

## EXPORTING WITHOUT METHYL BROMIDE

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In 1992, methyl bromide (MeBr) was listed as an ozone-depleting substance at the 4th Meeting of the Parties to the Montreal Protocol on *Substances that Deplete the Ozone Layer*. Developed countries were required to freeze production and importation of MeBr in 1994 at the 1991 levels and to reduce the use by 25% in 1999, 50% in 2001, 70% in 2003, and 100% in 2005. Developing countries were required to freeze consumption and production of MeBr by 2002, reduce it by 20% in 2005 and phase out by 2015. Exemptions exist for postharvest quarantine treatments under both the US Clean Air Act and the Montreal Protocol; however, it is expected that MeBr will become more expensive and difficult to source as the soil and structural uses are lost.

Hence, much effort has been made to find alternatives for MeBr. Treatments designed for fruits exported to Japan are particularly impacted. Japan has strict requirements for developing replacement treatments: tests must show no or little commodity damage; efficacy tests must be conducted on the least susceptible life stage and must show complete mortality on 30,000 treated individuals of the pest, followed by another demonstration with 10,000 individuals before a quarantine officer from Japan. The most likely replacement treatments that can reach this level of efficacy would be a type of temperature procedure, using either heat or cold.

A new developing technology is to use radio frequency (RF). RF has many manufacturing applications, but only recently has it been evaluated for postharvest disinfestation. Radio waves and microwaves are shorter than visible light, and they function by causing molecules to vibrate. Furthermore, when exposed to a range of electromagnetic frequencies, insect pests have been found to have more dielectric loss than their host commodity and that this increases exponentially as the waves become longer. This results in differential heating with the pest hotter than the commodity, particularly when exposed to energy in the RF range. Another advantage to heating by radio waves is that the whole fruit can be quickly heated at the same time rather than slowly by conduction, as in surface heating. Fruit quality seems to be retained better with RF than with other heat treatments. Predictive models can be developed for RF treatments from pest mortality and fruit quality data over time series at specific hold temperatures. The advantages of RF are: quick, effective against a wide range of pests, low fruit damage, continuous on-line treatment, commercially available, reduced safety and environmental concerns, and comparable in cost to current methods.

The controlled atmospheres temperature-times system (CATTS) is another new technology involving thermal treatments, but in low oxygen environments. Typically, nitrogen or carbon dioxide replace free oxygen in a heat chamber. This method is more efficient than heating under normal atmospheric conditions.

Hot water baths are an old technology. These treatments can be effective against surface pests. Surfactants and other additives can be included to increase efficacy. Also, the baths can be used in conjunction with other treatments, such as ultrasound.

Cold storage is another old technology. If time is not a factor, this method can be used against internal pests. Also, controlled atmospheres can be integrated to increase treatment efficacy.

Irradiation is also an old technology that has shown efficacy. The advantages are: fast, little phytotoxic effects at < 900 Gy, can be used on packaged fruits, no chemical residues, no change in taste, and reduced postharvest storage concerns. The disadvantages are: public acceptance, country acceptance for exports, transportation to central treatment site, cost, need for continuous operation, and possible inability to treat fruit in modified atmosphere packaging (MAP) because of ozone production.

Perhaps the most compatible method for quarantine security is the use of the Systems Approach. Here, the accumulated effect of the entire process assures no pests present in the commodity. Systems Approach can involve current procedures or incorporate any combination of the previously described treatments.

The Systems Approach starts in the field. It is essential to determine the host status of a particular commodity for the targeted pest. Life history data from laboratory and field studies can demonstrate host susceptibility. Field surveys indicate the presence of the pest in orchards. Pest control practices are also important and affect the infestation levels of the commodity at the packinghouse. Furthermore, operations within the packinghouse eliminate potentially infested fruits. In addition to any of the previously mentioned treatments, normal culling procedures are also very effective in reducing pests in product. Finally, strict inspections can validate that the fruits are free of pests.

Risk analysis quantifies each of the effects of the Systems Approach as applied to every pest life stage. A mathematical likelihood of possible pest establishment can be calculated. This process not only unifies all the components in reducing pests from commodities, but also provides a value of probability. Together, these procedures assure pest-free commodities without the use of MeBr.