LOW TEMPERATURE STORAGE OF FOOD AND OTHER ALTERNATIVES TO METHYL BROMIDE

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ABSTRACT

Cold treatments are predominantly used to inhibit decay of stored commodities and to extend their shelf life. Recently, cold treatments have been used successfully to control insect pests, mainly in tropical commodities, providing chilling injury can be avoided. This paper summarises the main uses of cold storage as a quarantine treatment.

Keywords: low temperature food storage, quarantine, chilling injury.

INTRODUCTION

Insects are poikilothermic animals. Their development is only possible between lower and upper temperature thresholds. Beyond these values, and depending on the time of exposure, temperature becomes lethal. Cold storage of food takes advantage of this physiological response of insects and can be a useful alternative to the use of methyl bromide (MB) as a postharvest treatment.

Low temperature storage is primarily used to inhibit decay and extend the shelf life of food commodities. Modern fresh fruit industry greatly depends on technology providing refrigerated facilities and transportation. When a combination of temperature and time of exposure exists that assures quarantine requirements (probit 9: 99.9968% mortality) (Baker 1939), and does not lead to unacceptable fruit damage, cold has a potential as a quarantine treatment, especially for those commodities where low temperature storage is used as part of the regular distribution and marketing practice.

Research on the use of low temperatures to control insect pests began at the end of the nineteenth century and expanded to cover a variety of food pests early in the twentieth century. Pests of stored products, such as the webbing clothes moth, *Tineola bisselliella* (Hummel) (Lepidoptera: Tineidae), the dark mealworm beetle, *Tenebrio obscurus* F. (Coleoptera: Tenebrionidae), or the cabinet beetle, *Trogoderma tarsalis* (Melsh) (Coleoptera: Dermestidae) were among the first to be tested (Gould 1994). Nevertheless, the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) soon atracted most of the attention. This pest was becoming established in new areas and was a serious concern for many import countries.

Cold storage was used as a quarantine treatment for the first time against *C. capitata* in Florida in 1929 (Richardson 1958). Since then, low temperature storage has been developed and successfully applied as a quarantine treatment against fruit flies (Diptera: Tephritidae) occurring mainly in temperate fruits (Table 1). A standard cold treatment against *C. capitata* requires a temperature of 2.22ºC (or below) for 16 days, and this is usually applied in transit (Anon 1992).

There are strict requirements for temperature monitoring in cold storage facilities in order to certify compliance with the required cold treatments. Cold quarantine has also been successfully applied to other insect taxa (Table 1), but problems have arisen from either the occurrence of extraordinarily cold-resistant stages (Moffit & Albano 1972), or cold habituation (Meats 1976; Czajka & Lee 1990).

Studies involving tropical fruit, such as mangoes, guavas and longans have usually resulted in unacceptable cold damage and have not been commercially used (Burditt & Balock 1985; McGuire 1998a). To prevent this kind of damage, preconditioning of fruit can be important (Hatton & Cubbenge 1982; Wild & Hood 1989; Houck *et al.* 1990; Miller *et al.* 1990; Crisosto & Smilanick 2000). Chilling injury may also be prevented by use of plant growth regulators (Ismail & Grierson 1977; McDonald *et al.* 1988), other chemical treatments resulting in curing the fruit (Schiffmann-Nadel *et al.* 1972; Wardowski *et al.* 1975; Chalutz *et al.* 1985; McDonald *et al.* 1991), and plastic wrapping (Ben-Yehoshua 1985; Yokohama *et al.* 1999b). Harvesting fruit in a less susceptible stage of ripeness can

also reduce chilling damage (Chan 1988; Crisosto & Smilanick 2000) and pest incidence in the field. Besides this, cold storage can be part of a multiple quarantine treatment including the combined use of temperature and controlled atmospheres, fumigation, or irradiation (Anon 1994; Anon 2001).

Low temperature storage has been used for a long time as a quarantine treatment, mainly for those commodities where cold storage was already part of their marketing procedure. Use of this technology should increase as research provides new ways of preventing chilling injury.

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TABLE 1: Pests and food commodities for which cold quarantine treatments are feasible.

Target pest	**Commodity**	**Country of origin**	**Observations**	**References**
Mediterranean fruit fly, *Ceratitis capitata* (Dip.: Tephritidae). Fruit flies in general.	Apple, apricot, cherry, etrog, grape, grapefruit, kiwi, loquat, lychee, nectarine, orange, passion fruit, peach, pear, persimmon, plum, pomegranate, quince, tangerine	Many (>68)		Several: Annon. 1992; Clayton 1993
Caribbean fruit fly, *Anastrepha suspensa* (Dip: Tephritidae)	Lychee Carambolas Citrus	Florida, USA Florida, USA USA	 +cold water treatment + harvesting practices	McGuire 1998b Gould & Hennessey 1997; Gould & Sharp 1991; Miller et al 1998 Benschoter, 1987
Omnivorous leafroller, *Platynota stultana* (Lep: Tortricidae); Black widow, *Lactrodectus mactans* (Araneae: Theridiidae)	Table grapes	California, USA	+SO_2	Yokohama et al. 1999a
Glassy winged sharpshooter, *Homalodisca coagulata* (Hom: Cicadellidae)	Table grape	California, USA		Scott & De Barro 2000
Hessian fly, *Mayetiola*	Hay	USA	+ harvesting,	Yokohama et al. 1999b

Target pest	Commodity	Country of origin	Observations	References
destructor (Dip: Cecidomyiidae)			handling and shipping practices	
Asian citrus psyllid, *Diaphorina citri* (Hom: Psyllidae)	Curry leaves	Florida, USA		McGuire 1999
Apple maggot, *Rhagoletis pomonella* (Dip: Tephritidae)	Apples	Canada	+ controlled atmosphere	Annon. 1994
Plum curculio, *Conotrachelus nenuphar* (Col: Curculionidae);blueberry maggot, *Rhagoletis mendax*; apple maggot, *R. pomonella*;	Apple, apricot, blueberry, cherry, hawthorne, huckleberry, nectarine, peach, pear, plum, prune, quince	USA		Stout and Roth 1983 in Gould 1994
Indianmeal moth, *Plodia interpunctella* (Lep: Pyralidae)	Dried fruits an nuts	USA		Johnson et al 1996
Codling moth, *Cydia pomonella* (Lep: Tortricidae)	Pome fruits, stone fruits and walnuts	USA	+ controlled atmosphere	Annon. 2001