Chapter 2

Review of literature

Plants are known to produce and store many biochemical products, lots of them can be extracted and used for research work. Medicinal plants are commonly called as “chemical Goldmines” as they have natural chemicals, which are acceptable to animals system and human also, many commercially important secondary metabolites are used in number of pharmaceutical compounds. For health care, humans have been dependents since the beginning of civilization. More than 80,000 medicinal plant species are found in nature out of 250,000 species of plants on earth (Thomas, 1997).

India has great plant diversity; over 7000 species of plant found were used by various indigenous systems of medicine. Such treasure can be used in insect pest management program; since the plants we known to have constituents, called allelochemics plays significant role in plant physiology and defense against insects (Ehrlich and Raven, 1964; Whittalkar and Fenny, 1971). These modify the insect behavior such as feeding, development and growth, oviposition etc. leading to decrease in insect pest population (Law and Regnier, 1971). Various plant products have been assessed for their pesticide potential worldwide (Klocks, 1987). Pavela (2008) surveyed 34 plant species, out of essential oils of Rosemary (Rosmarinus officinalis) and pennyroyal mint (Mentha pulegium) showed significant activity against adult houseflies (Musca domestica L.) in both fumigant and contact Toxicity assays.

In this chapter literature available four medicinal plants having various properties such as antibacterial, antiparasitic, laxative, antimicrobial and also some are used as medicine to cure diseases such as cancer and other.
The plant oils selected for assessing bioactivity against some insect pest/vector are as follows:
1. *Withania somnifera* (Ashwagandha),
2. *Curcuma longa* (Turmeric),
3. *Zinziber officinalis* (Ginger),
4. *Pelargonium graveolens* (Geranium), selected for research work has been reviewed.
1. *Withania somnifera* (Ashwagandha)

With chlorpyriphos as reference the crude extracts of Aksen (*Withania somnifera*), Absinthe (*Artimisia absinthium*), Chulai (*Amaranthus viridis*) and Babchi (*Psoralea corylifera*) were tested against termites (*Odontotermes gupta* and *Microtermes obesi*) in sugarcane (*Saccharum officinarum*), cv. HSF-240, which was sown in 880 m² area. All the treatments was done had comparable results with chlorpyrifos towards bud, seedling damage and population of foraging termites in the field were obtained in case of Asken. Absinthe, Chulai and Babchi was not successful in checking the percentage of bud damage (14.06b, 12.50b, 10.94b) when compared with Aksen and chlorpyrifos (4.68c and 1.56c) respectively. They were found to suppress the population of foraging termites in the field (Sohail, et.al, 2007).

The use of insecticide is causing serious health problems in society while controlling food pest. Ashwagandha (*Withania somnifera*) was evaluated for its larvicidal property against mature larvae of *Tribolium castenum* species. *Tribolium* is most common food pest. In tropical food stores it causes a great commercial loss. The extracts of different parts of *Withania* were prepared to treat late instar larvae of *Tribolium castenum* (Herbst). Treated larvae showed morphological abnormalities and significant mortality at higher dose levels of root extracts (Arora, et.al, 2011).

Ashwagandha has medicinal properties such as immune stimulatory stress releaser, energy boosting etc. For treating various diseases Ashwagandha is preferred. Even AIDS can be suppressed by Ashwagandha. Ashwagandha is considered one of the most important herbs and the best adaptogenic in Indian herbal system. Out of various constituents like cuseohygrine, anahygrine, tropine, and anaferine, glycosides, withenolide is one which consists of steroidal molecules and said to fight inflammation. Ashwagandha has stimulative effect on the immune system, combats inflammation, increases memory, and helps maintain general health and wellness. It also increases the production of bone marrow, semen, and acts anti-aging. Anti-tumor and anti-inflammatory agents of Ashwagandha are approved in several studies.
Higher steroidal content than that of hydrocortisone considered as common treatment in cancer cases found in Ashwagandha. Diseases like TB, chronic upper respiratory diseases and HIV were treated with Ashwagandha due to its strong immune stimulatory activity, and it is recognized as a blood tonic, especially in gynecological disorders including anemia and irregular menstruation. Anxiety problems of Patients can also be treated with Ashwagandha. (Umadevi et al, 2012)

