IRRADIATION DISINFESTATION OF DRIED FRUITS AND NUTS

Judy A. Johnson

The United States dried fruit and nut industry is located primarily in California, where virtually all of the nation's raisins, walnuts, almonds, and prunes are produced. The annual production of dried fruits and nuts in California exceeds 1 million tons, worth over $2 billion after processing. Postharvest insects cause product loss conservatively estimated at $96 million each year. Control of postharvest insects for dried fruits and nuts has been dependent on the use of methyl bromide and phosphine fumigants. Various toxicological, environmental, and regulatory concerns and the development of resistance in target pest populations have made the future availability of fumigants uncertain. For this reason, non-chemical control methods have been examined as potential alternatives. In 1984-85, a multi-disciplinary research project on the use of irradiation as a disinfestation method for dried fruits and nuts was conducted through the cooperation of several governmental agencies, universities, and industry groups. This report summarizes the results of the project.

Objectives The goal of the study was to investigate the technical and economic potential of irradiation as a substitute for fumigation for the dried fruit and nut industry. With the information generated, individual industries could make preliminary and objective appraisals of the feasibility and potential application of irradiation as a commodity treatment. Specific objectives included:

- *Efficacy:* Determine effect of radiation on the survival, reproduction and feeding of major insect pests of dried fruits and nuts.
- *Quality:* Determine effect of efficacious radiation doses on quality of dried fruits and nuts.
- *Economics and Engineering:* Compare cost of radiation with current practices and other alternatives, identifying relevant economic, logistical and engineering factors.

Methodology Selected target commodities, almonds, walnuts, raisins and prunes, were considered to be representative of the dried fruit and nut industry. Pistachios were also included in organoleptic studies. Target insects were codling moth (*Cydia pomonella*), navel orangeworm (*Ameylois transitella*), Indianmeal moth (*Plodia interpunctella*), and the driedfruit beetle (*Carpophilus hemipterus*). Radiation doses in all studies were below the FDA guidelines of 1 kGy (100 krads). Trained taste panels were used to evaluate the effect of radiation on product quality. Product was evaluated immediately after irradiation and throughout a period of accelerated storage (at 32.2°C) equivalent to one year. Economic studies compared the cost effectiveness of irradiation with current fumigation practices and alternative technologies such as modified atmospheres and/or refrigeration. Scenarios were considered that included the use of irradiation both with and without fumigation. Factors such as plant size, site location, processing plant integration, capital costs and operating costs, and processing rates were included. Combining irradiation with other control measures and multiple irradiation treatments were also considered

Results

Efficacy: Generally, radiation was efficacious in disinfesting almonds, walnuts, raisins, and prunes of codling moth, Indianmeal moth, navel orangeworm and driedfruit beetle at a dose of 300 Gy or less (about 1/3 the maximum allowed dose). Although the average longevity of irradiated larvae was significantly increased, they were unable to complete development and feeding damage was reduced. Pupae irradiated at this dose were unable to reproduce as adults. The extended life span of treated larvae may allow treated commodities to reach the consumer with live insects present. Irradiation was shown to be a potentially useful quarantine treatment for codling moth in walnuts.

Product Quality: No differences were noted between irradiated product and untreated controls for any of the commodities tested at any of the doses used (≤ 900 Gy) immediately after treatment. With the exception of walnuts irradiated at ≥600 Gy, all commodities remained acceptable throughout storage (up to 90 days at 32.2°C). Changes in walnut taste after radiation were due primarily to an increase in rancidity. Significant flavor damage was considered unlikely at the levels recommended for insect disinfestation.

Economics and Engineering: One or more technically feasible application points for irradiation were found in the processing of each commodity considered. The most promising points were the disinfestation of newly harvested almonds and walnuts as they are received at large processing plants, and the pre-shipment disinfestation of finished goods at the largest plants. The overriding problem with irradiation was the high fixed cost (estimated at greater than $500,000 per year) of owning and operating even the smallest commercial irradiation facilities. Irradiator use corresponding to existing processor insect control needs is, in each case, at too low a volume and/or too seasonal to make current technology irradiation costs competitive with alternative physical controls such as modified atmospheres. Even if the most efficient size irradiator is operated at full capacity, the cost of irradiation far exceeds the cost of current chemical treatments.

Conclusions: Although radiation treatments of dried fruits and nuts proved to be an efficacious method of reducing insect damage and preventing reinfestation without affecting product quality, the method was not economically competitive with either the current chemical methods or proposed alternative methods. The major problems of irradiation were as follows:

- Regulations may not allow commodities to be irradiated more than once, limiting the usefulness of the treatment during storage.
- Irradiated insects did not die immediately after treatment, increasing the chance of consumers finding live insects in the product.
- High building and maintenance costs for irradiators put them out of reach of most individual processors; use of large irradiators by several processors or commodity groups would increase the cost of handling product.

Radiation was found to have potential use in certain areas within the dried fruit and nut area, especially as a quarantine treatment for codling moth in walnuts.