"Natural Pesticides: A case Study of Combination of Pyrethrins and Rotenoids and its Environmental Implications as a Strategy in Integrated Pest Management"

By

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DECLARATION

This thesis is my original work and has not been submitted for examination for a degree in any other university.

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This work has been submitted for examination with our approval as the supervisors.

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ABSTRACT

Research and commercial interest in assessing additive compounds that suppress detoxification in insects while at the same time enhance the activity of pyrethrins started around 1940 when sesame oil was recognized as a synergist for pyrethrins. The active components in sesame oil were found to be sesamin and sesamolin each having the methylene-dioxyphenyl (MDP) moiety in the molecule.

The synergistic importance of the MDP moiety lead to the manufacture of many synthetic MDP compounds with synergistic effects. Currently, most compounds used as synergists are synthetic and are not compatible with integrated pest management (IPM) practices. This has necessitated the evaluation of natural synergist as preferred alternatives for most commercially used synthetic chemicals synergists. In this project, the synergistic potency of a botanical plant extract *Tephrosia vogelii* (that possesses an insecticidal activity of its own) was investigated. In addition, its toxicological and environmental implications were evaluated. Additional information on extraction capabilities of various solvents and the percentage concentrations of rotenoids in leaves and seeds of *Tephrosia vogelii* were determined and compared in this study.

The existence of synergism between pyrethrum and *Tephrosia vogelii* extracts, as representatives of the two botanical insect control agents pyrethrins and rotenoids was established when a series of mixture ratios of pyrethrum and *Tephrosia vogelii* (TV) extracts were tested against several insects in the target range of each individual extract. The observed percentage mortality for a given mixture ratio compared to the theoretical

percentage mortality expected calculated by adding the observed mortality rates due to that of each individual insecticidal compounds and the LC_{50} of each target insect established were used to evaluate the efficacy of the mixture. Studies revealed that when the two extracts were combined in the ratio of 1:4 (pyrethrum: *TV* extract) v/v a significant synergism effect occurred between them (co-toxicity coefficient = 3.4) that was not just an additive effect. At this ratio the activity of pyrethrins were found to be correspondingly enhanced against a wide range of insect species.

The percentage yield of rotenoids in crude *TV* leaves and seeds extracts was investigated. Samples were extracted with chloroform, ethanol, and methanol by soxhlet method and analyzed by HPLC. Generally a high percentage yield was recorded in leaves than in seeds in all samples. Chloroform recorded the highest yields (leaves 8.3% and seeds 2.7%) and ethanol gave 5.9% in leaves and 1.9% in seeds extract. Methanol extracts gave the least percentage yields (4.8 % leaves and 1.6% in seeds).

The potential effect of rotenoids on the environment was evaluated through establishment of its degradation rate. Samples were exposed to direct natural light and removed at prefixed intervals. The residues were dissolved with 5 cm^3 of the mobile phase (acetonitrile/water) and the residue level analyzed by HPLC. The data showed that the half-life ($t_{1/2}$) of rotenone was 3.2 hours while for the rotenoids in the *Tephrosia vogelii* (TV), and combination of pyrethrum and TV extract (in the volume ratio of 1:4) was found to be 6.1 and 6.5 hours respectively. The combination of rotenoids and pyrethrins was found to be more persistent (resistant) to photodegradation

All toxicity studies of the insecticidal mixtures were found not to cause harm or death with a single dose. The mixture was classified as non-irritant to the skin and irritant to the human eye. The LD_{50} was found to be 1mg/Kg body weight in juvenile rats and was classified as slightly hazardous. The results show that a combination pyrethrins and rotenoids produce a safe insecticidal formulation to the human and environment with an increased effectiveness than individual extracts for the control of some insect species fits as a supplement in IPM approaches.