The potential of leaf powder of Ashwagandha and other two were evaluated against *Callosobruchuschinensis*. Effective mortality (100 %) was observed in case of dried leaf powders of *T. procumbens* and *W. somnifera*. All test materials showed excellent ovicidal activity (100%). After treatment of 20 mg/g doses of all plant powders no F1 adult emerged. Conclusion can be made that these test materials can be used in integrated pest management strategies (Yankanchiet al.,2009)

About 55% Bihar farmers uses Endosulfanas pesticide of organochlorine group. Work was done to evaluate effect of Endosulfan on biochemical, hormonal and sub cellular anomalies of spermatozoa of mice and their restoration through root extract of *Withania somnifera*. Endosulfan was administered to Experimental mice for eight weeks followed by eight weeks administration of *Withania somnifera*. Degenerated mitochondria, degenerated microtubule and plasmamembranewas observed in case of Endosulfan administered group. While eight weeks *Withania somnifera* 1000 mg/kg/b.w/day administered group show greater degree of sub cellular restoration on mitochondria and nuclear membrane, Microtubules structure and Lipid peroxidation level were also restored toward normal. These combined effect finally resulted in restoration of spermatozoa structure in mice. It was found outstanding in restoring male fertility by combating endosulfan toxicity (Kumar, et. al., 2012)

Laboratory investigations of toxic effects of extracts of three plant species, *Rutachalepensis, Withania somnifera* and *Cassia senna*, against the khapra beetle, *Trogodermagranarium*Everts, larvae reared on treated wheat seeds. All extracts
showed varying but remarkable, the greatest toxicity being due to acetonic extracts. Of the three species, the acetonic extract of *R. chalepensis* showed comparatively more effective toxicity than others. The toxic effect was dependent on dose and exposure-time. It concludes that selected plants can be used effectively to control stored grain pest from above mentioned pest (Mohamed, et.al., 2012).

Rice weevil, *Sitophilus oryzae* is the major stored insect. Many health hazards, environmental pollution and detrimental to non-target organisms were reported when inorganic pesticides used for control. Plant-derived compounds are ecologically compatible alternative to synthetics for pest management. The efficacy of medicinal plant, *Withania somnifera* (Solanaceae) extracts against adults of *Sitophilus oryzae* was done in this study. The plant extracts were applied at five concentrations (20, 40, 60, 80 and 100% respectively) on green gram. Adults were exposed to treated green gram grains. Mortality was calculated after 5 and 10 days of exposure. After seven days damage percentage was calculated. The results concluded that mortality and damage percentage were proportional to concentrations. Higher concentrations had stronger toxicity and lowered the damage percentage. After treatment of DAT maximum mortality registered as 86.07% and 84.17% in five and 10 days, respectively. The population buildup (25.41%) was checked by even lower concentration (20%) of 10 DAT. With time toxicity was increased. When compared to control (8.13%), minimum damage registered in leaf extracts (2.40%), fruit extracts (2.47%) and root extracts (2.93%) at 100% concentration in another experiment. Overall the root extracts were effective compared to leaf and fruit extracts. The results of this study conclude that various extracts of *W. somnifera* were effective and can be used to manage stored pests in combination with other in integrated pest management tactics (Suvanthini S. et al., 2012).

