidase activity in blood and liver were found to be increased from 9th day onwards after drug administration. Superoxide dismutase and glutathione levels were found to be increased only on 12th day. These results indicate that *Aegle marmelos* extract effectively reduced the oxidative stress induced by alloxan and produced a reduction in blood sugar.

Bonjar (2004) studied that the forty-five species of 29 plant families used in the traditional medicine by Iranian people, showed antibacterial activities against one or more of the bacterial species: *Bacillus cereus, Bacillus pumilus, Bordetella bronchiseptica, Escherichia coli, Klebsiella pneumoniae, Micrococcus luteus,*
Pseudomonas aeruginosa, Pseudomonas fluorescens, Serratia marcescens, Staphylococcus aureus and Staphylococcus epidermidis. No plant showed activity against Serratia marcescens and Bordetella bronchiseptica being the most susceptible species.

Langfield et al. (2004) determined minimum inhibitory concentrations for small quantities of organic or water-soluble plant extracts. Bioassay-guided fractionation of the stem and leaves of Peperomia galioides using this method found fractions containing grifolin and grifolic acid, which inhibited growth of Staphylococcus aureus and Staphylococcus epidermidis.

Sohn et al. (2004) reported that antimicrobial activity of the 18 prenylated flavonoids, which were purified from five different medicinal plants, was evaluated by determination of MIC using the broth microdilution methods against four bacterial and two fungal microorganisms (Candida albicans, Saccharomyces cerevisiae, Escherichia coli, Salmonella typhimurium, Staphylococcus epidermidis and S. aureus). Papyriflavonol A, kuraridin, sophoraflavanone D and sophoraisoflavanone A exhibited a good antifungal activity with strong antibacterial activity. Kuwanon C, mulberrofuran G, albanol B, kenusanone A and sophoraflavanone G showed strong antibacterial activity with 5-30 microg/ml of MICs. Morusin, sanggenon B and D, kazinol B, kurarinone, kenusanone C and isosophoranone were effective to only gram positive bacteria, and broussochalcone A was effective to C. albicans. IC50 values of papyriflavonol A, kuraridin, sophoraflavanone D, sophoraisoflavanone A and broussochalcone A in HepG2 cells were 20.9, 37.8, 39.1, 22.1, and 22.0 µg/ml, respectively.

Kone et al. (2004) reported that sixty-seven crude ethanol extracts from 50 plants (31 families), which are used in North Cote-d'Ivoire as traditional remedies for bacterial diseases, were screened for invitro activity against Gram negative (Escherichia coli and Pseudomonas aeruginosa) and Gram positive (Staphylococcus
*Enterococcus faecalis*, *Streptococcus pyogenes* and *Bacillus subtilis*) bacteria. The antibacterial potency of these 10 plant species on a range of bacteria was studied. The results provided evidence that some of the studied plants might indeed be potential sources of new antibacterial agents, also against some antibiotic-resistant strains.

Tshikalange et al. (2005) revealed that extracts of six ethnobotanically selected medicinal plants (*Anredera cordifolia*, *Elaeodendron transvaalense*, *Elephantorrhiza burkei*, *Senna petersiana*, *Terminalia sericea*, *Cassia alata* and *Rauvolfia caffra*) used traditionally to treat sexually transmitted diseases (STD's) were investigated for antibacterial activity using the agar dilution method. Out of the six collected, *Terminalia sericea*, *Senna petersiana* and *Anredera cordifolia* were also investigated for cytotoxicity. The phytochemical studies on *Senna petersiana* resulted in the isolation of luteolin, which also showed antimicrobial activity. Only the *Senna petersiana* extract and luteolin isolated from it were tested for antiviral activity and showed some activity at the highest non-toxic concentration of 240 and 500 µg/ml respectively.

Yasunaka et al. (2005) reported that the thirty-two extracts from 22 Mexican medicinal plants of 15 different families were assayed to determine their antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*. Seventeen plants showed antibacterial activity, while five plants showed no activity against both bacteria. All of the extracts showed higher activity against *Staphylococcus aureus* (methicillin-sensitive and methicillin-resistant) than against *Escherichia coli*, except one.

Owoyale et al. (2005) reported that the methanolic, ethanolic and petroleum ether extracts of *Senna alata* leaves were screened for phytochemicals, antibacterial and antifungal activities. Out of the three crude extracts, the methanolic extract showed the highest activity than the ethanolic and petroleum ether extracts. The unidentified active components purified from preparative thin layer chromatography
exhibited low activities against *Mucor, Rhizopus* and *Aspergillus niger* at 70μg/ml while higher activity was exhibited against all the test organisms at 860μg/ml.

Lambertini *et al.* (2005) determined the expression of the estrogen receptor alpha (ERalpha) gene which may be a possible target for compounds present in plant extracts from *Aegle marmelos* and *Emblica officinalis*, used in traditional Asian medicine in the treatment of tissue inflammation and cancer. The extracts exhibiting the greatest effects were those obtained from *Aegle marmelos*. Gas-chromatography/mass-spectrometry (GC/MS) analysis enabled us to identify lupeol, a known triterpenoid, as the major bioactive component of *A. marmelos* plant extracts. Similar to the *Aegle marmelos* extracts, lupeol was found to stimulate the decoy effect of RA4 DNA sequence, increasing at a high level ERα gene expression in MDA-MB-231 ERalpha-negative breast cancer cells, and also inhibited cell proliferation.

The serial extracts of the leaves of *Aegle marmelos* Corr. for anti-inflammatory property were investigated by Arul *et al.* (2005). The analgesic and antipyretic properties were also evaluated. The most of the extracts derived from the plant *Aegle marmelos* caused a significant inhibition of the carrageenan-induced paw oedema and cotton-pellet granuloma in rats. The extracts also produced marked analgesic activity by reduction in the early and late phases of paw licking in mice. A significant reduction in hyperpyrexia in rats was also produced by the most of the extracts. This study established anti-inflammatory, antinociceptive and antipyretic activities of the leaves of *Aegle marmelos*.

The anticancer effect of hydroalcoholic extract of *Aegle marmelos* (AME) was studied in the Ehrlich ascites carcinoma bearing Swiss albino mice. The spatial effect of various AME administration schedules showed that six-day administration increased the survival of tumor bearing mice. The best antineoplastic action of AME was obtained when AME administered through intraperitoneal route than the oral route at equimolar dose. AME treatment resulted in a dose dependent elevation in the
median survival time (MST) and average survival time (AST) up to 400 mg/kg AME and decline thereafter. The effective dose of 400 mg of AME is 1/6th of the LD$_{50}$ dose, which increased the MST and AST up to 29 and 27 d, respectively. The acute toxicity study of AME showed that the drug was non-toxic up to a dose of 1750 mg/kg b. wt. The LD$_{10}$ and LD$_{50}$ was found to be 2000 and 2250 mg/kg (Jagetia et al., 2005).

The antiulcer activity of a hydro-ethanolic extract prepared from the stems of *Kielmeyera coriacea* Mart. (Guttiferae) was evaluated in rats employing the ethanol-acid, acute stress and Indomethacin models to induce experimental gastric ulcers. Treatment with *K. coriacea* hydro-ethanolic extract provided significant antiulcer protection in the ethanol-acid and Indomethacin models, but not in the acute stress model. These results suggested that the *K. coriacea* hydro-ethanolic extract increased resistance to necrotizing agents, providing a direct, protective effect on the gastric mucosa (Goulart et al., 2005).

Comparative study of the antiulcer and antisecretory activity of *Asparagus racemosus* Willd (Shatawari) and *Withania somnifera* Dunal (Ashwagandha) root extract with a standard drug, ranitidine, in various models of gastric ulcer in rats was reported by Bhatnagar et al. (2005). Ulcer was induced by the indomethacin (NSAID) and swim (restraint) stress treatment. Results demonstrated that *A. racemosus* as well as *W. somnifera* methanolic extract (100 mg/kg BW/day p.o.) given orally for 15 days significantly reduced the ulcer index, volume of gastric secretion, free acidity, and total acidity. A significant increase in the total carbohydrate and total carbohydrate/protein ratio was also observed. Study also indicated an increase in antioxidant defense, that is, enzymes superoxide dismutase, catalase, and ascorbic acid, increased significantly, whereas a significant decrease in lipid peroxidation was observed. *A. racemosus* was more effective in reducing gastric ulcer in indomethacin-treated gastric ulcerative rats, whereas *W. somnifera* was effective in stress-induced gastric ulcer. Results obtained for both herbal drugs were comparable to those of the standard drug ranitidine.
Antiulcerogenic effect of the alcoholic (ALJP) and aqueous (AQJP) extracts of the whole plant of *Justicia prostrata* was studied in aspirin+pylorus ligated rat models and analysed for gastric volume, ulcer index, free and total acidity. Biochemical parameters like total proteins, total hexoses, hexosamine, fucose and sialic acid were also estimated and reported by Sanmugapriya *et al.*, (2005). Both extracts (ALJP and AQJP) significantly reduced both the gastric volume and the acidity of gastric juice. It also significantly promoted gastric mucus secretion by increasing total carbohydrates and decreasing the protein concentration in aspirin+ pylorus ligated rats. The results suggest that both the extracts (ALJP and AQJP) possess antiulcer activity, whereas AQJP is more effective when compared with ALJP in aspirin+pylorus ligated rat models. The results were compared with the standard drug Rantidine, a H2 receptor antagonist.

A high-performance thin layer chromatographic (HPTLC) method for the rapid and simple quantification of the four major anthraquinone derivatives i.e. physcion, chrysophanol, emodin and chrysophanol glycoside in *Rheum emodi* is described. HPTLC of anthraquinone derivatives was performed on pre-coated RP-18 F254S HPTLC plates. The method was found to be reproducible and convenient for quantitative analysis of anthraquinone derivatives in the methanolic extract of rhizomes of *R. emodi* collected from three different locations of Western Himalaya, India (Singh *et al.*, 2005).

