Improving the quality and consistency of Australian cherries to ensure market access

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Technical Summary

Two surveys of cherry fruit quality were conducted during the 2010/11 and 2011/12 seasons in selected representative retail stores in Sydney and Adelaide. Fruit quality was assessed using the same quality criteria at both the Gosford Primary Industries Institute (NSW) and at the South Australian Research and Development Institute (SA). Fruit quality was assessed by determining the percentage of rots, fruit defects and overall consumer acceptability. On a sub-sample of fruit; the condition of the stem, fruit colour ('Australian Cherry Colour Chart'), fruit size, stem pull force, fruit firmness (FirmTech), TSS (total soluble solids) and TA (titratable acidity) were also measured.

An over-riding observation was the high level of unacceptable fruit on the market in both seasons. The average level of unacceptable fruit (as determined by defects and rots, rather than consumer taste testing) across both seasons was 11%. In the 2010/11 season, this level of unacceptable fruit was consistent across the entire season, whilst in the 2011/12 season there were some lines with very high levels of unacceptable fruit and many good quality lines. This was assessed from 50 fruit subsamples of each fruit sample purchased from each store. The main reasons for the unacceptable fruit were pitting, bruising and rots. These three reasons accounted for over ⅔ of all the major defects observed across both seasons. Similarly, pitting and bruising were also responsible for ⅔ of the level of minor defects. These levels of defects are well above the acceptable limits of defects and need to be addressed. Some poor out-turns were followed back through the supply chain and these issues were rectified.

The identification of pitting, bruising and rots as the most important quality issues at the retail level was not entirely surprising as these defect types are not readily identified or removed during the packing process. In addition, these defects frequently develop or progress after the fruit has been packed. A preliminary packing line survey of seven different cherry packing lines was conducted in NSW and SA in the 2011/12 season. Fruit from different sampling points from the orchard to the packed box were sampled and stored to assess for defects. The results of this preliminary survey showed there were key points in the packing line which require attention to minimise these defects. The cluster cutter and the final sorting / packing line were significant areas which need improvement. Although impact damage is a significant factor in pitting, more work is required to quantify this and identify other factors which need to be managed to improve fruit quality to the consumer.

In general, the level of fruit sugars (TSS) in the 2010/11 season was low and reflected the poor growing season. However in the 2011/12 season, fruit TSS was improved. Fruit TSS content of 15°Brix or higher is generally satisfactory for consumer acceptability and this limit is often a commercial standard. The results of the 2010/11 survey showed that although the average of all TSS measurements was 15°Brix, 54% of fruit samples had an average TSS of less than 15°Brix. However there were some sweeter lines of fruit sampled during the season. In the 2011/12

season, only 19% of all samples were less that the 15°Brix. However inconsistent eating experiences, such as those caused by low and inconsistent TSS fruit will have significant impacts on consumer acceptability and repeat purchases of cherries.

The addition of a one week storage period at 5ºC on selected fruit from NSW in the 2010/11 season showed a significant increase in the levels of unacceptable fruit following storage. In this study, the average level of unacceptable fruit increased three fold following storage. The progression of storage rots was the main contributor to the increase in unacceptable fruit when fruit was stored after purchase from the retailer. Pitting and bruising were also significant major and minor defects across the entire season at purchase and during storage. Indeed, these three defects (major and minor) accounted for over 87% of all defects across the season and during storage.

Observations in the retail store showed that significant deterioration in product quality does occur while the fruit is on retail display. The most obvious and consistent difference between samples observed out of the cool room (freshly delivered) and from the retail display was in stem quality, specifically stem browning. Stems of fruit sampled from the retail display were browner and appeared dehydrated compared to fruit sampled from the cool room. In addition, fruit bruising at the retail level was also a significant issue which needs to be addressed. Less obvious differences occurred in the firmness, colour and size of fruit. Observations in this survey indicate that factors prior to fruit being placed on retail display are more important for these quality parameters than changes that are occurring once fruit is placed on display. However the significant deterioration in stem condition warrants addressing at the retail level.

A series of stem quality experiments were conducted and showed that the storage and display environments have a significant effect on stem condition. Storage environments with low relative humidity, high air flow rates around the fruit and higher temperatures significantly result in browner and less fresh stems. The use of packaging to optimise fruit quality was assessed in a preliminary trial and showed the benefits of packaging, especially in the higher display temperature environments. The potential use of edible coatings and films was assessed and show some promise to maintain stem quality and minimise water loss.

Different types of retail display in supermarket and a small independent fruit and vegetable store were quantified and showed that there where large variants in temperature and relative humidity in the display which can impact on fruit quality. It was also found that it is important not to assume the static conditions of the retail display as large changes in temperature and relative humidity were observed over the day. The specialised refrigerated table was the best display presentation as it maintained low display temperatures and high relative humidities around the fruit.

