DEVELOPMENT OF COMBINATION HEAT AND COLD TREATMENTS FOR POSTHARVEST CONTROL OF CODLING MOTH IN APPLES AND PEARS

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Introduction

Codling moth, Cydia pomonella (L.), is the primary pest of quarantine concern for Northwest produced apples and pears. Apples are treated with methyl bromide prior to export to Korea, Taiwan, and Japan. Currently there are no postharvest treatments for the control of codling moth in pears. A model has been developed which describes codling moth mortality in relation to the rate of heating. The effects of heating rate on apple and pear quality was determined in order to identify potential treatments which would preserve fruit quality while controlling codling moth. We will describe the heating rate model and how this relates to the development of a combination heat and cold treatment for codling moth in apples and pears.

Heating Rate Model Development:

Models were developed to describe the effects of heating rate during heat treatments on the mortality of 5th instar codling moth, Cydia pomonella (L.). An old model, developed from previous studies over a limited range of heat treatments, was first formulated. Subsequent heat treatments, using a computerized water bath system and linear heating rates of 4, 6, 8, 10, and 12°C/h at 42,44 and 46°C, were used to test the old model. The mortality data from the water bath study was used to develop a now model. Although the old model provided a good estimate of the effects of heating rate on 5th instar mortality, it overestimated mortality at mid-range heating rates. Also, the old model was awkward to use since it required a correction for each treatment temperature. The now model incorporated treatment temperature into the equation, was more accurate and easier to use. It was determined that the slower the rate of heating, the longer the exposure to the final treatment temperature was needed to achieve 95% mortality.

The working model to predict codling moth mortality as a function of heating rate was calculated to be:

$$\ln(LT_{95}) = b_o + b_1 \ln(\text{heat rate}) + b_2(\text{treatment temperature})$$

Where:

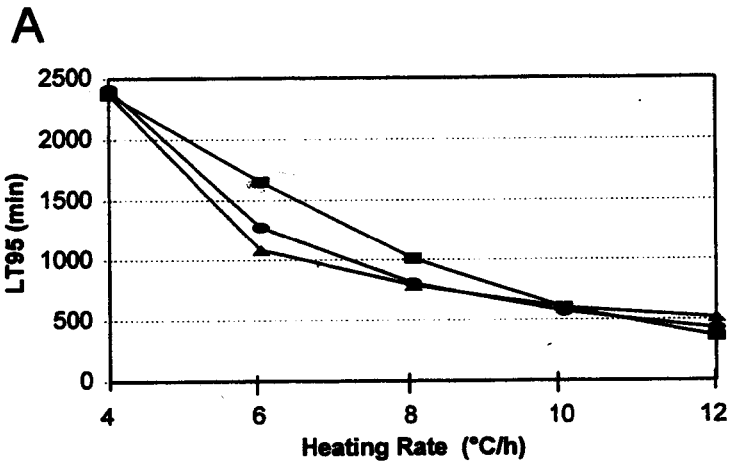
b_o 22.4462 ± 1.0486 S.E.; t 21.41; (p > t) 0.0001; ln(h)

b, -1.5745 ± 0.09844 S.E.; t -15.99, (p > t) 0.0001; ln(ht)/ln(°C/h)

b_2= -0.297036 ± 0.02339 S.E.; t = -12.70; (p.t) 0.0001; ln(h)/°C

R_2 = 0.972

Figure 1. Predicted LT_{95} values from the old model (-n-), the new model (-l-) and experimental LT_{95} from water bath studies (-s-). A=42°C, B=44°C, C=46°C.



