CHAPTER 6

Summary and Conclusions

The brief summary and following conclusions can be drawn from this work that, the tested plant materials (*Eichhornia crassipes*, *Plumbago capensis* and *Piper betle*) still have new antifeedant/ toxic compounds. Moreover the bioactive compounds isolated from these plants were easily conjugated with silica nano particles to prepare effective formulations. The prepared nanoformulations are successful in exhibiting improved shelf life and higher controlled release profile isolated compounds. In addition nano-formulations also enhance the antifeedant activity of the individual isolated compounds against *Spdoptera litura* F., *Achaea janata* L. and *Helicoverpa armigera* H.

- There have been many methods employed to isolate the principle bioactive compounds form water hyacinth which eventually yielded a single potent antifeedant and toxic compound, 2-propyl piperidine (coniine). I have discovered the occurrence of this chemical in water hyacinth plant for the first time and also its insect controlling activity/ use in pest control on agricultural crops for the first time. A patent was filed on isolation of an active insecticidal compound, 2-propylpiperidine (coniine) from aquatic weed water hyacinth, *Eichhornia crassipes* (Mart.). More particularly, the compound can be used as a total insect-controlling agent (Toxicant, antifeedant and growth regulator) for pest management in agricultural fields. The compound 2-propylpiperidine can be used as a substitute for chemical pesticides or as a supplement to chemical pesticides to reduce the usage of synthetic pesticide concentrations to protect the environment.

- Different isolations techniques and the purification methods lead to isolate an antifeedant compound from the *P. capensis.* The extensive spectroscopic analysis confirmed the compounds as plumbagin. The antifeedant activity of the plumbagin was enhanced to more than 10 folds on formulating with silica nanoparticles. Moreover the nano nature of formulation has an advantage of distributing the active compound on the leaf which enhances the bioavailability of the compound.

- Bioactivity guided fractionation of *Piper betle* L. yielded two bioactive fractions which on fractionation yielded total 8 bioactive compounds. After various chemical analysis such as, NMR, FTIR, EIMS, UV-VIS and HPLC, the isolated compounds were confirmed as Eugenol, α- pinene, Linalool, Limonene, Trans-caryophyllene, Nerolidol, Carene and Ocimene. The results reveal that the Eugenol was obtained in higher quantities from *P. betle*. However the rest of the compounds miner constituents of the plants and their quantity isolated from was little and are procured from Sigma-Aldrich to prepare the formulation and further investigations.

- The isolated compounds were conjugated with silica nanoparticles to increase its shelf life, controlled release properties as well as the bio-activity against major agricultural pests. All the formulations prepared showed high stability with higher zeta potential, controlled release property as well as enhanced shelf life of the isolated botanicals. The added advantage of these formulations is their ability to enhance the bioactivity of the isolated botanical compounds.

- The preparation of nanobioformulation with Trans-caryophyllene and silica nanoparticles showed enhanced efficiency of Trans-caryophyllene in controlling the population of two major agricultural pests. A patent was filed on synergistic nanobioformulation with Trans-caryophyllene and silica nanoparticles useful as insect controlling agent and a method of its formulation. Nano silica formulation protects the botanicals against degradation, enhance the bioavailability and create high local concentrations of the bioactive chemicals in target cells. The formulation controls the release rate and prolongs the duration of antifeedant effect of trans-caryophyllene. This formulation offer synergistic effect, which gives added advantage for the compounds in enhancing antifeedant activity as well as the duration of protection against agricultural pests.

- Result revealed that Trans-caryophyllene and its nano-formulations were directly not toxic to *A. janata, H.armigera* and *S. litura.* But they inhibit the feeding activity of

the insects leading to pest's starvation that ultimately leads to its death. Additionally the amorphous silica is considered to be safe for human by world health organization and US department of agriculture. Therefore their persistence on plant or soil after spraying in the field will not have any adverse effects on the environment.

- Regulation of the particle size, morphology, zeta potential, controlled release and shelf life of formulation can be easily done by adjusting the concerned parameters, e.g., the time of compound loading type of solvent used in the preparation and concentrations of precursor's i.e. isolated compounds and silica nanoparticles.

- Compositions of the isolated bioactive compounds and silica nanoparticles present in the nanobiocomposites are found to be directly influencing the size and bioactivity of the nanoformulations. Thus, to get the maximum antifeedant activity optimum composition of the botanicals were needed in effective nanoformulation.

- The result of present investigation indicated that, there is tremendous scope for developing nano-biocomposites in to future pest management as they are environmentally safer than the existing synthetic pesticides.

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