The *in vitro* antifungal potential of two phytoextracts (Phytoextract-K black coloured, WS/SA/2000, procured from Laxmi National Products Pvt. Ltd. Mumbai) and (Phytoextract- II, white coloured, SC/A/001 procured from Rym Export, Mumbai) of
Withania somnifera (Ashwagandha) against five phytopathogenic fungi i.e. Alternaria alternata, Curvularia lunata, Helminthosporium sp., Fusarium sp. And Phytophthora parasitica were done. Both the extracts inhibited the growth of fungi significantly. Maximum mycelial inhibition was observed in Phytoextract-I of W. somnifera followed by A. alternata, C. lunata, and Helminthosporium sp. Phytoextract-II of W. somnifera was most inhibitory to Helminthosporium sp. followed by Fusarium sp., Phytophthora sp., A. alternata and C. lunata. (Vipin, et.al., 2005)

Medicinal plants not only have antibiotic properties but they are also important sources of chemicals with potential application as pesticides. Antitermitic potential of seed extracts of Withania somnifera (Indian ginseng), Croton tiglium (jamalgoota) and Hygrophila auriculata (talimkhana) were studied. Changes in tunneling behaviour, number of bacterial colonies in hindgut and activities of enzymes in midgut of Odontotermes obesus were observed after the treatment of seed extracts. C. tiglium showed the lowest LT$_{50}$ (12.85 and 2.65 h) at concentrations of 50% (half dilution of the extract) and 100% (extract without dilution), respectively. Soil treated with 100% concentration of seed extracts of W. somnifera and C. tiglium showed no tunneling. Numbers of bacterial colonies in the gut of termites from soils treated with 50% and 100% concentrations of selected plants did not differ significantly. They differed with respect to untreated soil. At 100% concentrations the enzyme activities in the termites from soils treated with seed extracts significantly differed from controls (Sohail Ahmed, 2007).

Tribolium castaneum (Flour beetle) and Callosobruchus chinensis (Pulse beetle) are major pests of stored products. Recently, attention has been paid towards exploitation of medicinal plants in pest management strategies. Investigation were carried out to evaluate the grain protectant efficacy of Withania somnifera. Substrates were treated with five different concentrations (20, 40, 60, 80 and 100%) of W. somnifera and replicated five times. Adults of selected insect pests were exposed to treated rice and green grams respectively. Rice grain weight loss (GWL) by T. castaneum after 7, 30 and 60 days was calculated. Percentage damage on green gram by C. chinensis recorded after seven days. The results concluded that the extract was effective
for both pests when compare to control. Minimum GWL by *T. castaneum* as observed in 30 and 60 days (0.7 ± 0.12 and 3.17 ± 0.47 %) after treatment (DAT). Significant difference was noticed among concentrations at 30 DAT. Due to loss of efficacy GWL was increased. There was indirect relationship observed between damage percentage of *C. chinensis* and concentration. The sets treated with 100% of extracts recorded lowest damage (3.36 ± 1.31%). Control value recorded was 14.24 ± 2.07 %. This study concludes that *W. somnifera* extracts were effective to be incorporate into the integrated stored pest management (Suvanthini, et al., 2012).

Extracts from different plant parts of *Withania somnifera* were tested against *Callosobruchuschinensis*L. was studied. About more than 60% adult mortality was found in case of 10% ether extracts from root (Gupta and Srivastava, 2008).

Due to aphrodisiac property and potential to cure various diseases, *Withania somnifera* L. is one of the commercially important and most preferred medicinal plants in the Himalayan region. Since, the antioxidant activities of *W. somnifera* have not been carried out for so long, the study attempt was made to evaluate the antioxidant properties of *W. somnifera* collected from two different habitats that is, forest and roadside at Kullu, north-west Himalaya. There is significant variation in total phenolic and flavonoid contents and DPPH (1, 1-Diphenyl-2-pycrylhydrazyl) scavenging potential of leaves extract between the habitat (*p*<0.05). The results further concluded that the DPPH scavenging potential of leaves extract at forest site was found significantly higher that is 51% compare to other. The antioxidant activities of leaves of *W. somnifera* L. varies with respect to habitat and vehicular pollution. Because of these reason plantation and cultivation *W.somnifera* in vehicular pollution free areas was suggested (Sharma et al., 2012).

