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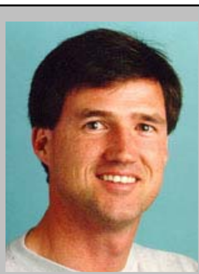

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Turn up the heat: using heat to control pathogens

Peter Taverner
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There is an interest by some Australian citrus packers in using heat to destroy pathogens. The concept of using heat to control pathogens has been around for a long time and is widely used in many industries, ie, pasteurization. The increased interest to use physical treatments, such as heat, has accelerated with consumer resistance and fungicide resistance (overseas) to postharvest chemicals. Despite considerable research efforts, the use of heat directly on fresh citrus has not been adopted in Australian citrus packingsheds. This is primarily because much of the early research involved immersing fruit for several minutes, which is not a very appealing prospect for large commercial packers. However, the concern with chemicals continues to grow and this impetus has resulted in some innovative approaches to using heat on citrus.

An important development has been the 'hybrid' use of fungicides in the hot water. The problem with immersing fruit in hot water was that the temperatures by time combinations to control pathogens were often very near the threshold to damage the fruit. The 'hybrid' approach was to add fungicides to water that were heated to lower, but safer, operating temperatures. It proved to have some very tangible benefits. For instance, it was possible to drastically reduce fungicide concentrations in heated water and still achieve effective decay control.

Why is this so? An indication can be found in the amount of fungicide deposited in the fruit. A number of studies have shown that higher fungicide residues are deposited in fruit when they are applied in heated water. For example, increasing the temperature of dip solutions from 32.2^{0}C to 43.3^{0}C (by 5.6^{0}C) increased imazalil residues by 1.5 to 2 times (Smilinick *et al.*,

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The phytotoxic effects of quaternary ammonium compounds

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Figures 1-5 -
1. No injury
2. Slight discolouration
3. Slight necrosis
4. Moderate injury
5. Severe injury

Several years ago researchers from the University of Florida conducted a study into the phytotoxic effects of quaternary ammonium compounds (quats). They examined the extent of rind injury on grapefruit and discovered that direct contact with grapefruit surfaces could cause injury. They also found that residues of quats, when redissolved on wet fruit, from condensation, could cause damage to fruit surfaces (University of Florida Packer Newsletter, 192)

We wanted to examine the phytotoxic effect of quats on Navel oranges when fruit was exposed as dry fruit on wet treated surfaces or as moist fruit on dry, treated surfaces. Fruit surfaces were examined for peel injury after fruit was exposed to treated surfaces for 5days at 22°C and high humidity.

We tested three commercially available quats: Cidal® (Castle Chemicals), Deccosan 315® (Decco) and Blended B33 (Woblea). Peel injury was rated on a scale of 1-5 where 1=no injury, 5=severe injury (see figures 1-5). Quats were tested at 3 different rates 500ppm, 1000ppm and 5000ppm.

Results showed that damage on fruit caused by quaternary ammonium compounds was greater when dry fruit was exposed to wet surfaces. The most severe damage occurring on fruit that was exposed to plates dipped in 5000ppm of quats, (see Figure 1). The damage was less severe when the quats were used at lower rates of 500ppm and the plates were allowed to dry before being exposed to fruit. No damage was observed on fruit placed on petri dishes treated with water.

Packers can minimize the risk to fruit by the following:

- Use quats at 500ppm or below – this is the recommended rate for most commercially available quats
- Rinse the bins with potable water after quat treatment. (Best to treat with the quat then leave overnight and rinse the following day before picking)
- Allow time for bins to dry before placing fruit in them

Other sanitisers such as chlorine at 200ppm (pH 6-7.5) can also be used, however they do not have the same residual protection as quats. Packers will have to consider the sanitation needs of their shed before deciding on the best method for sanitising bins. ❇