A simple high-performance thin-layer chromatographic (HPTLC) method has been developed for the simultaneous determination of the pharmacologically important quinazoline alkaloids vasicine and vasicinone in *Adhatoda vasica*. The assay combines the separation and quantification of the analytes on silica gel 60 GF254 HPTLC plates with visualisation under UV and scanning at 270 and 281 nm. Using this technique, the alkaloidal content of different parts of the title plant has been determined (Das *et al.*, 2005).
A hydroalcoholic extract of *Ocimum sanctum* leaves for its antioxidant activity in animal models of peptic ulcer with the aim of exploring a possible correlation between its antioxidant and antiulcer activities has been investigated by Kath and Gupta (2006). Gastric ulcers were produced in rats by ethanol treatment and pyloric ligation whereas duodenal ulcers were produced in guinea pigs by histamine treatment. The extract (100 mg/kg & 200 mg/kg) also increased the levels of SOD in pyloric ligated rats to 1.78 ± 0.12 U/ml and 1.89 ± 0.08 U/ml respectively when compared to 1.29 ± 0.06 U/ml in the diseased control. Since lowered levels of MDA and increased levels of SOD signify antioxidant activity, the antiulcer activity of *Ocimum sanctum* might be due to this mechanism.

The aqueous extract of *Hingwashtak churna* for gastroprotection in rats using the ibuprofen and ethanol induced ulcer models was evaluated by Shirwaikar *et al.* (2006). Efficacy was assessed by determination of mean ulcer size, ulcer number and ulcer index. Oral administration of the aqueous extract (750 mg/kg) significantly protected against gastric lesions by 84.96% and 91.12% as compared to ranitididine (95.54 and 95.2%) in the ibuprofen and alcohol induced ulcer models respectively. The findings suggest that the significant gastroprotective activity could be mediated by its antioxidant activity which was evaluated by using different antioxidant models of screening.

Govindarajan *et al.* (2006) studied the antiulcer potential and antimicrobial activity of the 50% aqueous alcoholic extract in order to validate ethnobotanical claims regarding the plant use in the above-mentioned disorders. Gastroprotective potential of the *Anogeissus latifolia* extract (ALE) (100 and 200mg/kg/body weight) was studied on aspirin, cold-resistant stress (CRS), pylorus ligated (PL) and ethanol-induced ulcers. Status of the antioxidant enzymes superoxide dismutase (SOD) and catalase along with lipid peroxidation (LPO) was also studied in CRS-induced ulcers. The results of the present study showed for the first time that the ALE possessed gastroprotective activity as evidenced by its significant inhibition in the formation of
ulcers induced by physical and chemical agents with a maximum of 84.16% curation (200mg/kg body weight) in CRS-induced ulcers. ALE decreased LPO and SOD with concomitant increase in catalase activity in CRS-induced ulcers.

Scopoletin (7-hydroxy-6-methoxy coumarin) was isolated from the leaves of *Aegle marmelos* and evaluated for its potential to regulate hyperthyroidism, lipid peroxidation and hyperglycemia in levo-thyroxine-induced hyperthyroid rats. Scopoletin (1.00 mg/kg, p.o.) administered daily for 7 days to levo-thyroxine-treated animals decreased the levels of serum thyroid hormones and glucose as well as hepatic glucose-6-phosphatase activity, demonstrating it’s potential to regulate hyperthyroidism and hyperglycemia. Scopoletin also inhibited hepatic lipid peroxidation and increased the activity of antioxidants, superoxide dismutase and catalase. Compared with the standard antithyroid drug, propylthiouracil, scopoletin exhibited a superior therapeutic activity, since unlike propylthiouracil, it also inhibited hepatic lipid peroxidation. These findings indicate that scopoletin has the potential to inhibit thyroid function and hyperglycemia without hepatotoxicity (Panda and Kar, 2006).

Propolis and *Zingiber officinale* have been shown to be specifically targeted against Helicobacter pylori strains, to possess anti-inflammatory, antioxidant and antitumoral activity and to be used in traditional medicine for the treatment of gastrointestinal ailments. Considering that these natural products could potentially serve as novel therapeutic tools also in combination with an antibiotic, the aim of this work was to evaluate their effect when combined with clarithromycin on clinical *H. pylori* isolates (n = 25), characterized in respect to both clarithromycin susceptibility and the presence of the cagA gene. The results showed that the combinations of propolis extract + clarithromycin and *Z. officinale* extract + clarithromycin exhibited improved inhibition of *H. pylori* with synergistic or additive activity. Interestingly, the susceptibility to combinations was significantly independent of the microbial clarithromycin susceptibility status. Only one *H. pylori* strain showed
antagonism towards the Z. officinale extract + clarithromycin combination. The data demonstrate that combinations of propolis extract + clarithromycin and Z. officinale extract + clarithromycin have the potential to help control H. pylori-associated gastroduodenal disease (Nostro et al., 2006).

The floras of Indian medicinal plants are potent source of bioactive principles. Anti-bacterial activity of Mimosa pudica, Aegle marmelos and Sida cordifolia against Bacillus subtilis, Staphylococcus aureus, Klebsiella pneumoniae, Pseudomonas aeruginosa, Escherichia coli and Salmonella typhi was studied by Balakrishnan et al. (2006). The maximum inhibitory zone of inhibition Sida cordifolia was against Bacillus subtilis (35mm) and Salmonella typhi (26 mm). Mimosa pudica and Aegle marmelos were found to be active against all the microorganisms tested and the maximum activity was noted against Pseudomonas aeruginosa and Salmonella typhi respectively.

To evaluate the antibacterial activity of Sapindus mukorossi (S. mukorossi) and Rheum emodi (R. emodi). Ibrahim et al. (2006) can conclude from this study that the extracts of S. mukorossi and R. emodi inhibited the growth of pylori in vitro and invivo studies, the H pylori infection cleared within seven days at very low concentrations. They also found that H pylori did not acquire resistance against these herbal extracts even after 10 consecutive passages.

Two known flavonoids were isolated from a tropical medicinal plant, Hyptis fasciculata (Labiatae), found in Brazil. Flavonoids were identified as cirsilineol (1) and cirsimaritin (2) by spectroscopic means and were exhibited potent antibacterial activity against Helicobacter pylori, and cirsilineol (1) had weak antibacterial activity against Escherichia coli and Salmonella enteritidis. Following up on the relationship between anti-H. pylori activity and flavonoids with methoxy groups, several methoxy flavonoids were evaluated for proliferation of H. pylori (Takahiko Isobe et al., 2006).
Three medicinal plant *Aegle marmelos, Lawsonia inermis, Albizzia libbeck* were extracted by soxhlet apparatus using petroleum ether, ethanol, chloroform and aqueous as solvent. Among those extract, the petroleum ether was considered as effective one. The extracts were subjected to preliminary phytochemical screening and the three plants with four extracts were tested against three Gram positive bacteria (*B. cereus, B. subtilis, S. aureus*) and three Gram negative bacteria (*E. coli, P. vulgaris, and P. aeruginosa*) by disc diffusion method. Maximum inhibition (3.8cm) was recorded in *Lawsonia inermis*. It also showed inhibitory action against all the six pathogen tested. The zone of inhibition of the extracts was compared with the standard antibiotics Streptomycin and Spectinomycin. The study suggests that the plant is promising the development of phytomedicine for antimicrobial properties (Sudharameshwari and Radhika, 2007).

Aqueous extract of fifty-two plants from different families were tested for their antifungal potential against eight important species of *Aspergillus* such as *A. candidus, A. columnaris, A. flavipes, A. flavus, A. fumigatus, A. niger, A. ochraceus* and *A. tamarii* which isolated from sorghum, maize and paddy seed samples. The test fungi were mainly associated with seed biodeterioration during storage. Among fifty-two plants tested, aqueous extract of *Acacia nilotica, Achras zapota, Datura stramonium, Emblica officinalis, Eucalyptus globules, Lawsonia inermis, Mimusops elengi, Peltophorum pterocarpum, Polyalthia longifolia, Prosopis juliflora, Punica granatum* and *Syzigium cumini* have recorded significant antifungal activity against one or the other *Aspergillus* species tested. *A. flavus* recorded high susceptibility and hence solvent extracts viz., petroleum ether, benzene, chloroform, methanol and ethanol extracts of all the twelve plants were tested for their antifungal activity against it. Among the solvent extracts tested, methanol gave more effect than ethanol, chloroform, benzene and petroleum ether, except for *Polyalthia longifolia*, where petroleum ether extract recorded highly significant antifungal activity than other solvent extracts (Satish *et al.*, 2007).
Plants have served as a natural source of antifertility substances. The reactivated interest in the evaluation of some lead plants for fertility prompted us to undertake studies on the antifertility potential of Aegle marmelos leaves. Taken together, it is inferred that the leaf extract of A. marmelos (AMLEt) suppresses fertility in male rats. Complete recovery of fertility was observed following the withdrawal of drug. Absence of any deleterious effect on the vital organs points to the safe use of the extract (Chauhan et al., 2007).

Shankarananth et al. (2007) reported that the methanol extract of leaves of Aegle marmelos at a dose level of 200 and 300 mg/kg showed significant analgesic activity on acetic acid-induced writhing and tail flick test in mice.

Umamaheswari et al. (2007) studied the antiulcer and antioxidant activities of 70% ethanolic extract of leaves of Jasminum grandiflorum L. (JGLE). The leaves of Jasminum grandiflorum L. (Family: Oleaceae) is used in folk medicine for treating ulcerative stomatitis, skin diseases, ulcers, wounds, corns - a hard or soft hyperkeratosis of the sole of the human foot secondary to friction and pressure etc., The reduction in gastric fluid volume, total acidity and an increase in the pH of the gastric fluid in APL rats proved the antisecretory activity of JGLE. Additionally, JGLE completely healed the ulcer within 20 days of treatment in AC model as evidenced by histopathological studies. Like antiulcer activity, the free radical scavenging activities of JGLE depends on concentration and increased with increasing amount of the extract. These results suggest that leaves of Jasminum grandiflorum possess potential antiulcer activity, which may be attributed to its antioxidant mechanism of action.