The quality issues identified require additional investigation to facilitate improvement and highlight the challenges of meeting consumer expectations consistently, including during periods of peak volume and unfavourable growing conditions.

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Improving cold treatment for disinfesting cherries for QFF

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Technical Summary

Market access is the most crucial issue for the Australian cherry industry. The presence of Queensland fruit fly (*Bactrocera tryoni* (Froggatt)) (QFF) in the major production areas is a constraint to marketing on domestic and international markets. In addition, the uses of postharvest fumigants such as methyl bromide as quarantine treatments are becoming restricted and non-chemical options are required. The use of a postharvest disinfestation cold treatment to kill QFF works well and is widely used and accepted, but the time in cold treatment is too long and limits marketing, particularly when cherries are a very perishable product with a short storage / market life. This project examined the potential of alternative postharvest disinfestation methods to improve the efficacy of cold treatment. Cold treatment is very effective in killing QFF larvae, but its effectiveness can be enhanced with other postharvest treatments. The use of combination treatments such as the pre-storage use of high CO_2 treatment and application of Vapormate^{TM} were assessed in combination with cold treatment.

The results demonstrated the effectiveness of high CO_2 treatment at low temperatures to reduce the time in cold disinfestation. The optimum treatment time was 2-3 days of high CO_2 treatment at the beginning of the cold treatment could significantly reduce the time in cold disinfestation for cherries against QFF.

The practicalities of the use of high CO_2 combination treatment as a potential disinfestation protocol will rely on its integration into existing supply chains. The current practice of handling and marketing cherries relies on the use of modified atmosphere bags. This project examined the effects of high CO_2 treatment on the effectiveness of the combination treatment on QFF mortality and fruit quality with the use of commercial MA bags. The results show that there was rapid loss of CO_2 from the MA bag following treatment with 95% CO_2 treatment, whereby within 5 days of treatment, there was no difference between the CO_2 treated MA bags and with MA with the passive generation by 5 days storage at 3^{o}C. Although the high CO_2 levels leaked from the MA bags during the early stages of treatment, the efficacy of the high CO_2 treatment on QFF mortality was greater than the non - CO_2 treatments. In addition, the results showed that there were no differences in quality between the untreated control fruit and the CO_2 treated fruit after storage and there were no difference in fruit quality between the different MA bag treatment combinations.

This research also demonstrated that the effectiveness of the high CO_2 treatment was due to the high CO_2 (95%CO_2 with 4%N_2 and 1%O_2), rather than the low O_2 (1%O_2). The results of this single experiment showed that the 95% CO_2 treatment resulted in 100% mortality of the QFF larvae by 6 days of cold storage, whereas in the fruit treated with 1% O_2 with N_2 or air, complete mortality of the QFF larvae was reached at the 10 day assessment. A parallel study of fruit quality after storage at 3^{o}C showed there were no differences in fruit quality, including flavour and off-flavours, between the different low O_2 treatments.

The current cold treatment for disinfestation of QFF in cherry fruit utilises 1°C or 3°C, however commercial refrigeration technology now allows 0°C disinfestation treatments to be routinely conducted. A series of experiments showed that 0°C cold disinfestation resulted in higher levels of QFF mortality and quicker disinfestation times to reach 100% mortality. The lower cold treatment did not adversely affect fruit quality.

Ethyl formate is registered in Australia as Vapormate™ for use in stored grains and horticulture and is formulated in CO_2 (containing 16.7% by weight ethyl formate). Vapormate™ has been trialled on mainly surface insects, however there is little information on its efficacy against QFF larvae within cherry fruit and its effects on fruit quality. A pilot trial showed that the Vapormate™ treatment was effective at killing first instar QFF in cherry fruit and its efficacy was improved with cold treatment. However the application of the commercial formation of Vapormate™ to the experimental treatment drums was problematic due to the inherent problems of using a small scale vaporiser. Another disinfestation experiment applied ethyl formate in CO_2 (equivalent to Vapormate™ treatment) against QFF in cherry fruit and the results showed no difference in QFF mortality between the ethyl formate (in CO_2) and the untreated control. However the major issue of Vapormate™ treatment was the negative effect of Vapormate™ treatment to stem condition, where all stems turned brown and were unacceptable. Although the levels of Vapormate™ within each treatment drum were not measured in this fruit quality assessment, the universal appearance of unacceptable stems in both Vapormate™ treatment concentrations (240 and 420 g ethyl formate per m^3) raises some critical issues for the use of Vapormate™ as a disinfestation treatment in cherry fruit.

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