MAINTAINING APPLE FRUIT QUALITY WITH CATTS DISINFESTATION TREATMENT.

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Tasmania is the only state in Australia with access for apples and cherries to Japan. In order to export these fruit to this country it is necessary for fruit to undergo a methyl bromide fumigation treatment against codling moth. This treatment, as well as being damaging to the ozone layer, has caused fruit damage in many shipments and it is desired to study alternative treatments and their impact on fruit quality.

During 2006 a series of experiments were conducted in experimental CATTS chambers to initiate studies on this treatment and its effects on apple fruit quality. The CATTS treatment utilised involved tempering fruit to 20°C for 24 hours prior to treatment and then placement in the chambers. The CO_2 in the chamber was increased to 10% and this resulted in a drop in the oxygen content, due to displacement, to 15%. For these experiments the oxygen was not further reduced as this is commercially an expensive exercise and it is desired to explore alternative methods of overcoming fruit damage. After the air was modified the chamber sealing was completed with the use of an external breather bag to allow for air expansion and contraction with the operation of the heating elements. The air temperature was then increased at 12°C / hour until it reached 47°C and this temperature was maintained until the core temperature of the fruit reached 45°C for 15 minutes. The relative humidity was maintained above 80% for the duration of the treatment by the placement of a water tray directly on top of the heating elements. After treatment the fruit were cooled using heat exchangers within the chamber at 12°C per hour until a core temperature of below 30°C. At this time the chambers were opened and fruit was exposed to fresh air and static cooling to 1°C. There were 4 chambers which operated simultaneously allowing for 5 treatments; 1) Untreated with fruit held at 20°C in air, 2) CATTS, 3,4,&5) One of the above treatment parameters varied for regression analysis. 'Fuji' fruit were harvested at commercial maturity and treated within a week. The treatments were reapplied to a new set of fruit from the same harvest after 2 months of storage at 1°C. After treatment the fruit were held at 1°C for 5 weeks to simulate shipment to Japan and then allowed to stand at 20°C for 4 days prior to assessment for skin greasiness, skin discolouration, surface rots, internal browning and firmness (stored fruit). A total of 15 fruit were used in each CATTS chambers. Variables that were studied included the rate of heating, the ultimate core temperature, the duration of the ultimate core temperature, the difference between the ultimate air temperature and target core temperature and the effect of reduced oxygen (15%) as opposed to increased CO_2.

One of the main findings of this research was that fruit damage was greatly increased in fruit that was stored prior to treatment (Table 1). It should be noted, however, that the level of internal browning in the fruit treated after harvest was still above the 2% threshold of market acceptance. The level of internal browning due to CATTS after fruit storage was totally unacceptable. The skin discolouration observed was similar to 'Fuji' stain and could also lead to claims in exported fruit. Of interest is that this skin discolouration also increased in stored untreated fruit although CATTS tended to increase its occurrence. Fruit in Tasmania is harvested in April and typically shipped to Japan in July, after 2 months of storage. Hence this treatment is not commercially acceptable in its current form.

The remaining results only concern fruit stored prior to treatment. Other than internal browning, the only other fruit parameter measured affected by CATTS treatment was fruit greasiness where it was reduced (on a 0-10 score) from 2.4 to 1.0. It should be noted that a score of 1.5 or lower is commercially acceptable while a score above this may lead to market claims. In this case CATTS treatment provided a positive effect on fruit quality.

It was found that increasing the duration that the core was at 45C° increased the percentage of fruit with internal browning while a duration of greater than 50 minutes caused massive damage levels (Figure 1). Increasing the air temperature from 47°C to 49°C appeared to lower the incidence of damage although this is probably due to the quicker treatment time (Figure 2). No increase in skin damage was noted with this temperature indicating that higher air temperature might be a useful treatment to reduce internal browning with the CATTS treatment.