The plant Aegle marmelos belongs to the family of Rutaceae. From the leaves of A. marmelos an alkaloidal-amide, Aegeline 2, was isolated and found to have antihyperglycemic activity as evidenced by lowering the blood glucose levels by 12.9% and 16.9% at 5 and 24h, respectively, in sucrose challenged streptozotocin
induced diabetic rats (STZ-S) model at the dose of 100mg/kg body weight. Aegeline 2 has also significantly decreased the plasma triglyceride (Tg) levels by 55% (P<0.001), total cholesterol (TC) by 24% (P<0.05), and free fatty acids (FFA) by 24%, accompanied with increase in HDL-C by 28% and HDL-C/TC ratio by 66% in dyslipidemic hamster model at the dose of 50mg/kg body weight. The reasonable mapping of compound 2 to validated pharmacophoric hypothesis and 3D QSAR model with an estimated activity (283nM) suggest that the compound 2 might be a beta(3)-AR agonist (Narender et al., 2007).

Chauhan and Agarwal (2008) studied the effects of *Aegle marmelos* on the testicular reproductive system, a 50% ethanolic extract of *Aegle marmelos* leaves was fed orally to male albino rats at the dose levels of 200 and 300 mg/kg body wt./day for 60 days. Recovery was assessed for an additional 120 days. The level of serum testosterone also declined and spermatogenesis was impaired. The number of normal tubules and the height of epithelial cells of the caput and cauda were reduced significantly. The cross sectional surface area of Sertoli cells and mature Leydig cells was reduced along with a dose dependent reduction of preleptotene and pachytene spermatocytes. Thus the antifertility effects of Aegle marmelos seemed to be mediated by disturbances in structure and function in testicular somatic cells including Leydig and Sertoli cells resulting in an alteration in physio-morphological events of spermatogenesis.

Sahare et al. (2008) studied the methanolic extracts of roots of *Vitex negundo* L. and extracts of leaves of *Vitex negundo* L., *Ricinus communis* L. and *Aegle marmelos* Corr. to explore for possible antifilarial effect against Brugia malayi microfilariae. It was observed that among the herbal extracts, root extract of *Vitex negundo* L. and leaves extract of *Aegle marmelos* Corr. at 100 ng/ml concentration showed complete loss of motility of microfilariae after 48 hr of incubation. Thin layer chromatography of the extracts revealed the presence of alkaloids, saponin and
flavonoids in the roots of *Vitex negundo* L. and coumarin in the leaves of *Aegle marmelos* Corr.

Ulceration of gastro-intestinal mucosa is caused by disruption of normal balance of corrosive effect of gastric acid and the protective effect of mucus on gastric epithelial cells. The major cause of ulcer is increased gastric secretions, which may be further aggravated by factors including NSAIDs, impaired production of somatostatins, *Helicobacter pylori* infection, by stress and dietary habits. Up to 80-90% of ulcers have been associated with *H. pylori* infection in the stomach. The parietal cells in the stomach secrete hydrochloric acid regulated by the protein H+/K+-ATPase also called proton pump. Acid secretion is also regulated by hormones such as gastrin, chemicals like acetylcholine and histamine. Acid neutralization was recognized as an effective treatment; however with the understanding of pathogenesis of peptic ulcer, treatment has become more effective. One approach for treating ulcer is to block the proton pump by using proton pump inhibitors like omeprazole and lansoprazole. In another approach, blocking of regulatory molecules that stimulate acid secretion like acetylcholine, histamine and gastrin either with anticholinergics or H2 receptor antagonist such as ranitidine, famotidine is effective. *H.pylori* infection can be eradicated using amoxycillin, clarithromycin, metronidazole or tetracycline. Gastro retentive dosage forms may prove beneficial as they exhibit a prolonged gastric residence time and act locally and systemically (Vinay Pandit *et al*., 2008).

Peptic ulcer disease is a deep gastrointestinal erosion disorder that involves the entire mucosal thickness and can even penetrate the muscular mucosa. Numerous natural products have been evaluated as therapeutics for the treatment of a variety of diseases, including this one. These products are usually derived from plant and animal sources that contain active constituents such as alkaloids, flavonoids, terpenoids, tannins and others. The alkaloids are natural nitrogen-containing secondary metabolites mostly derived from amino acids and found in about 20% of plants. There has been considerable pharmacological research into the antiulcer activity of these
compounds. In this work we review the literature on alkaloids with antiulcer activity, which covers about sixty-one alkaloids, fifty-five of which have activity against this disease when induced in animals (Heloina de Sousa Falcao et al., 2008).

A series of phenylethyl cinnamides, which included new compounds named anhydromarmeline, aegelinosides A and B, were isolated from Aegle marmelos leaves as alpha-glucosidase inhibitors. The structures of new compounds were characterized by spectroscopic data and chemical degradation. Out of the phytocompounds isolated, anhydroaegeline revealed the most potent inhibitory effect against alpha-glucosidase with IC(50) value of 35.8 µM. The result also supports ethnopharmacological use of A. marmelos as a remedy for diabetes mellitus (Phuwapraisirisan et al., 2008).

Gireesh et al. (2008) investigated the changes in the total muscarinic and muscarinic M1 receptor ([3H]QNB) binding and gene expression in the cerebral cortex of streptozotocin (STZ) induced diabetic, insulin and aqueous extract of Aegle marmelose leaf treated diabetic rats. The results showed that there is decrease in total muscarinic and muscarinic M1 receptors during diabetes which is up regulated by insulin and Aegle marmelose leaf extract treatment. This has clinical significance in therapeutic management of diabetes.

Sahare et al. (2008) reported that the methanolic extracts of roots of Vitex negundo L. and extracts of leaves of Vitex negundo L., Ricinus communis L. and Aegle marmelos Corr. were explored for possible antifilarial effect against Brugia malayi microfilariae. It was observed that among the herbal extracts, root extract of Vitex negundo L. and leaves extract of Aegle marmelos Corr. at 100 ng/ml concentration showed complete loss of motility of microfilariae after 48 hr of incubation. Thin layer chromatography of the extracts revealed the presence of alkaloids, saponin and flavonoids in the roots of Vitex negundo L. and coumarin in the leaves of Aegle marmelos Corr.
Liu and Liu (2008) analyzed the chemical components of the volatile oil in processed pieces of *Eriobotrya japonica* by GC-MS. The volatile oil was obtained by steam distillation. The amounts of the components from the volatile oil were determinated by area normalization method. The separated components were identified by GC-MS. The components of volatile oil in pre and post processed pieces of *Eriobotrya japonica* were different. The method is reliable, stable and has good repeatability. It will provide the certain scientific methods for further evaluation quality of *Eriobotrya japonica*.

Twenty-three known chemical compounds were identified in the leaves of *Leea indica* (Burm. f.) Merr. (Leeaceae) by GC-MS analysis, spectroscopic techniques and co-TLC with authentic samples. The identified compounds include eleven hydrocarbons, phthalic acid, palmitic acid, 1-eicosanol, solanesol, farnesol, three phthalic acid esters, gallic acid, lupeol, beta-sitosterol and ursolic acid. Gallic acid was isolated as n-butyl gallate and identified by co-TLC. This seems to be the first report of the presence of gallic acid in the leaves of *L. indica* (Srinivasan et al., 2008).

The antibacterial activity of an oil extract of *Chamomilla recutita* flowers against *Helicobacter pylori* (*H. pylori*) was evaluated by the agar dilution method using Colombia agar with 10% sheep blood, an inoculum of McFarland 0.5 and incubation in an anaerobic atmosphere at 37 degrees C for 3 days. The oil extract was prepared by olive oil extraction of *Chamomilla recutita* flowers using rotary pulsation. The MIC(90) (minimal inhibitory concentration) and MIC(50) were 125 mg/mL and 62.5 mg/mL, respectively. It was shown that the *Chamomilla recutita* oil extract inhibited the production of urease by *H. pylori*. In addition, it was found that the morphological and fermentative properties of *H. pylori* were affected by application of the *Chamomilla recutita* oil extract (Shikov et al., 2008).

Rajesh Kumar *et al.* (2008) carried out to determine the potential of using essential oil from leaves of *Aegle marmelos* to control insect infestation of stored
gram from *Callosobruchus chinensis* (L.) (Bruchidae) and wheat from *Rhyzopertha dominica* (F.) (Bostrychidae), *Sitophilus oryzae* (L.) (Curculionidae) and *Tribolium castaneum* (Herbst) (Tenebrionidae). The oil protected the stored gram from *C. chinensis* and wheat from *R. dominica* and *S. oryzae* for two years. Limonene (88 %) was found to be the major component in the oil through GC-MS analysis. Regression analysis of data on individuals in treated cowpea confirmed that significant reduction of oviposition and adult emergence of *C. chinensis* decreased with increase in doses. The findings emphasize the efficacy of *A. marmelos* oil as fumigant against insect infestations of stored grains and strengthen the possibility of using it as an alternative to synthetic chemicals for preserving stored grains.

*Tephrosia purpurea* (Linn.) Pers. (Fabaceae) has traditional use in curing different types of wounds including gastroduodenal ulcers. It was of interest to evaluate the in vitro anti-*Helicobacter pylori* activity profile of the plant extract and its fractions with a view to examining its therapeutic potential, the methanolic extract showed promising activity against clinical isolates and standard strains of *Helicobacter pylori*, including metronidazole-resistant strains. Fractionation of the extract revealed the n-hexane and chloroform fractions to possess marked activity. The extract and the less polar fractions remained functionally active in acidic condition similar to stomach environment, exhibited consistent bacteriostatic activity during repeated exposure, and demonstrated synergism, complete or partial, even with antibiotic-resistant strains (Chinniah *et al.*, 2009).