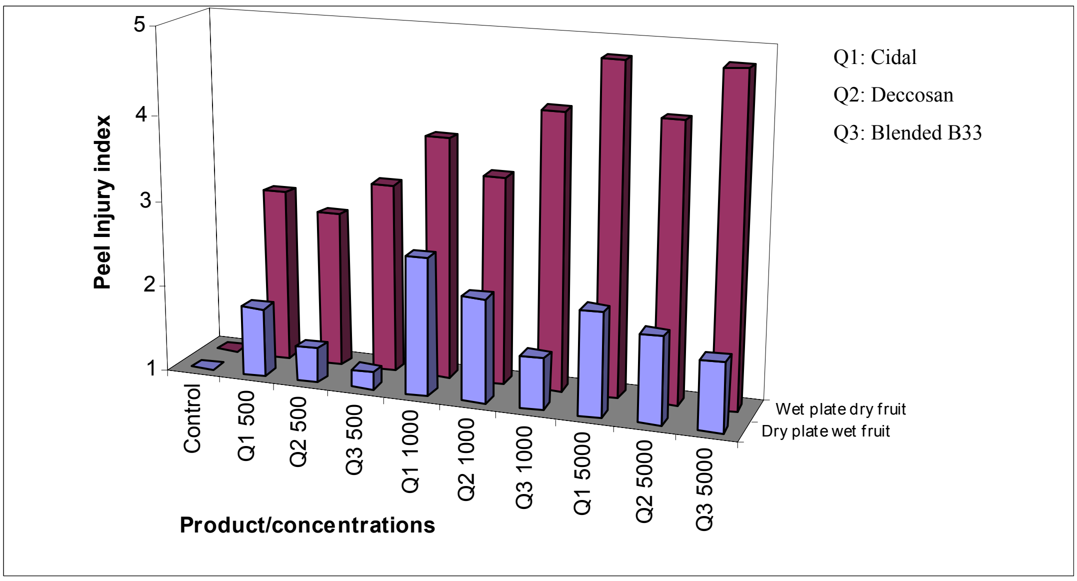

Figure1:

Graph showing peel injury on Navel oranges after exposure to wet and dry petri dishes

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1997). Given this result, it is not surprising that low concentrations of fungicide in heated water result in similar residues to higher residues in ambient water temperatures (20⁰C).

Hang on! Wait a minute! Laboratories have ambient temperatures of 20⁰C! The winter mornings in inland Australia during Navel packing season are well below 20⁰C and the water temperatures are correspondingly low. If high temperature leads to higher deposits, then do low temperature result to lower deposits? Does a low water temperature mean that we are creating very unfavorable conditions for applying our fungicides?

We really don't know the answer to these questions, but experience suggests that we are doing OK. Fruit testing shows that we are still able to achieve reasonable residues on fruit in winter without excessive fungicide concentrations or exposure periods. We haven't systematically studied residue accumulation at low temperatures, but perhaps, it needs to be investigated.

Unfortunately, many chemical sanitizers are not compatible with fungicides, but heat may provide the answer. Many overseas packinghouses heat their fungicide solutions to 71⁰C for a period overnight to sanitise the solution.

One reason we can still achieve reasonable residues may be that we are putting cold fruit in cold water. In other words, the effect of water temperature may not be as important as the temperature differential between the water and fruit. I would like to use a related example to explain this better. In food safety, it is considered a risk when fruit is immersed or washed in water warmer (by > 5⁰C) than fruit. A difference in temperature between the water and fruit causes a 'deficit vacuum'. Simply stated; this means that the water 'wants to equalise' temperatures by moving from hot to cold. Large temperature differences can result in heated water preferentially flowing into small cavities and wounds on the colder fruit surface. The risk is that pathogenic microbes will also be carried into the wound with the water. If we substitute fungicide for microbes, the risk becomes a valuable asset. When postharvest researchers think of fungicide application; 'coverage' is a by-word for 'success'. This effect could yield the sort of fungicide coverage that packer's dream of at night (Well! If they don't, maybe they should).

This example reminds us of another issue. It is important to remember that the addition of the fungicide does not remove the risk of microbial contamination. Postharvest fungicides do not control human health pathogens. In addition, some export markets do not allow guazatine and sour rot spores can accumulate in re-circulated fungicide solutions. The heated solution, or more specifically, the temperature differential, increases the risk of contamination. Re-circulated and heated fungicide solutions need to be sanitized.

Unfortunately, many chemical sanitizers are not compatible with fungicides, but heat may provide the answer. Many overseas packinghouses heat their fungicide solutions to 71⁰C for a period overnight to sanitise the solution. The solution cools before the next morning and can be used at ambient or elevated temperatures (40-46⁰C for mature fruit) during packing. A concern of using high temperatures to sanitise a fungicide solution is the potential to degrade the fungicide over time. It would be prudent to discuss with the manufacturer of the fungicide the potential of the fungicide to degrade during exposure to repeated high temperatures.

The use of heated water with fungicides does present a means to improve the residue on fruit. However, it is important to remember that the fungicide residue of fruit depends on various factors, including concentration, duration of treatment, method of treatment (dip, low volume spray, high volume flood or combined with wax), cultivar and fruit maturity. The potential for decay control will be dependent on coverage as much as total residues on fruit.