Ashwagandha possess good immunomodulatory anti-inflammatory, anti-tumor, antioxidant, anticancer properties and many pharmacologically and medicinally important chemicals, they protect the cells from oxidative damage and diseases. Work has unveiled the therapeutic knowledge about Ashwagandha, which is used to exploit
novel medicines. Further research is required to explore the potential from this medicinal herb (Sharma, 2011).

*W. somnifera* against methicillin resistant *Staphylococcus aureus* (MRSA) was done. Aqueous root extract of the plant has strong antibacterial activity against MRSA as concluded by the in-vitro agar well diffusion assay. By using two dimensional thin layer chromatography (TLC) and contact bioautography the separation of the bioactive compounds from the plant extract were carried out. At minimum inhibitory concentrations of 2.3 µg/µl and 5.2 µg/µl respectively, two TLC spots were found to be bioactive against the pathogen. One spot was of a mixture of essential oil, phenolic and the other one was alkaloids. The antioxidant activity was estimated to be Trolox Equivalent. Extract of plant has antioxidant capacity of 9.83 mg/gm and reducing power 0.11 mg/gm of dry weight of extract using ascorbic acid as standard. It can be concluded that the bioactive fractions separated from aqueous extract of *W. somnifera* is a potential source of antibacterial compounds with antioxidant property (Mehrotra, 2011).
2. *Curuma longa* (Turmeric)

In the life of Indian people turmeric has an important position. Turmeric is used as part of rituals; ceremonies and cuisine. In all kinds of poisonous affections; wounds; ulcer etc. turmeric has been used as a remedy. It is also used in cosmetics since it gives good complexion to skin. By destroying pathogenic organisms it also helps in purification of blood. To cure various disease such as ringworm, eczema, parasitic skin diseases, chicken pox, small pox etc. it used as paste alone or combined with a paste of neem (*Azadirachtaindica*) leaves. It is also effective in cold, cough, liver affections, conjunctivities; etc. (Nadkarni, 1954; Kurup et. al., 1979; kolammal, 1979).

Various medicinal formulations such as Jatyadi taila; Narayana gula etc. are prepared from rhizome of turmeric (Sivarajan and Balachandran 1994). “HabNarkachur” has roasted turmeric which is used as anti-dysenteric for children(Thakur et al., 1989).

*C. longa* is a perennial herd with 60-90cm height, having short stem with erect leaves.Branched orange color; ovoid; cylindrical rhizome is present. Simple; large, petiolate; lanceolate; 45cm long leaves are present. Pale yellow colored flower is another identification mark for *C. longa* (Kirkitar and Basy,1987; warrier et al,1994,Thakur,1989)

Ar-turmerone; ar-curcumene are major constituents of turmeric essential oil. The other compounds found are and B-pinene; sabinene ;myrceneterpinene- limonene, eugenol, p-cymene ;turmeroneetc.Sesquiterpenoids; bisabolane and guainane skeletons also found in turmeric(Husain et al., 1992).

5.8% essential oil is obtained from dry rhizome; comparatively fresh rhizome yields only 0.24% oil containing zingiberine (Chopra, 1980).

Essential oil obtained from dry rhizome contains B- phellandrene; d- sabinene; cineole; borneol; zingiberene and sesquiterpeneketones(50%)(Lawrence, 1982).

Heat oil is also extracted to find its major constituents(Behur et al., 1998). Comparative study of constituents between commercial and cultivated turmeric was done by Uehara et al (1992). Saturated straight chain; saturated iso-monoenoic and dienoic fatty acids are found as constituents(Rastogi and Metrotra 1991)
The constituents curcumin shows anti-inflammatory activity, antiprotozoal; spasmolytic; CNS active; antiparasitic; antibacterial; carminative, antiperiodic; laxative; diuretic; ophthalmic; tonic activities were seen by constituents obtain from rhizome (Husain et al., 1992; warrier et al 1994).