Antimicrobial activity was also studied against *Bacillus subtilis, Escherichia coli, Streptococcus aureus* and *staphylococcus* by using cup-plate method. Erythromycin was used as standard antibacterial agent. The methanol extract was diluted into different concentration (1, 2, 4, 6, 8, 10 mg/100 µl) with DMSO. The results of the study revealed that, the Amrycard powder exhibited significant antibacterial activity (Ashok Kumar *et al.*, 2009).
Several in vitro studies have looked at the effect of medicinal plant extracts against *Helicobacter pylori* (*H. pylori*). Regardless of the popular use of *Byrsonima crassa* (*B. crassa*) as antiemetic, diuretic, febrifuge, to treat diarrhea, gastritis and ulcers, there is no data on its effects against *H. pylori*. In this study, we evaluated the anti-*H. pylori* of *B. crassa* leaves extracts and its effects on reactive oxygen/nitrogen intermediates induction by murine peritoneal macrophages. Based on our results, *B. crassa* can be considered a source of compounds with anti-*H. pylori* activity, but its use should be done with caution in treatment of the gastritis and peptic ulcers, since the reactive oxygen/nitrogen intermediates are involved in the pathogenesis of gastric mucosal injury induced by ulcerogenic agents and *H. pylori* infections (Bonacorsi et al., 2009).

*Aegle marmelos* is an important medicinal plant of India. Leaves, fruits, stem and roots of *A. marmelos* have been used in ethno medicine to exploit its’ medicinal properties including astringent, antidiarrheal antidysenteric, demulcent, antipyretic and anti-inflammatory activities. Compounds purified from bael have been proven to be biologically active against several major diseases including cancer, diabetes and cardiovascular diseases. Preclinical studies indicate the therapeutic potential of crude extracts of *A. marmelos* in the treatment of many microbial diseases, diabetes and gastric ulcer. The biological activities of some isolated chemical constituents of *A.marmelos* and preclinical studies on some crude extracts and pure compounds to explore novel bioactive compounds for therapeutic application (Pallab Maity et al., 2009).

Antimicrobial activity and phytochemical constituents of an ethanolic extract of *Aegle marmelos* were investigated by Venkatesan et al. (2009). The phytochemical screening of the crude extract revealed the presence of Alkaloids, Cardiac glycosides, Terpenoids, Saponins, Tannis, Flavonoids, and Steroids. The crude ethanolic extract was tested for antimicrobial activity against gram positive organisms of *Bacillus subtilis* (NCIM: 3471), *Staphylococcus aureus* (NCIM: 2079), gram negative
Escherichia coli (NCIM: 2065) and Pseudomonas aeruginosa (NCIM: 2200) at different concentrations levels of 0.5, 1.0, 1.5, 2.0 and 2.5 mg/ml. At the 2.5 mg/ml concentration, gram negative Escherichia coli exhibits a zone of inhibition about 25.7mm; Pseudomonas aeruginosa 19.9mm; gram positive Staphylococcus aureus 29.0 mm; and Bacillus subtilis, a maximum zone of inhibition about 28.1 mm as compared to the control drug penicillin. Escherichia coli, Pseudomonas aeruginosa and Bacillus subtilis exhibit a maximum zone of inhibition, hence they were considered as susceptible to the plant extracts but Staphylococcus aureus doesn’t exhibit such a zone of inhibition and is therefore considered as resistant.

Aegle marmelos is a medicinal herb belongs to the family Rutaceae. The different parts of plants like leaves and flowers are extracted by using the solvent methanol. The methanol extracts were screened for the antimicrobial activity. They showed greater inhibitory effect against both gram positive and gram negative organisms. The organisms used were such as Escherichia coli, Pseudomonas aeruginosa, Proteus mirabilis, Salmonella typhi, Staphylococcus aureus. Based on the present investigation results it is concluded that the methanolic extracts of Aegle marmelos has great potential as antimicrobial agent against different microorganisms and they can be used in the treatment of infectious diseases caused by the resistant microorganisms (Suresh et al., 2009).

Zhou et al. (2009) was to purify and characterize an antimicrobial component from celery (Apium graveolens) seeds, which have been used for centuries as an herbal medicine with reported antibacterial effects. The purified component, termed 'compound with anti-Helicobacter activity' (CAH), had potent bactericidal effects against H. pylori; the minimum inhibitory concentration and minimum bactericidal concentration were 3.15 µg/ml and 6.25-12.5 microg/ml, respectively. CAH (M(r) = 384.23; empirical formula C(24)H(32)O(4)) had specific inhibitory effects on H. pylori and was not active against Campylobacter jejuni or Escherichia coli. MS and NMR data were consistent with a dimeric phthalide structure. The results appeared to
rule out mechanisms that operated solely by loss of membrane integrity or inhibition of protein or nucleic acid synthesis.

Dwivedi and Aggarwal, (2009) reported a brief review of those plants that could be useful in T2DM associated with hypertension, ischemic heart disease, and/or dyslipidemia. *Aegle marmelos* (bael), *Allium sativum* (garlic), *Curcuma domestica* (turmeric), *Eugenia jambolana* (jamun), *Murraya koenigii* (curry leaves), *Trigonella foenum graecum* (fenugreek), and *Terminalia arjuna* (arjun) have been found to be useful in diabetes associated with ischemic heart disease. Their active biomolecules have been identified. They have also been demonstrated to be safe in long-term use.

The triterpenoid, lupeol (1) has been isolated from the leaves extract of *Aegle marmelos*. Few novel derivatives (2-13) were synthesized from the naturally occurring lupeol (1) and screened for their antihyperglycemic activity (2-11) and antidyslipidemic activity (2-4 and 12-13). The derivative 4 lowered the blood glucose levels by 18.2% and 25.0% at 5h and 24h, respectively, in sucrose challenged streptozotocin induced diabetic rats (STZ-S) model at the dose of 100mg/kg body weight. The compound 4 also significantly lowered 40% (P <0.001) in triglycerides, 30% (P <0.05) in glycerol, 24% (P <0.05) in cholesterol quantity and also improved the HDL-cholesterol by 5% in dyslipidemic hamster model at the dose of 50mg/kg b.wt (Papi Reddy *et al.*, 2009).

Lipid lowering effect of 50% ethanolic extract of the leaves of *A. marmelos* (Linn.) was evaluated in triton and diet induced hyperlipidaemic models of Wistar albino rats. The extract at 125 and 250 mg/kg dose levels inhibited the elevation in serum cholesterol and triglycerides levels on Triton WR 1339 administration in rats. The extract at the same dose levels significantly attenuated the elevated serum total cholesterol and triglycerides with an increase in the high-density lipoprotein cholesterol in high-fat diet- induced hyperlipidaemic rats. The standard drugs
atorvastatin in the former and gemfibrozil in the latter studies showed slightly better effects (Vijaya et al., 2009).

Sun et al. (2009) reported the GC-MS fingerprint profile of the volatile oil in mulberry leaves (dried leaves of *Morus abla*) in order to provide the referent basis of quality evaluation. Seventeen common characteristic peaks were summarized from the fingerprint of the 10 baths of mulberry Leaves sample, which were classified into two categories by the result of hierarchical clustering analysis; samples collected in *Akesu area, Tulufan area, Hami area, Hetian Loupu county, Jiangsu province, Sichuang province, Shanxi province* and Guangzhou were in a group, whereas those from *Yili area* and Wulumqi were in another group. The established GC-MS fingerprint could be used for the identification and quality evaluation of mulberry leaves, the method was accurate and reliable, the fingerprint was intuitive and specific.

Lai et al. (2009) observed that the antiulcer effects of pomegranate tannins in animal models. Pomegranate tannins (500, 150, 50 mg x kg(-1)) significantly inhibited ulcerative formation induced by both water immersion stress and pylorus ligation, obviously decreased the gastric mucosa damages induced by intragastric absolute ethanol, in dose-dependent manner. Pomegranate tannins significantly inhibited absolute alcohol-induced elevation of MDA as well as decreasing of NO level, and activities of both SOD and GHS-PX from gastric mucosa. Pomegranate tannins significantly increased the secretion of adherent mucus and free mucus, but did not affect elevation of the free acidity, total acidity, and total acid output, gastric juice volume and gastric pepsin activity induced by pylorus ligation. Pomegranate tannins play a protective role against gastric ulcer. Its antiulcer effect is related to increasing secretion of adherent mucus and free mucus from the stomach wall, which may inhibit generation of oxygen-derived free radicals, and decrease the consumption of GSH-PX and SOD, and maintain content of NO at normal level.
The effects of the essential oil obtained from the aerial parts of *Baccharis dracunculifolia* on gastric ulcers were evaluated by Massignani *et al.* (2009). The antiulcer assays were undertaken using the following protocols in rats: nonsteroidal antiinflammatory drug (NSAID)-induced ulcer, ethanol-induced ulcer, stress-induced ulcer, and determination of gastric secretion using ligated pylorus. The treatment in the doses of 50, 250 and 500 mg/kg of *B. dracunculifolia* essential oil significantly diminished the lesion index, the total lesion area and the percentage of lesions in comparison with both positive and negative control groups. With regard to the model of gastric secretion a reduction of gastric juice volume and total acidity was observed, as well as an increase in the gastric pH. No sign of toxicity was observed in the acute toxicity study. Considering the results, it is suggested that the essential oil of *B. dracunculifolia* could probably be a good therapeutic agent for the development of new phytotherapeutic medicine for the treatment of gastric ulcer.

A number of ethnomedicinal plants and herbal preparations are used in traditional system of medicine for the management of hepatic disorders. However, many of them have not been investigated to valorize the traditional claims. *Aegle marmelos* is widely used in the treatment of hepatitis in folk medicine. Owing to its overwhelming ethnomedicinal significance, an attempt has been made to investigate effect of fruit pulp of *A. marmelos* for hepatoprotective activity. Results indicate that ethanolic and aqueous fruit pulp extracts of *A. marmelos* had moderate significant activity over CCl₄ treatment as compared to the control. Results of the present investigation suggest that CCl₄ induced liver damage in rats can substantially be ameliorated by treatment of ethanolic extracts from fruit pulp of *A. marmelos*. Also the study confirms the claim on this plant as a potential hepatoprotective agent in the traditional medicine (Rajasekaran *et al.*, 2009).

