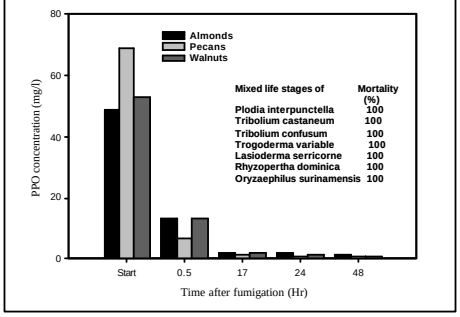
SORPTION AND INSECT TOXICITY OF PROPYLENE OXIDE IN DRIED FRUITS AND NUTS

J.L. Zettler[1]*, P.L. Hartsell[2], J.S. Muhareb[2], R.F. Gill[1], J.M. Hurley[2], and D.B. Allred[2]
[1]USDA, ARS, Parlier, CA 93648
[2]California Dried Fruit Association, Fresno, CA 93707

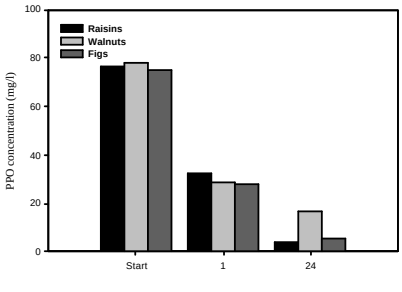
Dried fruits and nuts were fumigated with a mixture of propylene oxide (PPO) and carbon dioxide (8%:92% w/w) in 28.42-liter chambers to determine PPO sorption rates in dried fruits and nuts and PPO's toxic effects on a variety of postharvest insect pests. A 48 hr fumigation using a dose of 45 mg/l at 38^{B}C resulted in more than 97% sorption in almonds, pecans and walnuts. This fumigation protocol produced 100% mortality of mixed life stages of the following insects: Indianmeal moth, *Plodia interpunctella* (Hubner); red flour beetle, *Tribolium castaneum* (Herbst); confused flour beetle, *T. confusum* Jacqueline du Val; warehouse beetle, *Trogoderma variable* Ballion; cigarette beetle, *Lasioderma serricorne* (F.); lesser grain borer, *Rhyzopertha dominica* (F); and sawtooth grain beetle, *Oryzaephilus surinamensis* (L.) (Fig. 1). The 48 hr fumigations resulted in PPO residues in the nuts that were below the established tolerance of 300 ppm. Following aeration for three days, the residues fell to non detectable levels

Fig. 1. Concentrations of PPO during 48 hr fumigations of almonds, pecans, and walnuts at 38 °C and normal atmospheric pressure



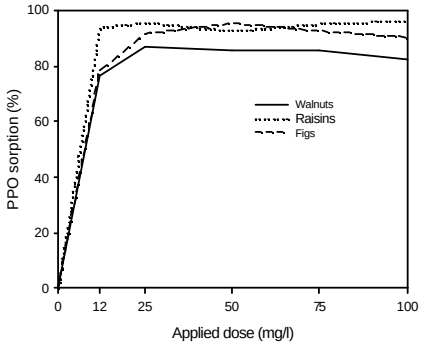
A 24 hr fumigation of walnuts, raisins and figs infested with *P. interpunctella, T. variable* and dried fruit beetle, *Carpophilus hemipterus* (L.), using a dose of 75 mg/l at 26.7^{B}C, resulted in 78, 95, and 93% sorption, respectively (Fig. 2) but failed to provide complete mortality of the insects. Larvae and pupae of *P. interpunctella* survived a dose of 12 mg/l, eggs of *T. variable* survived 12 mg/l while its pupae survived 62 mg/l, and larvae of *C. hemipterus* survived 5 mg/l. Susceptibility to PPO of these insects ranged as follows: *C. hemipterus* > *P. interpunctella* > *T. variable.*

Fig. 2. Concentrations of PPO during 24 hour fumigations in walnuts, raisins and figs at 26.7°C and normal atmospheric pressure



The rates of PPO sorption into walnuts, raisins and figs were independent of dose (Fig. 3). There was little or no difference in sorption at any of the five application rates from 12.5 mg/l to 100 mg/l.

Figure 3. Effects of applied dose on sorption of PPO in dried fruit and nuts



In summary, the PPO:CO2 mixture was effective in controlling postharvest insect pests when used at a dose rate of 45 mg/l, a temperature of 38^{B}C and a 48 hour exposure period. It is likely that the sterilizing fumigations presently used on processed commodities are insecticidal against postharvest insects. Sorption was significant and rapid in dried fruits and nuts, and was independent of dose. Residues were below the tolerance of 300 ppm, and they aerated quickly to nondetectable levels within 3 days. Finally, reducing exposure times to 24 hours and the temperature to 26.7^{B}C allowed low levels of survival in some test insects. Based on the doses of PPO at which survival occurred, the susceptibility ranged: *C. hemipterus* > *P. interpunctella* > *T. variable*. Further developmental work is warranted to more accurately define the effects of PPO sorption on insect toxicity.