Anti-fertility activity was observed in extract of *C. longa* (Garg et al., 1978) chloretic action of turmeric essential oil. Due to phentastic character of curcumin an Anti-oxidant properties are seen in curcuma powder (Dey, 1980)

Excellent insect repellent activity against housefly was showed by rhizome of *Curcuma longa*. Essential oil obtained from rhizome also has fungi toxicity (Asolkar et al 1992). Clinical studies also supports that it definitely reduces cough and dyspnea (Rastogi and Mehrotra, 1991). Nematicidal; cytotoxic and tumor reducing properties are also found in turmeric (Kinchi et al., 1993; Soudamini and Kuttan, 1998).

Free-radical induced blood lipid peroxidation and especially peroxidized LDL play a central role in the pathogenesis of atherosclerosis and related cardiovascular disease. Recent research marks key contribution of apolipoprotein B (apo B) to atherogenesis as the main inductor of one of its earlier steps, i.e. macrophage prolipheration. This has forced to investigate the apo B response to a very effective phenolic lipid-antioxidant, namely anhydroalcoholic extract of *Curcuma longa*, which according to our previous work does not show any toxic effects and decreases the levels of blood lipid peroxides, oxidized lipoproteins and fibrinogen. The study concluded that a daily oral administration of the extract decreases significantly the LDL and apo B and increases the HDL and apo A of healthy subjects. All data on the increased anti-atherogenic action of the physiological antioxidant tocopherol in the presence of phenolic co-antioxidants (which eliminate the tocopheroxyl radical), confines planned clinical research to test the usefulness of the curcuma extract as a co-antioxidant complement to standard treatments to prevent or retard atherosclerosis (Ana Ramírez-Bosca et al., 2000).

To determine the efficacy of *Curcuma longa* rhizomes and *Cymbopogon citratus* leaves extracted with different organic solvents (petroleum ether, hexane, methanol and acetone) for the control of *Trogoderma granarium*, a laboratory study was done.
Completely randomized experimental design was used with four replications. The effectiveness of the extracts of selected botanicals was assessed under laboratory conditions at room temperature for their biological activities against *T. granarium* (Kharpra beetle) in stored groundnut seeds. In plastic vials 0.3% of the extracted essential oils were mixed with 50g of the groundnut seeds which were put. The effects of the treatments on insect mortality and adult emergence were done. All the treatments showed significant levels of toxicities to the insects. The treatment of turmeric extracted with methanol recorded the highest mortality out of the turmeric extracts while Petroleum ether extract of lemongrass showed the highest mortality amongst the lemongrass extracts. Considerable number of adults emerged (10.00%) in the control when compared with the other treatments. The study concluded that selected essential oils can serve as a means of conserving groundnut seeds. The use of turmeric and lemon grass is recommended for insect pest control (Asawalam and Igwe, 2012).

With natural compounds derive from medicinal plant such as curcumin, could have important effect on treatment of lung cancer. Curcumin from *Curcuma longa* rhizome has many anti-cancer activities. Therefore, to study inhibitory effect of *C. longa* total extract on telomerase in A549 lung cancer cell line as in vitro model of lung cancer was done in work. First, total extract of *C. longa* were prepared by n-hexane, methanol and dichloromethane. Secondly, cytotoxic effect of n-hexane phase was studied on A549 lung cancer cell line with 24, 48 and 72 h MTT assays. Finally, to measure amount of relative telomerase inhibition by the extract, cells were treated with n-hexane extract and TRAP (Telomeric Repeat Amplification Protocol) assay was done. Data analysis showed that n-hexane extract of *C. longa* has dose-dependent cytotoxic effect on A549 lung cancer cell line with IC50 = 0.23 - 0.28 mg/ml. The extract inhibits telomerase activity with dose-dependent manner was observed. N-hexane extract of *C. longa* has cytotoxic and telomerase-inhibitory effect on cell line A549 and could be exploited as potential source for developing novel drugs against lung cancer can be concluded after study (Pourhassan Mohammad, 2010).
3. *Zingiber officinale* (Ginger)
Ginger borne horizontally near surface soil. It is a perennial herb with robust branched rhizome. It is used in medicine and also for flavoring purposes. It increase digestive power; dispels cardiac disorders and cures omitting; cleanses throat and tongue; also used in diarrhea; cholera, diabetes, eye diseases etc. It is also used to cure inflammation of liver and rheumatism (Aiyer and Kalammal, 1966, Kurup et al., 1979). It is also effective to reduce the serum cholesterol level in rats (Singhal and Joshi, 1983). In anorexia, vitiated condition of vata and kapha, dyspepsia, inflammations and pharyngopathy raw ginger is very useful. Dry ginger was found to be effective in asthma, cough, colic, diarrhea, cholera, vomiting, nausea, elephantiasis and inflammations etc. (Warrier et al., 1996)