Chauhan and Agarwal (2009) evaluate the contraceptive effect of an aqueous extract from the leaves of *Aegle marmelos* (AMLAq) on the reproductive organs of male rats with an emphasis on reversibility. Biochemical analysis of the reproductive
tissues for sialic acid, protein, glycogen, fructose, ascorbic acid, acid and alkaline phosphatase indicated a significant decrease whereas testicular cholesterol level significantly increased indicating alterations in the biochemical milieu of the genital organs. Fertility and other effects gradually returned to control levels 120 days after cessation of treatment. No clinical signs of side effects on general metabolism were detected throughout the treatment, and after withdrawal, body weight gain was similar in all groups together with no alterations in the weight of vital organs', hematological and serological parameters.

Lipid lowering effect of 50% ethanolic extract of the leaves of *A. marmelos* (Linn.) was evaluated in triton and diet induced hyperlipidaemic models of Wistar albino rats. The extract at 125 and 250 mg/kg dose levels inhibited the elevation in serum cholesterol and triglycerides levels on Triton WR 1339 administration in rats. The extract at the same dose levels significantly attenuated the elevated serum total cholesterol and triglycerides with an increase in the high-density lipoprotein cholesterol in high-fat diet-induced hyperlipidaemic rats. The standard drugs atorvastatin in the former and gemfibrozil in the latter studies showed slightly better effects (Vijaya *et al.*, 2009).

Biosorption of Pb(II) on bael leaves (*Aegle marmelos*) for the removal of Pb(II) from aqueous solution using different doses of adsorbent, initial pH, and contact time was investigated by Chakravarty *et al.* (2010). The sorption process was best described by pseudo second order kinetics. Among Freundlich and Langmuir isotherms, the latter had a better fit with the experimental data. The activation energy E(a) confirmed that the nature of adsorption was physisorption. Bael leaves can selectively remove Pb(II) in the presence of other metal ions. This was demonstrated by removing Pb from the effluent of exhausted batteries.

Yildiz *et al.* (2010) determined the current level of atmospheric heavy metal content on the Bozdag Mountain of the Aegean Region, Turkey. Twenty nine different
plants were selected to study their potential as biomonitor of trace elements such as Ni, Zn, Fe, Pb, Mn and Cd (μg g⁻¹, dry weight). The samples were collected from two different altitudes of Mt. Bozdag. The concentrations of trace elements were determined by atomic absorption spectrometry. The mean concentrations determined at 1000 m altitude ranged from 0.025 to 1.609, 0.232 to 0.731, 0.578 to 5.983, 0.287 to 0.565 and 0.176 to 2.659 (μg g⁻¹, dry weight), for Ni, Zn, Fe, Pb and Mn, respectively. At the altitude of 1600 m, the values ranged from 0.023 to 0.939, 0.258 to 1.254, 0.839 to 5.176, 0.301 to 1.341 and 0405 to 3.351 (μg g⁻¹, dry weight) for Ni, Zn, Fe, Pb and Mn, respectively. No Cd was detected at either altitude. Statistical significance was determined by the independent sample t-test and comparisons were made in order to determine if there were any differences between the averages of herbaceous and woody plants.

Natural antioxidants fight against free radicals and keep the oxidative stress state in balance, thus preventing degenerative diseases and aging symptoms. Dheeba et al. (2010) evaluated antioxidant activity of ethanol, ethyl acetate, and aqueous extracts from bark of Aegle marmelos. *Aegle marmelos* is commonly known as beal in India. It is a spiny tree belongs to the family of Rutaceae. The leaves, bark, roots, seeds, and fruits of *Aegle marmelos* are edible. The medicinal properties of this plant have been described in Ayurveda. The bark was collected, shade dried and coarsely powdered. The powder was successively extracted with ethanol, ethyl acetate and water using cold percolation method. The extracts were concentrated by distilling the solvent and air dried. The phytochemical screening of the crude bark extracts proved the presence of alkaloids, flavonoids, tannins, glycosides, phenols, sterols and terpenoids. The antioxidant activity of ethanol, ethyl acetate, and aqueous extracts were determined using three complement assays: DPPH, Phosphomolybdate, Thiocyanate method. The result obtained in the present study indicates that the bark of *Aegle marmelos* is a potential source of a natural antioxidant.
Sandeep Majumdar (2010) investigated the antioxidant potential of the ethyl acetate fraction of the aerial parts *Eclipta alba* L. Hassk (EA) which was widely used as hepatoprotective plant. EA was orally administered at doses of 50, 100 and 200 mg/kg (n=6) for 7 days in male Charles Foster rats. The extent of hepatoprotective potential of *E. alba* was studied by assessing the biochemical parameters like lipid peroxides (LPO), superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), glutathione reductase (GR), ascorbic acid and α-tocopherol in the liver of rats. Oral administration of the EA significantly decreased LPO and elevated the activity of antioxidant enzymes SOD, CAT, GPx and GR as well as endogenous levels of ascorbic acid and α-tocopherol in the liver of male Charles Foster rats. This study has revealed the significant antioxidant potential of *E. alba* in rat liver.

*Aegle marmelos* (L.) belongs to the Rutaceae family and is traditionally used for curing different ailments. Uma Devi *et al.* (2011) investigation was carried out to determine the possible chemical components from *Aegle marmelos* leaves by GC-MS Technique. This analysis revealed that the ethyl acetate fraction of *Aegle marmelos* leaves contains Benzo[b]-1,4-diazabicyclo[2.2.2]octane, 3,4-Dimethoxybenzoic anhydride, Cinnamic acid, Palmitic acid, 1-Phenylpyrrole, Cinnamamide, 4-Methoxybenzaldehyde, Gamma-Sitosterol, Caryophyllene oxide, Alpha-amyrin, Loliolide etc., justifying the use of this plant to treat many ailments in folk and herbal medicine.

*Aegle marmelos* (Bael) is a popular medicinal plant in the Ayurveda and Siddha systems of medicine and folk medicines used to treat various disease and disorders including fever. Amber Vyas *et al.* (2011) study was undertaken to evaluate the antipyretic property of *Aegle marmelos* (L.) Correa leaves (Family: Rutaceae) on Brewer’s yeast-induced pyrexia in albino rats. It reveals that the ethanolic extract, at dose of 200 mg kg-1 body wt. and 400 mg kg-1 body weight, produced significant (p<0.001) reduction in elevated body temperature in a dose dependent manner.
followed by aqueous extract. The antipyretic effect of extracts was comparable to that of paracetamol (100 mg kg⁻¹ body weight, p.o.), a standard antipyretic agent.

The effect of bark extracts of *Boswellia serrata* (Family Burseraceae) was evaluated in aspirin induced ulceration (200mg/kg) in albino rats. Antiulcer activity was evaluated by measuring ulcer index and percentage of ulcer healing. The petroleum ether (250mg/kg) and aqueous extracts (250mg/kg) of bark of *Boswellia serrata* plant showed significant antiulcer activity as evidenced by the data obtained. Histopathological findings also confirm the antiulcer activity of *Boswellia serrata* bark extracts in albino rats (Khaja Zeeyauddin *et al.*, 2011).

Ramamurthy and Selvarani (2011) reported that the ethanolic extract of *Holostema reedi* leaves was evaluated for its anti-ulcer activity against pylorus ligation induced gastric ulcer (anti secretory) in albino rats. Various biochemical parameters such as gastric volume, pH of gastric content, free acidity and total acidity, total carbohydrate content such as total protein, hexoses, hexosamine, fucose and sialic acid were estimated in 90% alcoholic precipitate of gastric juice and examined on the test and control group rats. The extract at a concentration of 200 mg/kg exhibited a protective effect on ulcer-induced models in a dose dependent manner and was comparable with the standard drugs Ranitidine. The present study revealed that the extract of *H. reedi* had ulcer protective activity comparable with standard drugs Ranitidine, which may be mediated by its antioxidant effects.

Dhanaraj *et al.* (2011) carried out physico-chemical analysis of ethnolic extracts from leaves of *Aegle marmelos* variants. It is commonly called Vilvam in Tamil. The leaves of Aegle marmelos variant-I and variant-II of the plant were collected and investigated for their phyto-chemical. The leaves of variants showed distinct variations. Anti microbial activity of ethanolic extracts of both the variants of *A.marmelos* showed positive result against tested organism in a concentration dependent manner.
The anti-ulcer activity of aqueous extract of *Aegle marmelos* leaves was investigated on an indomethacin induced ulcer models in wistar rats. In model the common parameter determined was ulcer-index aqueous extract of dosage 175, 350 mg/kg p.o which produced significant inhibition of gastric lesions induced by indomethacin induced ulcers. The extract 175mg/kg & 350mg/kg showed significant (p<0.01) reduction in gastric volume, free acidity and ulcer index as compared to control. Chandaka Madhu *et al.* (2012) indicated that *Aegle marmelos* leaves extract have potential anti ulcer activity. This results may further suggests that aqueous extract was found to posses antiulcerogenic as well as ulcer healing property, which might be anti secretory activity.

Vinay Kumar Verma *et al.* (2012) conducted and experiment to test the hypothesis that *Moringa oleifera* Lam. leave has hepatoprotective as well as antioxidant activity. For this purpose, a study was designed using alcoholic extracts of *Moringa oleifera* leave which produce significant hepatoprotective and antioxidant activity. This indicated that the generation of relative oxygen species during stress might be the causative factor for the inactivation of gastric peroxidase. The alcoholic leaves extract of *Moringa oleifera* has shown ulcer protective effect as dose dependently against pylorus-ligation, ethanol, cold restraint stress, and aspirin-induced gastric ulcer in rats. The said extract of *Moringa oleifera* was found to decrease ulcer and acid pepsin secretion. A change was also seen in SOD, CAT, and LPO levels in rat gastric mucosa due to antioxidant property of alcoholic leaves extract of *Moringa oleifera*. Antioxidant defense mechanism of the extract was probably due to metabolising lipid peroxides and scavenging H_{2}O_{2}.

