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**INFLUENCE OF TEMPERATURE MANAGEMENT
DEFICIENCIES DURING POSTHARVEST ON THE
QUALITY OF SEA EXPORTED BLUEBERRIES**

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ABSTRACT

After harvest, fresh blueberries deteriorate rapidly due to fungal decay and softening. Postharvest softening is a major problem for the export industry, although the mechanisms for this softening are not completely understood. In order maintain product quality during the postharvest chain, blueberries need to be rapidly stored at the optimal temperature (0°C) and relative humidity (RH) (90-95%). However, rapid cooling is inhibited by the requirement of packing the product at an intermediary temperature (10 °C). Subsequently during marine export, blueberries are often shipped in reefer containers which are set up at the optimal temperature. Nevertheless, it is not known whether temperature heterogeneity within containers (4°C around the set point) constitutes an important factor affecting quality at the market place. Controlled atmosphere (CA) (8-15% CO₂ combined with O₂ > 1%) is also used in sea exported blueberries as a complementary technology to delay pathogen development, although is not clear what O₂ concentration range delivers the best quality benefits. This thesis investigated the impact of cooling delays and temperature heterogeneity during shipping on the final quality of sea exported highbush and rabbiteye blueberries, as well as the interactions of these factors with CA. In addition, the influence of moisture loss on blueberry softening was investigated as a way to improve the current understanding of this quality defect.

Cooling delays of 12 and 24 h at 10°C, simulating the packing process, were found to impact the quality of blueberries after a subsequent storage period of 6 weeks at 0°C. A delay of at least 12 h considerably increased the total moisture loss of blueberries over 6 weeks storage. However, the incidence of rotten fruit over the period of coolstorage was not affected by delays in cooling at 10°C. Considering that decay is the main factor limiting blueberry postharvest life, this result may place less relevance on accelerating the packing process despite its effect on fruit moisture loss.

A laboratory recreation of temperature heterogeneity of 4°C around the set point, as reported for reefer containers, was shown to affect the quality of blueberries by the end of a coolstorage period. Compared to optimal storage conditions, commercially packed blueberries subjected to 4°C considerably increased (up to 20 fold) the

incidence of rots after 6 weeks storage. Furthermore, this variability of 4°C led to slightly increased moisture loss from blueberries during simulated shipping. This result suggests that environments used during shipping of blueberries should minimise temperature variations below 4°C in order to improve blueberry quality.

A flow-through system was utilised to simulate 3 different storage atmospheres (2.5% O₂ + 10% CO₂, 20% O₂ + 10% CO₂ and air) and assess the effect on blueberry quality during 6 weeks of storage, confirming that CA comprising increased CO₂ concentration provides a clear effect in reducing blueberry decay incidence during storage. In addition, CA was found to slightly improve firmness retention during storage, although this benefit was not large enough to suggest a commercial impact. Moreover, increased O₂ concentrations were able to alleviate the high CO₂-induced softening during storage. The effect of CA on decreasing rot incidence was attributed to the influence of CO₂ on pathogen growth, with no benefits achieved by reducing O₂ concentration. This indicates that the export industry may benefit from improved quality outcomes and lower CA operational costs if O₂ is maintained around 20% and CO₂ increased within recommended ranges.

The gas composition of storage atmosphere influenced the impact of temperature variability within shipping containers on blueberry quality. Controlled atmosphere comprising 10% CO₂ in combination 2.5 or 20% O₂ substantially reduced by up to 50% the effect of temperature on blueberry rot incidence during storage. In contrast, atmosphere composition did not alter the effects of cooling delays on blueberry quality. Therefore, CA seems to provide a valuable protection against temperature deficiencies that occur during marine export.

Finally, an independent experiment was conducted to test the existence of a causal relationship between moisture loss and postharvest firmness for blueberries. Storage conditions were controlled so only the extent of moisture loss varied between treatments. Opposing firmness outcomes were obtained under different weight loss ranges, in addition to a high correlation between both parameters. Furthermore, different water loss patterns for firming and softening were suggested as observed in MRI analysis. This result provides evidence that fruit moisture loss plays a major role in determining firmness responses of blueberries.

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