In fevers ginger, juice of fresh rhizome and ‘chaturbhadakavatha’ (containing the medicinal plants) given to patients. Household remedies for indigestion, flatulence, dyspepsia, sore throat etc. also contain ginger taken by adding it to tea. In unani preparations such as “Hub-gul-pista” “sutafshivin” used for clearing respiratory system, dysentery, it is used (Thakur et al., 1989)

Ginger paste applied to forehead in headache gives relief, also effective in tooth-ache, face-ache. In cholera collapse stage powdered ginger rubbed to improve local circulation. It also effective in chronic rheumatism, colds, catarrhal attacks, increasing appetite etc. (Nadkarni, 1998).

Originated in south Asia and widely grown in India, China, Sumatra, Africa, Mexico Jamaica, Hong Kong, Australia, Nigeria, Siezza, heone and japan. India is largest producer and exporter of ginger where it is chiefly produced in the states of Kerala and Assam.

Ginger is a slender, perennial, rhizomatous herb. It beans linear, sessile and glabrous leaves. White to yellowish brown, irregularly branched, annulated, laterally flattened rhizomes are found. It has yellowish green flowers, arranged in oblong and ensheathed in a few glabrous bracts. Few scales covers growing tip. Rhizomes surface is smooth (Warrier et al., 1996)

Gingers organoleptic properties are due to gingerols. Due to constituents of gingers steam volatile oil it gets odour and houour while pungency is produced by nonvolatile components, known as gingerrole. It essential oil contains mainly mono and
sesquiterpenehydrabons and oxygenated compounds. These monoterpenic constituents also contributes to its aroma, 3-Carene, x-pinene, cumenecomphene, B- pinene, myrcece, limonene, 18 cineole, were the monoterping found so far (Dodge, 1912, Nigam et al.,1964, Jain et al., 1962).

In essential oil sesquiterpene hydrocarbons constitutes major fraction, of which B-Zingiberene and ar-curcumumene are found in high % others found are x-Zingiberence, B- isobolane, B-D- cucumene. R-selinene, B- farnesene, x- copaene etc.(Nigam et al., 1964, Bednarczyk and Kramer, 1975, Soden and Rojahan, 1900)

The two hydrated sesquiterpenes reported were Cis-sesquithujene hydrate and Zingiberenol (Terhune et al, 1975). Gingerol, Shagaols, dihydrogingerols, gingerdiols, (n)-paradol, Zingerone, ginger diones etc. were reported as major pungent compounds (Lapworth et al,1917; Connell,1970; Nelson, 1917; Nomura, 1918).

An inhibitor of spontaneous motor activity, antipyretic, analgesic effects were shown by (6)-Gingerol and Shagaol. Out of these (6)-Shagaol was more active than other. Both of these found to suppressed gastric contractions in situ (Suekawa et al, 1984).