The ethanolic extract of *Nigella sativa* L. seeds were evaluated for its anti-ulcer activity against pylorus ligation induced gastric ulcer (antisecretory) in albino rats. Ramamurthy and Umamaheswari (2012) found that *N. sativa* extract at a dose of 100 mg/kg p.o. markedly decrease the incidence of ulcers. The extract of *N. sativa* showed significant reduction in gastric volume, free and total acidity and ulcer index.
The extracts of seeds possess significant gastro protective activity as compared with standard drug. The present study revealed that the extract of *Nigella sativa* had ulcer protective activity comparable with standard drugs, which may be mediated by its antioxidant effects.

The ethanolic extract of *Aegle marmelos* leaves was evaluated for its anti-ulcer activity against pylorus ligation induced gastric ulcer (antisecretory) in albino rats. Various biochemical parameters such as gastric volume, pH of gastric content, free acidity and total acidity, total protein, total carbohydrate content such as hexoses, hexosamine, fucose and sialic acid were estimated in 90% alcoholic precipitate of gastric juice and examined on the test and control group animals. The extract at a concentration of 200 and 300 mg/kg exhibited a protective effect on ulcer-induced models in a dose dependent manner and was comparable with the standard drugs ranitidine. The extract of *Aegle marmelos* showed significant reduction in gastric volume, free and total acidity and ulcer index. The extracts possess significant gastro protective activity as compared with standard drug. The present study revealed that the extract of *Aegle marmelos* had ulcer protective activity comparable with standard drugs ranitidine, which may be mediated by its antioxidant effects (Ramamurthy, 2012).

Sayyed *et al.* (2012) evaluated the Pharmacognostic features and phytochemical profile of the *Aegle marmelos* (Rutaceae) leaves. The plant is sacred in Hindu scripture and reported to possess several claims like hypoglycaemic, antidyslipidemic, immunomodulatory, antiproliferative, wound healing, anti-fertility, and insecticidal. They investigate detailed morphological and microscopical features of the leaves of the plant. In the present work, other identification parameters are also studied which includes powder characterization and fluorescence analysis of the leaves. In the investigation the leaves are subjected to extraction with different solvent and resulted extracts were evaluated for phytochemical profile and the preliminary
A phytochemical investigation has revealed presence of resins, lipids, alkaloids, phenolic compounds, flavonoids in different extracts.

*Tecomaria capensis* is being used as a traditional medicine for the treatment of various diseases. Considering the above claims, the present work was undertaken to validate the anti-ulcer potential of the ethanolic and ethylacetate extracts of leaves of *Tecomaria capensis* against *invivo* Aspirin induced method. The extracts (100 and 200 mg/kg) significantly reduced the ulcer index. The extracts also significantly increased the pH of gastric acid while at the same time reduced the volume of gastric juice and total acidities. In conclusion, the present studies provide preliminary data on the antiulcer potential of leaves and support the traditional uses of the plant for the treatment of gastric ulcer (Elamaran Tamil Jothi *et al*., 2012).

The *Aegle marmelos*, commonly called as Bael is one of the most useful medicinal plants of India. All parts of this tree-stem, bark, root, leaves and fruit at all stages of maturity have medicinal virtues and have been used as medicine for a long time. This is the first article to study the amount of minerals, vitamins and fatty acids present in the *Aegle marmelos* leaves. Presence of phytonutrients in the *Aegle marmelos* leaves would eventually recommend and support the dietary intake of these leaves (Umadevi Kumba Janarthanan *et al*., 2012).

Ethanol extracts of *Dodonaea viscosa* were used traditionally in India for the treatment of skin diseases. Ramamurth *et al.* (2013) investigated *invitro* antimicrobial activity against pathogens namely *Staphylococcus aureus*, *Bacillus subtilis*, *Streptococcus pyogenes*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *Aspergillus niger*, *Trichoderma viride* and *Candida albicans* using the agar well diffusion method. The results revealed that the plant leaf extract possessed the highest inhibitory activity against the bacteria (*Staphylococcus aureus* in 22 mm) and fungi (*Candida albicans* in 15 mm). Among the leaf extracts of *Dodonaea viscosa* possess higher inhibitory activity than the root extracts. A parallel study was performed to identify the distribution
and the concentration of the phytocompounds in the roots and leaves of this plant. For this purpose we have prepared alcoholic extracts from each part of the plant and we have studied them separately.

Medicinal plants are known to have potential value and used them in herbal medicines. The therapeutic effect of medicinal plants for the treatment of various diseases is based on the chemical compounds in the plants. The major components are organic compounds, with biological activity, but none of them act efficiently and crude fractions have a better efficacy and exhibit synergetic effects. Then medicinal plants contain metal which are useful as well as toxic at higher doses. Hence, ten important medicinal plants are selected from the North Karnataka India. The selected traditional and popular medicinal plants are Ocimum sanctum, Catharanthus roseus, Trigonella foenum-graecum, Azadirachta indica and Aegle marmelos, Zingiber officinalis, Emblica officinalis, Anacardium occidentale, Momordica charantia and Syzygium cumini. The trace metal contents of, Mn, Fe, Cu and Zn was studied by AAS and suggests that the monitoring of trace elements in these medicinal plants does not exceed the limiting values set by WHO values. Hence, these medicinal plants can be safely used for medical purposes (Morabad et al., 2013).

2.2 Toxicological and insecticidal activities of plant extracts

Plants are members of traditional pharmacopeia in many Asian, African cultures and have also been used for pest control. Piper guineense and Piper nigrum are used as insecticides in several areas of Africa (Ivbijaro et al., 1990). Insecticides from medicinal plants are an alternative for pest management because they pose low threat to the environment or to human health compared to synthetic insecticides (Moreiva et al., 2007).

A number of plants like Euphobia sp., Dononea vescos, Eucalyptus sp and Chinus tribintitalia are known to possess insecticidal properties (Mazen et al., 2009). Kumar and Arya (2006) have studied the insecticidal activity of the essential oil of the
medicinal plant *Aegle marmelos* correa against four stored grain insect pests. Meisner and Witchell (1982) have reported the phagodeterrent effect of neem extracts and Azadirachtin on flea beetle, *Phyllotreta stereiolate*. Bhagat and Tripathi (1988) have studied the efficacy of neem in combination with Tulasi against *Rhizopertha dominica* in stored maize. The effect of plant extract *Catharanthus roseus* on the mortality of *Gryllodes sigilatus* has also been studied (Syed Mohamed Shah, 1992).

Desmukh and Borle (1975) have made a detailed study on the insecticidal properties of indigenous plant products. Insecticidal effect of plant extracts from tropical and sub tropical species was carried out by Ursula Stein and Klingauf (1990). Campagne *et al*., (1989) have studied the insecticidal activity of phytochemicals and extracts of the meliaceae plants. Okoro oji *et al*., (1992) studied the insecticidal activity of *Xylopia acthiopia* and *Piper guineese* on the stored bean beetle. Olwa odeyk *et al*., (1992) have also, made a study on the larvicidal and molluscidal activities of the plant extract of *Solanum acculegtrum* on mosquito larvae and snail. Ghoneium *et al*., (2000) have studied the effect of Neem Azal on growth and development of the Egyptian cotton leaf worm, *Spodoptera littoralis*.

Nasar and Abdullah (2001) made an evaluation of Azadirachtin on the control of the red palm weevil *Rhinocophorus ferrugineus*. Effects of neem seed extract on growth and development of larvae of *Pieris brassicaceae* was studied by Osman (1993). The effects of neem seed extract on *Pholeastor glomeatus* a parasitoid of *Pieris brassicaceae* was studied by Osman and Bradly (1993). Neeranjana Devi (2007) made a study on the impact of phytopesticide neem gold on certain selected tissues in the adult insect *Periplaneta americana* in relation to reproduction.

Abbasi *et al*. (2003) have studied the effects of alkaloids extracted from three plants of arid areas in the desert locust. Sharma and Gupta (2009) have studied the biological activity of some plant extracts against *Pieris brassica*. Mazen *et al*. (2009) found that the aqueous extract of some medicinal plants is toxic to the sweet potato
whitefly *Bemisia tabaci*. Oji and Okafor (2000) have studied the toxicological studies on stem bark, leaf and kernel of yellow oleander, *Thevetia peruviana*. Emara *et al.* (2002) have studied the biological effects of four botanical extracts on the different developmental stages of cotton leaf worm *Spodoptera littoralis*. Larvicidal, ovicidal and repellent activities of *Pemphis occidula* against filarial and dengue vector mosquitoes were studied by Samidurai *et al.* (2009).


Somnath Roy *et al.* (2009) have studied the Antifeedant and insecticidal activity of *Clerodendron infortunatum* extract on tea mosquito bug *Helopeltis theivora*. “Botanical pesticides as tools of pest management” a review made by Rao *et al.* (2005) studied the biological activity of an extract from *Hyocyamus muticus* on *Musca domestica*.

Hassan (2002) has studied the biological and bio chemical effect of some botanical extracts on cotton leaf worm *Spodoptera littoralis*. The study of insecticidal effects of extracts of seven plants species on larval development and offspring production was performed by *Tribolium Castaneum*. Fenny (1968) has found that the tauric acid rich oak leaf caused significant reduction in larval growth and pupal weight of the moth *Aperophra brumata*. Sujatha *et al.* (1988) have studied the impact of the petroleum ether extracts of some *Acorus calamus* and *Ageratum conyzoides* on
different mosquito species. Srinivasa Perumal et al. (1990) have found the effect of tannic acid extracts of the leaf *Ricinus comanunis* on the Army worm *Pereallia ricini*.

Kim et al. (2003) studied the insecticidal activities of aromatic plant extracts and essential oils against *Sitophilus oryzae* and *Callosobruchus chinensis*. Biopesticides act as environmentally soft tool for the management of insects/mosquito vectors (Muruga, 2006). Ramamurthy et al. (2012) studied the repellent activity of some indigenous plant extracts against rust red beetle *Tribolium custanacum*. Tanani et al. (2009) studied the impact of the wild plant *Fagonia bruguieri* extracts on the orthopteron insect *Schistocerca gregaria*. Biochemical studies on *Spodoptera littoralis* developmental stages after larval treatment with different botanical extracts were carried out by Bakr et al. (2002).

