PROPYLENE OXIDE: A FUMIGANT FOR QUARANTINE PURPOSES AS A POTENTIAL ALTERNATIVE TO METHYL BROMIDE

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Propylene oxide (PPO) is a liquid fumigant under normal temperature pressure (NTP) with a relatively low boiling point (35 °C) and a noticeable ether. PPO is a FDA approved fumigant to control microbial contamination on certain dry food products such as dry and shelled walnuts, cocoa powder and spices. A disadvantage of PPO is that it is flammable from 3% to 37% volume in air and therefore, to avoid flammability it should be applied under low pressure or CO_2-enriched atmospheres. Some preliminary studies on insecticidal properties of PPO at low pressure against the stored product insects were reported by Griffith (1999) and Isikber (2001). Methyl bromide (MB) is apparently the only fumigant available for quarantine treatment of commodities where rapid disinfestation techniques are essential. The loss of MB could have a significant negative impact on world agriculture, particularly because no available alternatives to either fumigant currently exist for rapid disinfestation of commodities. Thus, there is a critical need to develop new fumigants for quarantine purposes. Therefore, PPO at low pressure (100 mm Hg) was tested in his study for rapid disinfestation of durable stored products as replacement for methyl bromide by evaluating its toxicity to various stored product insects, its sorption by various commodities and its residue on various commodities.

Toxicity trials were carried out on all life stages of 4 species of stored product insects: red flour beetle, *Tribolium castaneum* (Herbst); Indian meal moth, *Plodia interpunctella* (Hübner); almond moth, *Ephestia cautella* (Wlk.); and saw-toothed grain beetle, *Oryzaephilus surinamensis* (L.). All the tests were carried out in 2.6 L desiccators at a temperature of 30 °C and 70% relative humidity at 4-h exposure time. For PPO treatment with 100 mm Hg vacuum, four to five concentrations of PPO ranging from 1 mg/L to 26 mg/L were tested for each stage of the insect. Probit analysis was applied to data on mortality of each stage of the insect. Sorption of PPO alone by corn, wheat and cacao bean was at PPO concentration of 82 mg/L by using a gas chromatograph. Residue level of PPO on the commodities was determined by commercial analytical laboratory services (Aminolab Ltd.) following propylene oxide analysis distillation method.

PPO at 100 mm Hg was toxic to the 4 species of stored product insects tested, *T. castaneum*, *P. interpunctella*, *E. cautella*, and *O. surinamensis*. Eggs and pupae of tested insect species are the more tolerant than the adults and larvae requiring LD_{99} values ranging from 12.2 to 22.4 mg/L. Generally, PPO at 100 mm Hg is more toxic to *P. interpunctella* and *E. cautella* with than to *O. surinamensis* and *T. castaneum*. A Ct product of 89.2, 88, 57.2 and 34.4 mg/L/h required to obtain 99% kill of pupae of *O. surinamensis*, *T. castaneum*, *E. cautella* and *P. interpunctella* respectively. The complete mortality of all life stages of tested insect species was achieved at a Ct

product of 96 mg/L/h. It appears that PPO at 100 mm Hg is less toxic than phosphine, but is more toxic than methyl bromide, carbonyl sulfide, ethylene dichloride and carbon tetrachloride.

Sorption of PPO by corn, wheat and cacao bean after 4-h exposure time was relatively high, varying from 57% to 79% of initial concentration. The greatest sorption of PPO for 4 h exposure period was observed by corn (79%), whereas the wheat displayed the lowest sorption of PPO (57%), which indicate a reasonable sorption of PPO by the commodities tested at short exposure time (4-h). The PPO residue in corn, cocoa bean and wheat were a maximum average of 157, 117 and 133 ppm respectively at 0-1 day after termination of aeration, which all were below the 300 ppm maximum tolerance. A very low PPO residues ranging from 6 to 14 ppm was detected at 3 days after termination of aeration. This data indicate that the PPO rapidly desorbs from the commodity at conditions of NAP and 30-35 °C

Based on its high and rapid toxicity to insects, its reasonable sorption by the commodities and its rapid desorption from the commodities, the combination of PPO with low pressure can be a potential as fumigant for replacing alternative methyl bromide for quarantine purposes where rapid disinfestation of commodities is essential. However, more research is needed to obtain data on its penetration through the mass of commodities and its phytotoxicity of PPO.

Reference

Griffith, T., 1999. Propylene oxide, a registered fumigant, a proven insecticide. In: Obenauf, G.L., Williams, A. (Ed), *Annual International Research Conference On Methyl Bromide Alternatives And Emissions Reductions* November 1-4 1999, UNEP and USDA, San Diego, California.

Isikber, AA, Navarro, S, Finkelman, S, Rindner, M, Azrieli, A, Dias, R, 2001, Toxicity of propylene oxide in combination with vacuum or CO_2 to *Tribolium castaneum*, in *Annual International Research Conference On Methyl Bromide Alternatives And Emissions Reductions November 5-9 2001*, Ed by Obenauf, GL, and Williams, A. UNEP and USDA, San Diego, California.