CHAPTER 6

6.0 CONCLUSION

Cereal grains are the primary source of calories and proteins for humans and livestocks. Wheat, however, dominates the list of grains preferred by the masses acrosss the globe. Talking about our nation, India is the second largest producer of wheat which itself speaks about the importance of the grain in our nation. However, wheat grains are prone to different types of infestation during its journey from harvesting till storage in the warehouse. While focusing into the shelf life of wheat grains in the storage, it is often seen to be affected by a wide range of factors including insects. Among all, *Tribolium casteneum* is the primary pest of wheat flour and secondary pest of wheat grains. Moreover, it is one of the highly resistant pests and known to damage a wide range of stored grains. Resistance development in them is aided by the qualities like sexual selection by the females for fitness of the progeny, easy adaptation to a new environment, and rapid dispersal to colonise new food patches. Hence, it continues to cause economic damage, which brings down the market price and nutritional efficiency of the grains. It is estimated that every year, approximately 40% of weight loss of wheat flour is caused due to *T. casteneum* infestation. Apart from financial loss, the beetle secretes toxic quinones' which is marked by the characteristic colour change of the flour. Moreover, quinones' are carcinogenic thus possess serious health risks to human consumption. Hence, controlling the pest is of utmost importance.

Control measures exclusively rely on fumigation with methyl bromide and phosphine for managing a wide range of stored grains pests. However, the use of methyl bromide was banned worldwide due to its direct association in ozone layer depletion. Moreover, phosphine was found to be least effective in controlling the pest due to the fast-growing resistance. Hence, the development of natural, eco-friendly management tools is of great health and economic importance. Amongst all, plant-based research has drawn global attention for possessing a wide range of secondary metabolites including EOs. Moreover, EOs do not accumulate into the environment and are least toxic to non-target organisms, including humans.

Artemisia annua, a species of Asteraceae family, is well known for its medicinal properties and used extensively in Asian countries as a combined therapy for Malaria. However, studies to decipher a better solvent for the extraction of EOs from *A. Annua* have not been recorded yet. Hence, the potential of EOs of *A. annua* extracted with both polar (methanol & chloroform) and non-polar (petroleum ether & n-hexane) solvents against *T. casteneum* was analysed and compared. In the present study, Biology of the flour beetle was studied to identify each stage of the life cycle. The repellency and acute toxicity assays of *A. annua* EOs against the pest was explored. EOs obtained by hydro-distillation was evaluated through Gas chromatography-mass spectrometry to identify the major chemical constituents. Additionally, metabolic interference inflicted in the treatment sets of *T. casteneum* was assessed. Nutritional properties of the undamaged and *T. casteneum* damaged grains were also analysed.

Seven larval instars of the flour beetle were found in the biology study. The EOs extracted with the solvents yielded oil in the order of methanol> chloroform> n-hexane> petroleum ether. Though all the EOs were effective in controlling the pest but petroleum ether EOs was found effective in the repellency and contact toxicity assays. On the other hand, fumigant toxicity and repellency through multi-arm olfactometer have demonstrated n-hexane as the most efficient EOs. The bioefficacy of EOs was further authenticated by the biomolecular assays of the lethal sets. In the result protein, AChE, GST, GSH was found to decrease significantly whereas LPO has increased in the LD_{90} most followed by LD_{50}. Moreover, the nutritional properties of the wheat grains and flour were heavily deteriorated by the *T. casteneum* infestation.

In a nutshell, the bioactivity of non-polar solvent derived EOs of *A. annua* against the flour beetle is validated. Moreover, biomolecules of EOs were highly effective against the pest. Hence, there is a prospect that these compounds can be used for designing eco-friendly insecticides that can work in synergy and would hinder the life supporting detoxification processes in the target insects. Additionally, the future research using non-polar solvents to elute EOs from *A. annua* would be highly resourceful in the pest management studies.