The use of heated fungicide solutions can offer some additional benefits. The heated fruit makes it easier to

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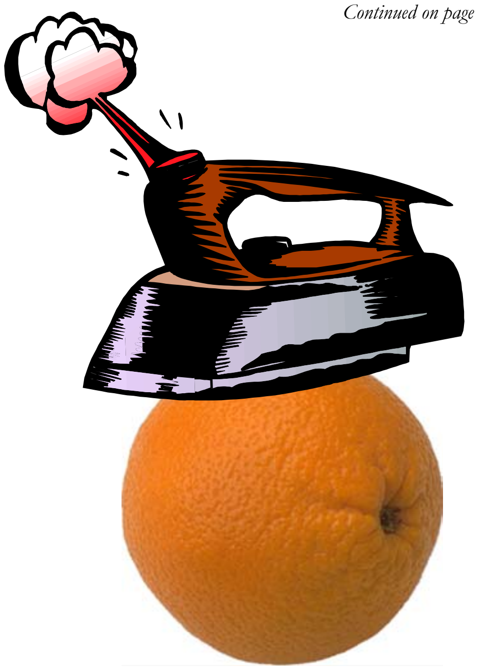

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dry before washing and can result in a superior shine. It allows a lower concentration of fungicide to be used in solution, which is environmentally and economically advantageous because it means less fungicide is dumped with the wastewater. The reduction in solution concentration still maintains the same chemical residue in fruit. This is a good outcome for the packer, but not all the chemical concerns of the consumer have been addressed. To move on to the next step, we must seriously consider 'chemical-free' packing.

Many researchers have looked at using curing and hot water treatments to control postharvest decay, but the Israeli researchers seem to be more passionate than most about reducing our reliance on chemical fungicides. Fallik et al. (1999) reported a novel method of rinsing and disinfecting fruit and vegetables with hot water and brushes (Israeli patent 116965). The technique involves rapid rinsing of fruit with sprays of hot water (62^{0}C for 20 seconds) as they move along sets of brushes. The system has been adopted in various fruit and vegetable washing plants (240 commercial units) (Lurie, 2003) and some organic citrus packing houses in Israel (Porat R. et al., 2000).

The claims made for heat, including hot water brushing, are numerous. Not surprisingly, it can remove of a large proportion of surface pathogens (up to log 4 reduction) and temporarily inhibiting the growth of survivors. Sufficient heat melts the surface waxes sealing cracks that may serve as future entry points for pathogens. There are also very interesting reactions occurring beneath the surface of the fruit. After heat treatment, the presence of pathogens in wounds can induce a defense response in the fruit. It seems likely that the response involves a multiple array of defensive processes. Unfortunately, the response appears to be transient and a combination of all these mechanisms can only provide relatively short-term protection from pathogens.

Another interesting benefit of heat appears to be an increased resistance to chilling injury. The benefits of curing (Grierson, 2002; Hatton and Cubbedge, 1982) and hot water dips (Wild and Hood, 1989) in reducing chilling injury in various cultivars have been known for some time. However, benefits have been attributed to shorter exposures of heat, such as with hot water brushing.

Overall, organic or 'chemical-free' citrus packers may consider hot water brushing a significant advance, particularly for supplying close markets. However, for most packers it still remains tantilisingly short of wide commercial viability, and reminds us of our fragile reliance on a few very effective chemical fungicides. ✽

References

Cabras et al. (1999) Factors affecting imazalil and thiabendazole uptake and persistence in citrus fruits following dip treatments. Journal of Agricultural and Food Chemistry. ***47****, 3352.*

Fallik et al. (1999) A unique rapid hot water treatment to improve storage quality of sweet pepper. Postharvest Biology and Technology. ***15****,25.*

Grierson (2002) A brief history of Florida chilling injury research. Procceedings of the Florida State Horticultural Society ***115****, 41.*

Hatton and Cubbedge (1983) Temperature for prestorage conditioning on Marsh grapefruit to prevent chilling injury at low temperature. HortScience. ***18****, 721.*

Lurie (2003) A hot water brush machine to improve decay control and fruit quality. Presentation at the 25th Annual Citrus Postharvest Pest Control Conference, Santa Barbara, CA. Internet source: www.ucextension.net/ns/phpc/ on June 2003.

