IRRADIATION AS A QUARANTINE TREATMENT OF TROPICAL FRUITS

James H. Moy
University of Hawaii
Honolulu, HI 96822

Lyle Wong
Dept. of Agriculture, State of Hawaii
Honolulu, HI 96814

Quarantine Problems in the Tropical and Subtropical Regions

Most of the tropical fruits grown in Hawaii and other tropical and subtropical regions are under USDA quarantine due to their infestation by a number of pests such as fruit flies, mites, aphids, etc. Unless it can be proven that these fruits are grown in a fruit fly-free zone, an approved quarantine treatment procedure must be applied to the commodity before they can be shipped to markets in non-infested areas, such as the U.S. continent. Over the years, the quarantine restriction in Hawaii has limited crop development and export marketing of some attractive, delicious tropical fruits because farmers were not sure of the return on their efforts and investment.

Past and Present Quarantine Treatments Procedures Used in Hawaii

Since 1953, postharvest fumigation with ethylene dibromide (EDB) has been used as the main quarantine treatment procedure for Hawaii grown papayas and other plant materials except pineapple of the *Smooth Cayenne* variety which is not a host to fruit flies. Methyl bromide was tested on some tropical fruits. But the papaya packers used EDB preferentially probably because of a difference in host tolerance to these two chemicals. EDB was canceled by the Environmental Protection Agency in September, 1984 on the ground of its potential carcinogenicity to humans. Shortly before the EDB ban, the papaya industry scrambled for an alternative quarantine treatment. Available alternatives were thermal, or cold treatment, or irradiation. An international conference on Radiation Disinfestation of Food and Agricultural Products was held in November, 1983 to provide a forum to present up-to-date information to the industry and to discuss all aspects of irradiation as a disinfestation technique Meanwhile, USDA researchers in Hawaii developed the double-dip hot water treatment which the papaya packers adopted (42 deg C/30 min, then 49 deg C/20 min). Technical and quality problems of the double-dip method caused considerable loss of sales of exported papayas. Packers gradually changed over to a refined vapor heat treatment which requires heating papayas with 90-100% R.H. air to 47.2 deg C in 4 to 6 hrs. Also developed was the High Temperature Forced Air (HTFA), also known as dry heat treatment, by researchers at USDA-Hilo and the University of Hawaii at Manoa. Studies showed that 5 to 10%, and sometimes more, of the HIFA- treated papayas developed lumpy texture in the fruits. Scalding of the vapor heat treated fruits have been observed. Currently, four papaya packers on the Island of Hawaii use the vapor heat method while those on the Island of Kauai are using the dry heat method.

Technical Feasibility of Using Irradiation as a Quarantine Treatment Method

The technical feasibility and effectiveness of disinfesting various tropical fruits and vegetables by gamma-radiation have been demonstrated by studies conducted around the world in the past three-and-a-half decades. Researchers at USDA-Hawaii and the University of Hawaii were particularly interested in understanding all aspects of using gamma-radiation as a quarantine treatment because of the pest problem mentioned above. Scientific and government literature have been available on regulations,

radiation technology, facilities, product quality, economics, marketing, consumer acceptance, and safety of irradiated foods. There are three concepts of using irradiation as a quarantine treatment of plant foods that might be infested by fruit flies: (1) Sterility of any stages of a fruit fly treated can be achieved with 0.15 kGy; (2) Quarantine security level of probit-9 (less than 32 survivors in one million original units treated) can be achieved at 0.26 kGy; and (3) Egg mortality (100%) would result at dose level of 0.40 to 0.70 kGy (based on a study on 35 different fruits). USDA-APHIS since January, 1989 has approved irradiation of Hawaii grown papayas as a quarantine treatment at a minimal dose of 0.15 kGy.

Interest in Adopting Irradiation as a Quarantine Treatment of Hawaiian Fruits

Recent decline in pineapple and sugar production in Hawaii has resulted in many acres of good agricultural land becoming available for diversified agriculture. If the marketing question can be answered, it would greatly help interested farmers decide what to plant. The marketing question relates to having available an efficacious (effective and efficient) quarantine treatment method for these commodities. While thermal treatment is a workable quarantine procedure, it is commodity-specific, meaning different time-temperature regimes have to be developed for different products. On the other hand, the irradiation dosage to be used for quarantine treatment is generic and sufficiently low to preserve product quality without affecting ripening, thus allowing a broad-range of products to be treated.

Recent Shipping, Irradiation, and Marketing Activities

Air shipping, irradiation, and marketing of papayas and lychees were conducted in April and June of 1995 to gather technical data and gain experience in using irradiation as a quarantine treatment of Hawaiian commodities. Special permits were issued by the Animal Plant Health Inspection Service (APHIS) of USDA to allow shipments of untreated, but inspected, fruits from Honolulu to Chicago. Fruits were treated at a pilot irradiator in Morton Grove, IL at a minimum dose of 0.25 kGy, then sent to a nearby produce market called Carrot Top for marketing. Some of the papayas treated in June were also sent to stores in Toledo, OH for marketing. Signs were displayed to inform consumers about the irradiated fruits, as per U.S. FDA regulations. Sales were very good, indicating a high degree of consumer acceptance of irradiated fruits.

Lessons and Outlook

These recent activities have shown that: (1) Irradiation is an effective and efficient quarantine treatment of fruits. It is a good alternative to chemical fumigation (i.e., EDB and MB), and to thermal treatments. In a commercial irradiator facility, treatment time of cartons of fruits on a conveyer is envisioned to be less than 30 min. (2) Quality control is very important. Papayas should be about one-quarter ripe before irradiation. Dosimetry and product pallet configuration should be optimized to give as narrow a dose range on target fruits as possible. (3) Consumer eduction to explain the safety and purpose of irradiation is highly desirable. Some demonstration and sampling to familiarize the consumers with an unfamiliar fruit would also be highly desirable.
To allow other tropical fruits grown in Hawaii to be irradiated, USDA-ARS and USDA-APHIS are working on a rule amendment to set a generic dose of 0.25 kGy for quarantine control of fruit flies on tropical fruits, and possibly other plant foods and ornamentals.