TITLE: Electron beam source irradiation as an alternative quarantine treatment for sweet cherries

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REPORTING PERIOD: Terminating Report

The current treatment for the disinfestation of cherries involves fumigation with methyl bromide. Methyl bromide has been identified by the EPA as an ozone depletor. It is most likely the production and use of this chemical will be banned by the year 2000. The potential of the loss of methyl bromide is of great concern for the cherry export market. In 1994, over 1.7 million boxes of cherries from the U.S. were shipped to Japan for an estimated value of $42 million dollars. This level of trade will be jeopardized if a suitable alternative quarantine treatment is not found.

Gamma irradiation has been used to sterilize insects and is a proposed alternative for methyl bromide quarantine treatments. The major problem in the use of gamma radiation as a treatment is consumer acceptance. However, medical technology has developed non-source irradiators, which generate gamma radiation from an electrical source. Therefore, there is no radioactive waste to be disposed of or continuing contaminating source on site. Most phytotoxicity and insect sterility data have been obtained from irradiation with source irradiators. It is necessary to find if electron-beam irradiators can deliver and effective dose for insect sterility while maintaining fruit quality.

RESULTS:

ENTOMOLOGY:

A report from Dr. J. Nation at the University of Florida indicated that irradiated Caribbean Fruit Flies can be differentiated from non-irradiated flies by a simple freeze/thaw test. He showed that the levels of phenoloxidase were greatly reduced in treated insects and that this was reflected by a reduced ability to melanize following freezing. He proposed that this method may be applicable for determination of irradiation treatment for all insects since phenoloxidase is a common hemolymph component.

We tested the theory that changes in phenoloxidase could be detected in irradiated codling moth. We treated fifth instar codling moth at 0, 100, 300, 600, and 900 Gy and tested levels of phenoloxidase at 0, 2, 4 and 6 days following treatment. The freeze/thaw experiment along with protein electrophoreses, dot blot and enzyme activity analyses were performed.

Freeze/thaw: There was a general trend for the irradiated insects to show a decreased rate of melanization. It was more noticeable with increasing days following treatment. However, there was great variation in the rates and were greatly affected by prior damage incurred by the insect during extraction from the diet medium and also by any disease present. We found this method too unreliable to be of any use for the determination of irradiated codling moth.

Protein Electrophoresis: We observed 3 major isoforms of phenoloxidase in the hemolymph of untreated fifth instars of codling moth. No change in the isoforms were observed on day 0 of the treatments. Slight and inconsistent changes in the banding pattern were observed over subsequent days following treatment. These changes were too inconsistent and unreliable to use as a method for determination of irradiation treatment.

Protein Dot Blot: Diluted samples of fresh hemolymph were transferred to nitrocellulose membrane and reacted against a phenoloxidase reagent. There were variable differences in reactivity of phenoloxidase in relation to irradiation treatment.

Specific Enzyme Activity: We tested the phenoloxidase activity and protein content in fifth instar codling moth to obtain a base line and standard deviations. When radiation treated insects phenoloxidase values are compared against the base line and standard deviation of untreated controls, there were no significant differences observed.

HORTICULTURE:
Bing and Rainier sweet cherries were obtained from commercial sources after handling and packing, the day of harvest in 1994 and 1995. Cherries were divided immediately into groups of 2.5 kg and packed into boxes with liners. The boxed cherries were packed in Coleman coolers containing gel refrigerant and a temperature recorder. Boxed cherries were shipped overnight express to the Florida Dept. of Agriculture and Consumer Services, Irradiation Research Facility, Gainesville FL (1994) or the Iowa State University, Irradiation Research Facility, Ames IA (1995) for treatment. Irradiation treatments (0, 150, 300, 600 and 900 Gys) were performed using the linear accelerator at each of these facilities. After treatment the cherries were returned overnight express to the Tree Fruit Research Laboratory, Wenatchee, WA and stored at 1°C. Quality evaluations on the cherries were determined before shipment, immediately after return, after 7 days and 14 days of storage. The time required for shipment and treatment did not exceed 3 days and temperatures in the coolers did not exceed 10°C.

Eakin (1985) reported that control of codling moth on Bing cherries can be achieved with a radiation dose of only 250 Gy and cherry fruit fly can be controlled with a dose of only 150 Gy. In this study quality losses were not evident in Bing or Rainier sweet cherries with radiation doses up to 300 Gy. At a dose rate above 600 Gy there was a definite loss in firmness and a change in fruit color of Bing cherries. Rainier cherries also displayed a similar loss in firmness, but firmness loss was initiated at a lower dose rate (above 300 Gy). A color difference was also evident for Rainier cherries at or above 300 Gy. This change in color for Rainier cherries was evident to the human eye at a radiation dose level of 900 Gy. No change in Bing cherry stem color was present due to radiation dose level, but Rainier cherry stems displayed color differences above 300 Gy. Visual color of Rainier cherry stems improved as radiation dose rates increased. As irradiation dose increased there was a loss in titratable acidity, for Rainier cherries, particularly at the 900 Gy dose. No fruit defects were present for Bing cherries at the radiation dose levels considered, but increased defects at the highest radiation dose (900 Gy) were present in Rainier cherries.

Consideration radiation levels necessary for quarantine control (<500 Gy) and the lack of quality loss in Bing and Rainier cherries at 500 Gy and less, these two cherry cultivars are good candidates for quarantine treatment using the linear accelerator as the source of radiation. Quality loss in irradiated sweet cherries is small particularly when one considers that the more conventional means of disinfestation (Methyl bromide) can result in considerable loss.

As a result of these studies we will petition the Animal Plant and Health Inspections Service to accept 300 Gy as a quarantine treatment for codling moth on sweet cherries without future research.

PUBLICATIONS:

Neven, L. G. 1995. Biochemical determinants of irradiation in codling moth. International Research Conference on Methyl Bromide Alternatives and Emissions Reductions (submitted).

Drake, S. R. and L. G. Neven. Influence of electron beam irradiation on sweet cherry quality. International Research Conference on Methyl Bromide Alternatives and Emissions Reduction (submitted).