6-8 and 10-gingerol from ginger were identified as cardiotonic principles. Leaves of ginger also showed antioxidative properties (Shoji et al,1982; Lee et al, 1982)

D-camphene is main constituent of essential oil. The alcoholic extracts of ginger stimulates the vasomotor and respiratory centers of anaesthetized cats (Husain et al,1992). Denyer et.al. (1994) isolated antirhinoviralsesquiterpenes from ginger. 6-gingerol and 6-Shagol were identified as pungent constituents of Z.officinale (Takashashi et al,1993)

Remarkable repellent activity against both the kitchen insects Periplanetaamericana and the agricultural pest Bruchaspisorum shown by the essential oil (Garg and Jain, 1991).

Various remarkable physiochemical properties of oil were found by CSIR (1953) as

1. Specific gravity at 30°c = 0.868 – 0.880
2. Optical rotation at 20°c = -28°c - -45°c
3. Refractive Index at 30°c = 1.4840 – 1.4894
4. Saponification value = 20
4. *Pelargonium graveolens* (Geranium)
Pelargonium graveolens has attractive, strongly rose-scented leaves and pinkish white flowers. Pelargonium graveolens is, much-branched shrub which is erect and can reach a height of up to 1.3 m and a spread of 1 m. The hairy stems changes from herbaceous to woody as it becomes aged. Leaves are velvety deeply incised, strongly rose-scented and soft to the touch due to the presence of numerous glandular hairs. The show white to pinkish flowers are present from late winter to summer (August - January) peaking in spring (September - October).

The genus Pelargonium gets its name from the resemblance of the shape of the fruit to the beak of a stork, pelargos in Greek. The species name graveolens refers to the strong fragrance of the leaves, graveolens meaning strong-smelling in Latin.

The genus belongs to the family Geraniaceae, which also comprises four other genera, Geranium, Erodium, Monsonia and Sarcocaulon. There are ± 220 species within the genus Pelargonium, and 80% of them are confined to southern Africa. Pelargonium graveolens is used in the production of geranium oil, which is used as a substitute for the expensive attar of roses in the perfume trade.

With the dilution of essential oils in DMSO changed the susceptibility of the strains. The pure essential oils showed the most extensive inhibition zones and they were very effective antimicrobial compounds. The most susceptible strain reported was Staphylococcus aureus. It was observed that β-citronelol is a prominent part of P. graveolens volatile oil and caryophyllene oxide is a famous and important part of V. agnus-castus volatile oil and their probable synergistic effect with other constituents are responsible for the antibacterial effects of these oils (Ghannadi et al., 2012).

The study of effects of essential oils of Pelargonium graveolens and Cymbopogon citratus on maize weevil (Sitophilus zeamais) has shown the most significant insecticidal activity against it with a maximum mortality rate of 100%. It was observed that essential oils have high contact and ingestion toxicity than fumigant / respiratory poison. This is confirmed from 90% mortality of weevils that come in contact or ingest contaminated food and only 40% when inhaled. This observation concludes
that the non volatile active components are more efficient than the volatile compounds. The insecticidal activity was more intense but short for higher concentrations of these oils. The activity was low and long-lasting for average concentrations. From statistical results it was observed that the difference between the insecticidal activity of essential oils of *P. graveolens* (geranium) and *C. citrates* (lemongrass) was not significant in the three tests. So the study confirmed that these essential oils can serve, in one way or another, as a means of conserving maize corns for a longer time (Kabera et al., 2011).

Water extracts from selected *Geraniaceae* plants, to which paraffin oil was added as adjuvant, were tested. It was observed that the plant extracts researched limited Colorado potato beetle feeding and development and adding adjuvant increased the effects. The highest antifeedant activity towards Colorado potato beetles and their larvae was observed in extracts obtained from *Pelargonium hortorum* Bailey and *Geranium pusillum* L. The extract from *Pelargonium hortorum* Bailey added to food showed a negative effect on the development of female reproductive organs and embryo development and showed the highest effectiveness in field conditions (Lamparski, and Wawrzyniak, 2005).