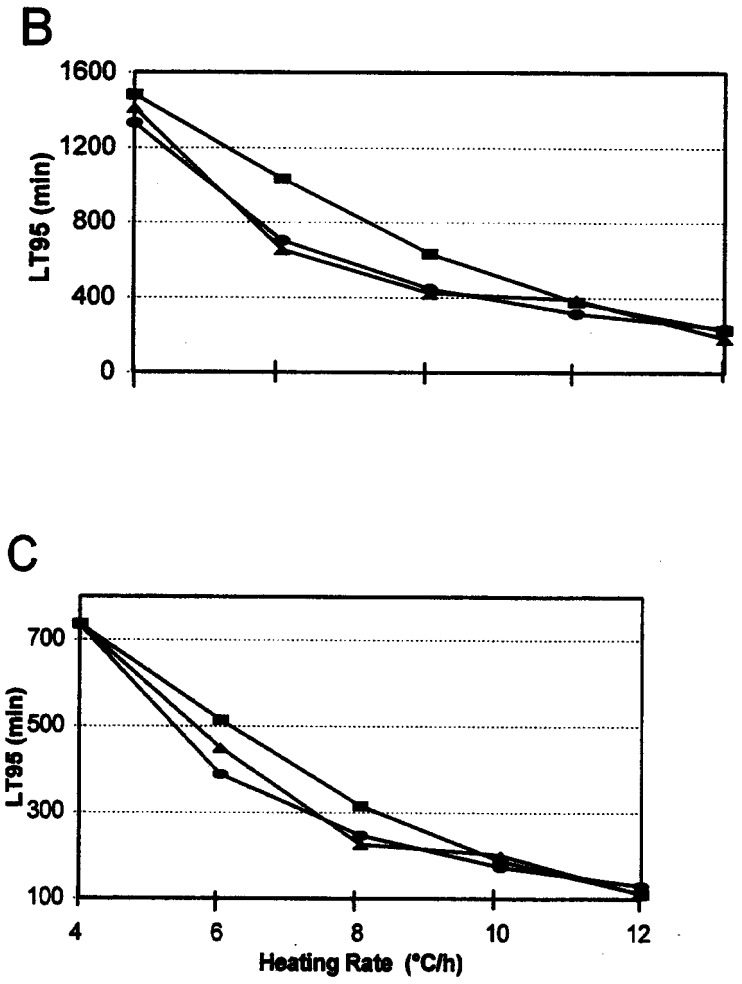
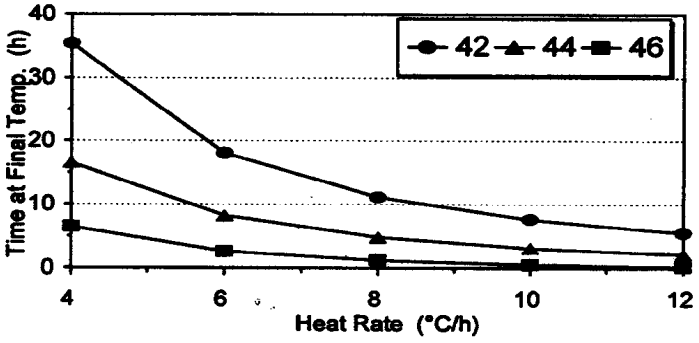


Figure 2. Relationship between the time at the final treatment temperature to achieve 95% fifth instar mortality and heating rate. 42°C (-l-) 44°C (-s-), 46°C (-n-)



Combination Cold and Controlled Atmospheres on Codling Moth Mortality:

Apples infested with 5th instar codling moth were subjected to cold storage at 2°C for 13 weeks at either regular atmospheres, CA1 (1% 0_2, 1% $C0_2$), or CA2 (1% 0_2, 3% $C0_2$). For the first 2 months, larval mortality was higher with the higher levels of $C0_2$. However, after 3 months, there were no differences in mortality between the three treatments.

Effects of Heating Rate on Fruit Quality:

Red Delicious, Golden Delicious, Granny Smith, and Fuji apples, and d'Anjou and Bosc pears were subjected to heat treatments at 44 and 46°C using heating rates of 4, 6, 8, 10, and 12°C/h directly after harvest Durations of the heat treatments were correlated to the codling mortality model. The fruit was stored at 2°C for 90 d at regular atmospheres. Firmness, titratible acidity, soluble solids, external and internal color, scald, and total quality was determined at 0 and 7 d following the cold storage period. At least one heating rate/temperature combination was determined to provide quality equal to controls for each fruit variety tested.

Table 1. Heat treatments which result in acceptable quality and provide control of codling moth larvae.

Variety	Heat Rate (°C/h)	Temp (°C)	Duration (h)
Red Delicious	8,10,12	44°C	8; 7; 4
Red Delicious	10	46°C	3.5
Golden Delicious	8,10	44°C	11; 7
Golden Delicious	10	46°C	3.5
Fuji	10,12	44°C	7; 4
Fuji	10,12	46°C	3.5; 2
Granny Smith	10,12	44°C	7; 4
Granny Smith	4, 6, 8,10,12	46°C	8; 6.5; 4; 3.5; 2
d'Anjou	4	44°C	16
d'Anjou	4,6,8,12	46°C	12; 9; 6; 2
Bosc	6,10	44°C	18; 7
Bosc	10,12	46°C	2.5; 2