Propylene Oxide as a Potential Quarantine Fumigant for Insect Disinfestation of Nuts

A.A. Isikber[1], S. Navarro[2], S. Finkelman[2], M. Rindner[2] and R. Dias[2]

[1]Department of Plant Protection, Faculty of Agriculture, University of Kahramanmaras Sutcu Imam, 46060 Kahramanmaras, Turkey, e-mail: <isikber@yahoo.com >
[2]Department of Food Science, Agricultural Research Organization, The Volcani Center, P.O.Box 6, Bet-Dagan 50250, Israel, e-mail: <snavarro@volcani.agri.gov.il>

MB is the only fumigant available for quarantine treatment of commodities for which rapid disinfestation techniques and a very high degree of insect mortality are essential. The loss of MB could have a significant negative impact on world agriculture, particularly because no available alternatives to MB currently exist for rapid disinfestation of commodities. Thus, there is a critical need to develop new fumigants for quarantine purposes. Propylene oxide (PPO) is commonly used as a sterilant to reduce bacteria, mould and yeast contamination on processed spices, cocoa and processed nutmeats except peanuts. Several reports on insect toxicity indicated that PPO would be an effective replacement for methyl bromide in some postharvest situations (Creasy and Hartsell, 1999; Griffith, 1999; Isikber et al., 2001; Zettler et al., 2002; Navarro et al., 2004). PPO is a liquid fumigant under normal temperature pressure (NTP) with a boiling point of 35ºC and a noticeable ether odor (Weast et al., 1986). As a fumigant, PPO has reduced environmental risks compared with methyl bromide. It is not an ozone depleter and it degrades into nontoxic propylene glycol in the soil and in the human stomach. Human health and environmental effects of PPO are reviewed in Meylan et al. (1986). A disadvantage of PPO is that it is flammable from 3% to 37% in air and therefore, to avoid flammability it should be applied under low pressure or in a CO_2-enriched atmosphere. Propylene oxide (PPO) at a low pressure of 100 mm Hg was tested for rapid disinfestation of nuts as a potential replacement for methyl bromide, by evaluating its toxicity to the Indianmeal moth, *Plodia interpunctella* (Hübner) in the absence and presence of three species of nuts. Eggs and larvae were the most tolerant stages.

Complete mortality of all life stages was achieved at a Ct product of 61.2 mg h/L for empty space fumigation. Dosages of 13.9, 60.3, 72.1 and 93.1 mg/L were required to kill 99% of the larvae when fumigation of 4-h duration took place in an empty chamber, and in presence of peanuts, almonds and walnuts, respectively. After an initial dose of 68.7 mg/L, and a 5-h exposure time, sorption of PPO by peanuts, almonds and walnuts was relatively high, ranging from 87% of the initial concentration for peanuts to 91% for walnuts. PPO residues measured in peanuts, almonds and walnuts were 111, 46 and 80 ppm respectively 0-1 days after termination of fumigation, all of which were below the 300 ppm maximum tolerance set by the FDA of the United States.

Although sorption of PPO by the nuts tested was relatively high, the fumigation still enables a sufficient build up of gas concentrations to achieve insect mortality. Based on its high and rapid toxicity to insects, and its rapid desorption from the commodities, the combination of PPO with low pressure can become a potential fumigant for replacement of MB for quarantine purposes where rapid disinfestation of the nuts is essential.

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