Essential oil from the leaves of *Aegle marmelos* was reported to show insecticidal activity against four stored grain insect pests including *Callosobruchus chinensis*, *Rhyzopertha dominica*, *Sitophilus oryzae* and *Tribolium castaneum*. Essential oil from the leaves of *Aegle marmelos* was reported for insect repellent activity against *Sitophilus oryzae* and *Tribolium castaneum* (Mishra and Tripathi, 2011).

Sreelatha and Geetha (2011) have studied the pesticidal effects of *Clerodendron infortunatum* on *Oryctes rhinoceros*. Mohamed et al. (2010) have studied the biological and histopathological effects of some insecticidal agents on red palm weevil *Rhyncophorous ferrunigineus*. Samira Aly et al. (2010) have studied the effects of the wild plant *Fagonia bruguieri* on the adult performance and phase transition of *Schistocerca gregaria*. The effects of different extracts from the wild plant *Fagonia bruguieri* on the adult performance of the desert locust including survival, emergence, morphogenesis, sexual maturity and longevity were found by Samira et al. (2010). Schmutter (1990) found that Neem products are known to affect larval instars and adult insects.
Bioassay directed fractionation of the ethyl acetate extract of the stem bark of *Aegle marmelos* afforded a new compound named Skimmiarepin C, along with Skimmiarepin A. This compound exhibits moderate insecticidal activity against the insects *Phaedon chleariae* and *Musca domestica* (Samarasegara et al., 2003). Most of the compounds have not properly been evaluated for the exploration of new lead molecule or pharmacophore. Moreover, mechanisms of action of a few bioactive compounds have been identified so far. Hence, extensive research is required to find out the mechanisms of action as well as bioactivity of the various phytochemicals and efficacy of the insecticidal values of *Aegle marmelos* (Sandeep Dhankhar et al., 2010).

### 2.3 Biochemical studies of insects

Abdel-Wahab (1970) investigated the free amino acids in the haemolymph of larvae of *Gryllotalpa africana*, *S. exigua* (Hb), *Agrotis ipsilon* (Hfn.), *Earias insulana* (Boizd.), *Pectinophora gossypiella* (Saund) and *Sesamia cretica* led by partition chromatography. Most of the common amino acids were present in the haemolymph of the six species. Methionine and tryptophan, however, were found only in the haemolymph of *Gryllotalpa africana*. Proline, which was present in all the species that attack cotton, was absent from the larvae of *S. cretica*.

Lafage *et al.* (1974) mentioned that, diapause larvae of *Pectinophora gossypiella* (Saund.) possessed more amino acids on a molar basis than did non-diapause larvae. There was an alteration of the molar ratios of amino acids between diapause and non-diapause larvae. Thus, total amino acids are a reflection of the diapause state.

Mjeni and Morrison (1976) concluded that there was a pronounced decrease in haemolymph protein of allatotropized blow fly *Phormia regina* treated topically with juvenile hormone analogue. Wigglesworth (1976) stated that in Lepidoptera, trehalose makes up over 90% of blood sugar (0.2-1.5 g%).
Chippendale (1978) stated that insect carbohydrates are present both in free form and combined with other molecules including purines, pyrimidines, proteins and lipids. Carbohydrates are involved at all levels of cellular organization. The most abundant monosaccharide is D-glucose, which is the parent monosaccharide from which all other sugars can be derived. The most common disaccharide is trehalose; and it is uncommon to find oligosaccharides that contain more than two sugar residues. The polysaccharides present are glycogen, Chitin and mucopolysaccharides.

Ismail (1980) reported that treatment of *Spodoptera littoralis* pre-pupae with Juvenile hormone analogue (Isopropyl, 3, 7, 11-trimethyl, 2, 4, Doden cadienoate) increased the carbohydrate, protein and lipid contents in the pupae.

Cohen and Patana (1982) determined the haemolymph total protein content of the fifth-larval instar of Spodoptera exigua and found to be 26 g/l. Abdel-Hafez *et al.* (1983) studied the effect of different concentrations of IGR’s, diflubenzuron and triflumuron on protein and amino acids concentrations in laboratory and profenofos-resistant strain of *S. littoralis*. They found that, there was reduction in the levels of protein and free amino acid in laboratory and resistant strain as a result of both IGRs treatments.

El-Herrawie *et al.* (1985) found that the percentage of haemolymph proteins of *Heliothis armigera* larvae was reduced to 9.53% when they were fed on castor oil leaves treated with LC 50 level of Dimilin, however, the protein bands were increased up to 12 bands compared with 8 in control.

El-Kordy (1985) studied the biochemical effects of Triflumuron and Diflubenzuron on newly hatched larvae (one day old) of *Musca domestical* fed on treated diet for three days and 4-days old larvae fed till pupation. He showed that both IGR’s reduced the chitin content without any appreciable effect on cuticle protein level. The protein-chitin ratio in case of one-day old larvae was higher than in the case
of 4-day-old larvae at all concentrations. Also Triflumuron and Diflubenzuron caused a considerable decline in the protein bands.

Ismail and Fouad (1985) tested Juvenile hormone analogues (Isopropyl, 3, 7, 11-trimethyl, 2, 4, Dodencadienoate) to the pre-pupae of Chrysomia albiceps immediately following ecdisis from the last larval instar. They found that the total carbohydrates and total proteins of the pupal instar were significantly decreased. Meanwhile it does not greatly affect the total lipids.

Mullins (1985) stated that, haemolymph total protein content in lepidopterous larvae varies from 60 to 100 mg/ml. Nabila (1985) investigated the ovarian amino acids content of Musca domestica and showed considerable variation in its level depending on the dosage of JH-1 utilized and on the stage of the ovarian development. Schloter (1985) found that, treatment of the last instar larvae of Epilachna varivestis with high doses of azadirachtin caused reduction in storage protein formation.

Bakr (1986) studied the effect of three insect growth regulators, Dimilin, Bay sir, Altosid when incorporated into the larval medium of the 2-days old larvae of Musca domestica. When fed continuously they found that, these compounds reduce the mean total protein in the 2nd and 3rd larval instars, 1-day, 2-day, 3-days and 4-days old pupae. Also they stated that Dimilin and Bay sir are of remarkable reducing effect on the total protein of larvae and pupae.

Reda (1986) showed that treatment of Musca domestica larvae with various insect growth regulators (Dimilin, Bay Sir 8514 and Altosid) led to decrease the total protein and increase the free amino acids of the larvae and developed pupae. Sammour et al. (1986) showed no newly formed protein fractions in Spodoptera littoralis larvae and pupae after treatment with Dimilin and SIR (insect growth regulators) were detected by mean of poly-acrylamide gel electrophoresis. At the beginning of Dimilin action (in newly moulted 6th instar larvae) the main tendency in the haemolymph and
Integument is a decrease in concentration of some protein fractions. At the end of Dimilin action (four-day-old 6th instar larvae and pupae) the main tendency is an increase of some protein fractions. The action of SIR was similar to Dimilin.

Abdel-Hafez et al. (1988) reported that there was a reduction in the level of protein when the larvae of profenofos-resistant strain of *S. littoralis* were treated with diflubenzuron and triflumuron. Hamdy (1988) studied the biochemical effect of Chlorfluazuron and Teflubenzuron on Musca domestica larvae fed on treated diet. He reported that protein in the case of Chlorfluazuron was higher than Teflubenzuron at lower concentration. Also treatment with both Chlorfluazuron and Teflubenzuron resulted in a considerable decline in the protein bands. The most important feature of both Chlorfluazuron and Teflubenzuron treatment was not the increase of number of bands, but the blocking or the increase of density of some major protein.

Ayyangar and Rao (1990) studied the effect of an injected dose of Azadirachtin (1mg/g) on certain haemolymph constituents of the last larval instar of *S. littoralis*. Azadirachtin significantly decreased total haemocyte count, protein and trehalase.

El-Sheakh et al. (1990a) found that treating 4 larvae of *S. littoralis* with phytoalexins (plant extract) caused reduction in the total crude protein and total lipids whereas soluble protein was increased.

El-Sheakh et al. (1990b) studied changes in the level of amino acid transferases (GOT and GPT) activity and total soluble protein in the 4th instar larvae *S. littoralis* during the different time intervals after treatment with the LD$_{50}$ of Ofunac, Sumithion and Glyceollin (plant extract). Total soluble protein was increased after 2 days of Ofunac and Sumithion treatment, while after one day Glyceollin treatment it came under the control level.
Mostafa (1993) studied the effect of the IGR compounds pyriproxyfen, flufenoxuron and teflubenzuron and Margosan-O (3000 ppm neem seed extract) on the total soluble protein and certain enzyme activities in the cuticle and haemolymph of 4th and 6th instar larvae of *S. littoralis*. The changes in the larval total protein and enzyme activities were determined at 0.24, 48 and 96 hour in time intervals. The tested compounds showed significant decrease in the level of total soluble protein in the two tested instar larvae at all time intervals. Both flufenoxuron and teflubenzuron was more effective on the 6th instar larvae than on those of the 4th instar while pyriproxyfen showed varied trend.

Abou El-Ela *et al*. (1995) stated that, when larvae of *Musca domestica* were treated with water extracts of the four plants: *Calotropis procera*, *Hyoscyamus muticus*, *Datura stramonium* and *Zygophyllum album*, the total lipid content is significantly increased, the total protein content is significantly decreased and the total carbohydrate content is significantly increased.

Abo El-Ghar *et al*. (1995) showed that acetone and ethanol extracts of *Melia azedarach* reduced the haemolymph carbohydrates of 6th Instar larvae of *Agrotis ipsilon* also the petroleum ether extract of *Anmi majus* and *Apium graveolens* fed to 6th instar larvae of *Agrotis ipsilon* greatly reduced the haemolymph carbohydrates.

