PHYTOCHEMICALS AS FUMIGANTS AND REPELLENTS AGAINST STORED PRODUCT INSECTS

Moshe Kostyukovsky[1]*, Uzi Ravid[2], Dana Maor[2], Joshua Ogendo[3], Josphat Matasyoh[4] and Eli Shaaya[1]

[1]Dept. of Food Sciences, ARO, The Volcani Center, P.O.Box 6, Bet Dagan, 50250, Israel. *Corresponding author (e-mail: inspect@volcani.agri.gov.il)

[2]Department of Aromatic, Medicinal and Spice Crops, ARO, Newe Ya'ar Research Center, Ramat Yishay 30095, Israel

[3]Department of Crop and Soil Sciences, Egerton University, P.O. Box 536 Egerton 20107 Kenya

[4]Department of Chemistry, Egerton University, P.O. Box 536 Egerton 20107 Kenya

The use of synthetic fumigants and insecticides against stored product insect pests has posed serious problems to man and the environment due to their high toxicity and persistence, and negative effects to non-target organisms. Thus, there is an urgent need to develop safe alternatives that have the potential to replace toxic chemicals. Phytochemicals, such as essential oil components are known to possess insecticidal or repellent activities and show low toxicity to mammals, thereby posing them good potential candidates for use in pest management. Most of them are used as flavors and fragrances in perfumery, food industry and in aromatherapy.

In our laboratory, we have succeeded in screening a large number of essential oils and essential oil components extracted from Israeli and Kenyan aromatic plants for fumigant insecticidal and repellent activities against a number of main stored product insects. We have isolated a number of very active compounds with fumigant activity at low concentrations, which showed similar potency as methyl bromide against the major dry stored products insect pests.

Essential oil P62 obtained from Kenyan aromatic plant (*Labiatae* spp.) showed both insecticidal and repellent activity against main stored product insect pests. In space fumigation, total mortality of *Rhyzopertha dominica* and *Oryzaephilus surinamensis* adults was observed at very low concentration of 1 µl/l air and 24 h exposure time; 94 ± 5% mortality of *S. oryzae* was reached at 10 µl/l air. In parallel, a strong repellency effect of this oil to *S. oryzae* was found. The repellence index at a concentration of 4 µg/g was 90 ± 3%.

Two stereoisomers α- and β-thujone (a monoterpene ketone) which occur together in the essential oils of many herbs, including *Artemisia* and *Salvia* spp, were very active against adults of *R. dominica* and *O. surinamensis*. In space test, total mortality of these insect pests was recorded at concentrations of 5 and 7 µl/l air respectively and exposure time of 24 hours. α- and β-thujone are active ingredients in the liqueur absinthe, and in herbal medicines and seasonings for food and drinks. Former studies established that α- and β-thujone have an

insecticidal activity, acting as noncompetitive blockers of the gamma-aminobutyric acid (GABA)-gated chloride channel.

Insecticidal and repellent properties of *Lantana camara* and *Tephrosia vogelii* from Kenya were found against *S. zeamais*. In stored maize grain dry powdered plant materials of these species at concentration of 10% w/w caused 90% and 94% insect mortality, respectively. *T. vogelii* repelled 87.5% of the insect at 7.5% w/w.

In addition, studies using essential oils and their constituents against quarantine insects attacking cut flowers such as *Frankliniella occidentalis* (thrips) and *Bemisia tabaci* (whitefly) also showed effective mortality at low concentrations and exposure time, with no concomitant phytotoxic effects, as those observed when methyl bromide was used.

The results showed that some essential oils isolated from aromatic plants and their active ingredients are potential alternatives to methyl bromide as fumigants or repellents against stored product insect pests.

Key words: *Essential oils; Fumigants; Methyl bromide; Repellents; Stored product insects; Thujone*