Nafussi et al. 2001 Mode of action of hot-water dip in reducing decay of lemon fruit. Journal of Agricultural and Food Chemistry. ***49****, 107.*

Porat et al. (2000) Reduction of postharvest decay in organic citrus fruit by short hot water brushing treatment Postharvest Biology and Technology. ***18****, 151.*

Schirra et al. (1997) Effect of heated solutions on decay control and residues of imazalil in lemons. Journal of Agricultural and Food Chemistry. ***45****, 4127.*

Smilinick et al. (1997) Improved control of green mould of citrus with imazalil in warm water compared with its use in wax. Plant Disease. ***81****, 1299*

Wild and Hood (1989) hot dip treatments reducing chilling indury in long-term storage of Valencia oranges. HortScience. ***24****, 109.*

Got a postharvest problem? Who do you call?

Peter Taverner
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During a recent citrus postharvest meeting, people were lamenting the lack of a directory of citrus postharvest researchers – A list of people you can contact if have a certain type of problem. For many years, everyone just contacted two people - Barry Tugwell and Brian Wild. Times move on, as have Barry and Brian, and, perhaps, we do need to identify existing and potential contributors to the citrus postharvest scene. I will begin with some current researchers in citrus and related postharvest researchers. If you feel aggrieved because you are not on this list; please let me know.

- Ken Bevington (NSW Agriculture, Dareton) [ken.bevington@agric.nsw.gov.au] has a wealth of citrus research experience and is supervising a large project predominantly looking at on-orchard influences on postharvest fruit quality, such as GA spray timing. Ken is interested in feedback from packers on rind breakdown problems. The program has many research directions, but is often referred to as 'the rind quality project'.
- Steven Falivene (NSW Ag, Dareton) [steven.falivene@agric.nsw.gov.au] is a citrus extension specialist involved in the rind quality project. Steve provides an excellent 'rind quality' seasonal update on the Australian Citrus Growers Inc. website at www.austcitrus.org.au/season
- Michael Treeby (CSIRO, Merbein) [Michael.Treeby@csiro.au] is also involved in the rind quality project, and with Katina Lindhout, a PhD student, is looking a number of aspects, including developing tools to predict rind aging. Michael is also supervising work on the physiology of rind breakdown in citrus, and has extensive knowledge on albedo breakdown.
- Mark Gibberd (CSIRO, Merbein) [Mark.Gibberd@csiro.au] is involved in projects to optimize the quality of citrus for Asian markets. He is involved with CSIRO's Agrifood top five 'flagship' program and the Australian Center for Food and Health. Mark is interested in modeling quality parameters in citrus, such as nutritional value, for marketing purposes. Robert Henriod (CSIRO,Merbein) is conducting research on chilling injury in citrus.
- Jim Hill (PIRSA, Rural Solutions) is a postharvest consultant [Hill.Jim@saugov.sa.gov.au] with a broad practical knowledge in packingshed operations. He has more recently been involved in developing quality management systems, packingline impact assessment (instumented sphere), and posthavest oil application and monitoring.
- NSW Agriculture has recently increased the size of its Postharvest and Market Access Group at Gosford. Two new members of the team working on a range of commodities are Suzie Newman, a postharvest physiologist [suzie.newman@agric.nsw.gov.au] and Elena Lazar, a postharvest pathologist [Elena.lazar@agric.nsw.gov.au]. Andrew Jessup [Andrew.Jessup@agric.nsw.gov.au] is a long-standing disinfestation scientist. He has implemented and verified many disinfestations protocols, particularly for fruit fly in citrus.
- Ed Hamacek (QDPI) [ed.hamacek@dpi.qld.gov.au] is an important member of the team involved in area wide management of fruit fly in Central Burnett.
- Andrew Miles [Andrew.miles@dpi.qld.gov.au] works for QDPI as a pathologist. He is interested in pre-harvest management of postharvest diseases, particularly black spot in citrus. Andrew will soon be working a project for the Macadamia industry, but maintains an interest in citrus.
- Robert Holmes is postharvest pathology and disinfestation leader at Knoxfield IHD, Victoria. They are currently involved in market access and food safety issues for a range of fruits and vegetables.
- Peter Taverner [taverner.peter@saugov.sa.gov.au] supervises a citrus postharvest research and extension program at SARDI. The areas of research are diverse and include food safety issues, fungicide compatibility, evaluation of new products, and systems approaches for surface pest disinfestations (eg oil and high pressure washes). Peter also deals with a wide range of issues as the editor of the Packer Newsletter. Nancy Cunningham [cunningham.nancy@saugov.as.gov.au] has expertise in microbiology, food safety and fungicides compatibility issues. She also conducts microbiological surveys of packingsheds and practical sanitation workshops for packingshed staff.