Shoukry (1997) reported that the treatment of *Musca domestica* with the two volatile oils of chamomile, *Matricaria chamomilla* L. flower and jasmine *Clerodendron inerma* G leaves induced serious effects on the biology and biotic potential of *Musca domestica* by increasing the acidic and the aromatic amino acids during oogenesis. In contrast, the quantity of aliphatic amino acids was significantly decreased while the hydroxy amino acids have inconsistent results. The hydroxy amino acids were remarkably increased in the ovaries during three days of development.
Khalaf (1998) stated that, the volatile oils of *C. citratus* and *R. officinalis* induced biochemical disturbance in the pupae of *M. stabulans* by decreasing the mean total carbohydrate, the mean total protein and the mean total lipids. The two investigated oils induced various degrees of disturbance in the amino acid composition of *M. stabulans* pupae treated as larvae.

Romoser and Stiffolano (1998) stated that, the carbohydrates are not considered to be essential nutritive substances for most insects, but they are probably the most common source of chemical energy utilize by many lepidopterous insects. Also, they reported that the trehalose, a disaccharide composed of two glucose molecules (thereby containing twice as much energy as a single glucose molecule) is the major blood sugar in most insects. Much of the carbohydrates found in insects' blood are in combination with proteins forming glycoproteins.

Shoukry and Hussein (1998) studied the biochemical effects of two plant volatile oils on the larvae of *Galleria mellonella*. They found that, third instar larvae treated with LC50 of *Lantana camara* and *Vitex agnus* showed marked decrease in the total protein content and a significant decrease in total lipid content. They found a significant reduction in the total carbohydrate content in last larvae of *Calleria mellonella* where the depression in the carbohydrate levels reached 20.51% and 18.40%, respectively.

Teleb and Rashad (1999) tested the bioactivity of propolis ethanolic extract against 3rd larval instar of *Musca domestica*. They found that the total protein content increased significantly in treatment with LC25, LC50 and LC75. The protein content in house fly larvae was stained with COBB. 9 bands were identified in larvae fed on artificial media (control); while tissue protein of larvae subjected to propolis ethanolic extract with different doses were electrophoretically separated into 8 bands with LD75, 10 bands with LD50 and 8 bands with LD25.
Chitra and Reddy (2000) reported that, feeding *Spodoptera litura* with *Annona squamosa* seed extract caused a decrease in total proteins, compared to untreated *S. litura*, in all investigated stages, (3rd, 4th instars, Pupa and adult). Yi and Adams (2000) studied the effect of Pyriproxyfen and photoperiod on free amino acid concentrations and proteins in the haemolymph of the Colorado potato beetle, *Leptinotarsa decemlineata*.

Vijayaraghavan and Chitra (2002) studied the effect of botanicals and insecticides on the protein and amino acid content of *S. litura*. The treatments applied to larvae included neem (*Azadirachta indica*), Annona seed extract, cypermethrin and quinalphos. In all the treatments, the total protein content increased from the II instar larval stage to pupal stage, and was reduced in adults. Peak value of protein content was observed in the pupa in all treatments. Free amino acid content was also reduced due to botanicals and conventional insecticides. The neem extract caused a greater reduction in the protein and amino acid content than the Annona extract.

Abo El-Maaty (2003) treated the 3rd larval instar of *M.domestica* with various concentrations of two water extracts of *Limonium pruinosum* and *Calotropis procera* to examine their effects on total carbohydrate, lipid, and protein. Contents induced reduction in the mean of total carbohydrate, lipid and protein in the treated larvae. This reduction is directly proportional to the concentration of the plant extracts.

Shoukry et al. (2003b) studied the biochemical changes in the haemolymph of plodia interpunctella larvae treated with sublethal concentrations of two volatile oils and three fixed oils. All oil treatments increased the levels of haemolymph lipids and proteins but decreased their carbohydrates contents. However, electrophoretic assays on the haemolymph of the treated larvae revealed the presence of additional protein patterns due to treatments. The metabolic features of both oils are considered having juvenilizing action, where some morphogenetic abnormalities in treated larvae as well as developed pupae and adults were observed.
Sabry (2004) showed that treatment with plant fixed oils and volatile oils affect biochemical activities of *C. albiceps*. The content of haemogenate carbohydrate significantly increased in treated larvae. Protein content significantly decreased in all treatment. While, lipid content significantly decreased with volatile oils treatment and significantly increased with fixed oils treatment.

Hussein (2005) studied the effect of the volatile oil of *Calendula micrtantha* plant extracted and the components were identified by GC/MS. Adulticidal efficiency of the volatile oil and gibberelic acid; "plant growth promoting hormone" as well as their mixture was assessed against the Mediterranean fruit fly *Ceratitis capitata*. The result showed that the two compounds capable have characteristic resembling to insect juvenile hormones and have suppressive effect on reproductive potential. They induced the significant disturbances in the ovarian protein fraction and the amino acids patterns.

Khalaf (2005) treated the early third instar larvae of *Fannia canicularis* with various concentrations of *Rumex dentatus*, *Protulaca deracea* and *Piper cubebae* extracts. The *Rumex dentatus* was more toxic than *Protulaca deracea* and *Piper cubebae*. The results indicated that the tested mixtures had delayed effects represented by the decreased ovarian and testicular protein and the disturbance of their amino acid contents. This might be due in part to the interference of these mixtures with gonadal development, which affected negatively the fecundity and fertility of adults.

### 2.4 Effect of plant extracts on insect reproduction and reproductive organs

Bhaduri *et al.* (1968) have made a critical review of standard literature on ancient Indian medicinal plants and reported that 52 plants are believed to possess antifertility effects. Much of the efforts have been expanded by several workers towards the screening of indigenous plants for their reproductive deterrent or antifertility properties against some insect pests (Deepti Shukla, 2001; Shah *et al.*, 2005 and Swathi *et al.*, 2010).

Research on anticancer agents has provided many leads to the discovery of insect reproductive inhibitors (Borkovec, 1962). In the case of Dysdercus, the *Catharanthus roseus* leaf alkaloid gave better sterilant action than the root alkaloid (Svoboda, 1963). Svoboda and Blakes (1975) have reported that the activity of the *Catharanthus roseus* extract was found entirely in its alkaloidal constituents and the leaf alkaloids were far more active than those of stems or roots.

Sukumar and Osmani (1981) have reported that the leaf and root alkaloids of Catharanthus held promise as good sterilants against *Dysdercus cingulatus*. Crude extract of Podocorpus indigenous has been shown to produce sterilization in the cotton leaf worm *Spodoptera littoralis* (El-Ibrashy, 1974). The methanol flower extract of *Thevitia nerifolia* when applied to male fifth instar nymphs of red cotton bug, *Dysdercus similis* showed remarkable effects on the reproductive organs. The testis lobes were found small with incomplete development of testicular follicles (Raju *et al.*, 1990).

Treatment of *Catharanthus roseus*, *Parthenium hystereophorus* and *Nephrolepsis excaltala* plant extracts have produced malformed adults. The malformed adults are unable to mate (Rajendran and Goplan, 1980). Exposure to Eucalyptus oil odour to fifth nymphal instar of *Dysdercus koenigii* has resulted in the inhibition of reproductive performance in adults (Krishna, 1990). The effects of azadirachtin on the early development of spermatogonia in the testes of *Schistocerca gregaria* was studied by Linton *et al.*, (1997).
In male azadirachtin induced over aged nymphs of *Oncopeltus fasciatus* showed reduction of reproductive potentials (Dorn *et al*., 1987). The flower extract of *Thevetia nerifolia* has been shown to induce sterility in the male red cotton bug *Dysdercus similis* accompanied by anatomical defects, including incomplete testis follicles (Raju *et al*., 1990). Continuous feeding of *Oleandnerium indicum* sap during the larval period significantly affects fertility and spermatogenesis in male *Helicoverpa assulta* (Seongeun Jeong *et al*., 2001).

Histological studies of structural damage to the cells of the testes *Ephilachana varivestis* treated with azadirachtin were carried out by Schultz and Schluter (1984). Rathinam (1997) studied the effect of Nimbicidine on histopathological changes in the testis of the adult male insect. The testis follicle of the azadirachtin treated male insect *Melanoplus sanguinpus* shows destruction of cells and reduction in cell size in the apical part of testicular follicle (Tayade, 2012).

The neem treated testes of *Rhynchophorus ferrugineus* were smaller in size. The cysts of spermatocytes and spermatogonia were severely reduced in number (Mohamed *et al*., 2010). Linton *et al*. (1997) studied the azadirachtin effect in *Schistocerca gregara* (Forkal) and revealed that the insects suffered from arrested spermatogenic meiosis at metaphase.

Schulz and Schiter (1983) found that in *Ephiichna varivestis*, the degeneration of sperm bundles without sperm formation has been reported after the treatment of azadirachtin. The neem treated *Odontopus vericornis* exhibited remarkable changes in the testis such as disintegration of nutritive cells (Ambika and Selvi Sabanayagam, 2012). The pesticidal activity of neem has a wide spectrum having repellent, phagodeterent, insect growth regulatory and antifertility effects. The plant extracts of neem are capable of disrupting growth, development and reproduction in *Rhynchophorus ferrugineus* (Mohamed *et al*., 2010). Growth regulatory and sterilizing effects in insects treated with azadirachtin were observed by Klocke (1990).
The total leaf alkaloids and root alkaloids of *Catharanthus roseus* induced significant sterility in males and females of the housefly *Musca domestica*. The leaf alkaloid showed superior action when compared to root alkaloid. The root alkaloid has been shown to be inferior in its efficiency in inducing a higher degree of sterility (Kumuda Sukumar, 1987).

Saxena and Barrion (1987) have reported that, meiotic cells were significantly less in male progenies of *Nilaparvatha lugens* and *Nilaparvatha virescens* collected from rice plants sprayed with neem seed kernel extract. The antifertility effects of the aqueous extracts of leaves of *Aegle marmelos* was reported in male albino rats (Sathyaraj *et al.*, 2010), and leaves of this plant are used to cause infertility/abortion in human (Dineshkumar Sekar *et al.*, 2011).