Increasing core temperature from 44 to 45°C is associated with a large increase in the level of internal browning, although even at 45°C the level is above market acceptance (Figure 3). It was also found that fruit should be either heated slowly (5C°/hr) or quickly (40°C/Hr) with the high rate of heating providing no internal browning problems (Figure 4). This data suggests that if fruit is graded and packed into boxes and forced draft heating is applied at 40°C / hr a commercially acceptable outcome could be achieved. Of interest is that fruit that underwent this treatment also were observed to be a superior shade of red. A further advantage of this treatment is a short treatment duration providing efficient use of capital infrastructure. The data for lowered oxygen (not presented) showed that the internal browning observed with CATTS treatment was due to lack of oxygen and not due to carbon dioxide injury.

These trials were intended to obtain a broad picture on the treatment. Further research is needed to verify the results and in particular those relating to the rate of heating and increased air temperature response. There is also an indication in the data that the impact of elevated oxygen on CATTS damage of fruit should be studied further. Commercially the impact of treating stored fruit with an initial core temperature of 1°C should be studied as tempering fruit to 20°C prior to treatment is an expensive exercise. Studies also need to be undertaken on the rate of post treatment cooling. The data suggests that a commercially feasible treatment for stored apple fruit may be developed without the need to lower oxygen to 1%.

Table 1. Effect of CATTS treatment on freshly harvest or stored 'Fuji' apple

	Skin discolouration %	Internal Browning %
Freshly harvested	0.4	3.76
Stored fruit	11.9	63.11
Significance	*	**

* and ** significant 'T' at p = 0.05 and 0.01 respectively

Figure 1. The effect of Ultimate core temperature duration on internal browning of 'Fuji' apple due to CATTS treatment.

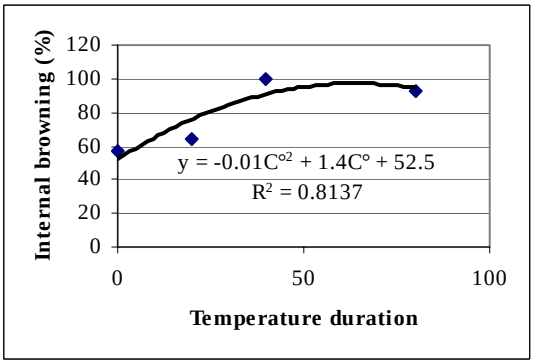

Figure 2. The effect of the air temperature above the ultimate desired core temperature (45°C) on internal browning of 'Fuji' apple due to CATTS treatment.

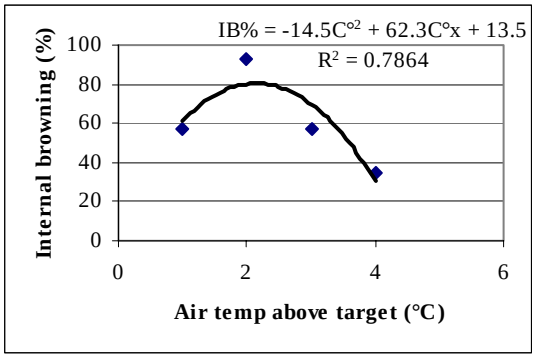

Figure 3. The effect of ultimate core temperature on level of internal browning OF ‘Fuji’ apples due to CATTS treatment.

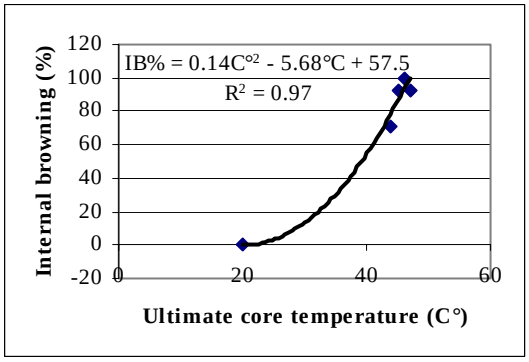

Figure 4. The effect of rate of heating on level of internal browning OF ‘Fuji’ apples due to CATTS treatment.