The Effect of Calcium Applications on Kiwifruit Quality Preservation during Storage

Antunes M D C\(^1\), Neves N\(^2\), Curado F\(^2\), Rodrigues S\(^3\), Franco J\(^4\), Panagopoulos T\(^1\)
\(^1\) Universidade do Algarve, F.E.R.N., Campus de Gambelas, 8000-117 FARO, PORTUGAL. Email: mantunes@ualg.pt
\(^2\) Direcção Regional de Agricultura da Beira Litoral, Av. Fernão de Magalhães, 465, 3001-955 Coimbra, Portugal.
\(^3\) KIWICOOP - Cooperativa Frutícola da Bairrada, C.R.L., Malhapão, Oiã, 3770 Oliveira do Bairro, Portugal.
\(^4\) Escola Superior Agrária de Coimbra, Bencanta, 3040 316 Coimbra, Portugal.

Abstract

It is well known that calcium increase the storage capacity of many fruits. This study investigated the effect of foliar calcium application, as well as postharvest application on the storage behaviour of kiwifruits cv. ´Hayward’.

Three applications of 0.03% CaCl\(_2\) or CaO were made in June, July and September. After harvest half of the fruits from the sprayed vines were dipped in a solution of 2% CaCl\(_2\); the other half did not have any treatment. All fruit were then stored at 0°C and relative humidity of about 90-95%.

Foliar application of CaCl\(_2\) appeared to be more effective in keeping fruit quality through storage than CaO. Kiwifruit dipped in 2% CaCl\(_2\) postharvest maintained higher firmness through storage than undipped fruit mainly in large sized fruits, but soluble solids content was not affected.

Keywords: Kiwifruit, storage, calcium, firmness, soluble solids content.

1. Introduction

It is well known that calcium play a significant role in maintaining quality in a number of different fruits (Hopkirk, et al., 1990). The pre and postharvest application of calcium salts has been used successfully in many fresh fruits to reduce loss of firmness and to slow down the ripening process (Souty et al., 1995). Calcium alters intracellular and extracellular processes which retard ripening exemplified by lower rates of colour change, softening, CO\(_2\) and ethylene production, increase in sugar, and a reduction in total acid content (Conway, 1987).

Kiwifruit can be air-stored for 4 to 6 months at 0°C, although extensive softening will occur (Antunes and Sfakiotakis, 2002). Removal of ethylene from storage rooms is important. Freshly harvested kiwifruit soften rapidly to around 2kgf during the first 2 months at 0°C, after which they soften slowly (Antunes and Sfakiotakis, 1997). Retaining and controlling postharvest kiwifruit ripening is of a great commercial importance to be able to feed continuously the market.

Gerasopoulos et al. (1994) and Xie et al. (2003) reported the benefit of preharvest calcium chloride and calcium chelate application on retaining kiwifruit firmness through storage. Postharvest dipping kiwifruit on calcium solutions was also reported (Hopkirk, et al., 1990; Antunes et al., 2005).
The objective of the present work was to study the effect of calcium preharvest application in two different forms (CaCl\(_2\) and CaO) and CaCl\(_2\) application postharvest on the quality preservation of ‘Hayward’ kiwifruit during storage.

2. Material and methods

Kiwifruit vines (cv. Hayward) grown in an orchard in Northwest Portugal were sprayed with 0.03% CaCl\(_2\) (Antistip) or 0.03% CaO (Chelal) at one, three and four months before harvest. Control did not have any treatment.

Fruits were harvested in the first half of November and immediately transferred to a storage room at 0°C. After 15 days, fruits free of defects were selected and separated according to predetermined sizes: 65-74, 75-84, 85-104 and >104g. Then, half fruits from each calibre were dipped for 2 min in a solution of 2% CaCl\(_2\), left to dry and stored at 0°C. The other half was stored at the same temperature without any treatment.

Treatments were identified as follow: Treatment 1 = control (no Ca spraying); Treatment 2 = kiwifruit sprayed with 0.03% CaCl\(_2\); Treatment 3 = kiwifruit sprayed with 0.03% CaO; Treatment 4 = Kiwifruit without any Ca spraying + dipping in 2% CaCl\(_2\) postharvest; Treatment 5 = Kiwifruit sprayed with 0.03% CaCl\(_2\) + dipping in 2% CaCl\(_2\) postharvest; Treatment 6 = Kiwifruit sprayed with 0.03% CaO + dipping in 2% CaCl\(_2\) postharvest.

Ten fruits per replication were removed from storage at intervals of 15, 60, 120, and 180 days, for measurements of flesh firmness and SSC.

Flesh firmness was recorded by puncture with a Chatillon penetrometer (John Chatillon & Sons, Inc. U.S.A) fitted with a flat-8mm diameter tip. The tip was inserted after skin removal, at the fruit equator, in opposite sides, to a depth of 7mm. The SSC were measured using a digital Atago refractometer (model PR1-Atago Co. LTD, Japan) in juice from the equatorial zone of the fruit. Weight loss was calculated as a percentage of the initial fruit weight.

Statistical analyses were made with a SPSS computer program. Two-way analyses of variance (ANOVA) and Duncan’s Multiple-Range Tests (P<0.05) for comparisons between treatments over time were conducted.

3. Results

There were no significant differences among treatments in marketable fruit production (Fig. 1). Yield was significantly higher for kiwifruits of 85-104 g, so those were the ones used to present in this paper.

The SSC increased mostly in the first 60 days storage, and remained almost constant thereafter for all treatments (Fig. 2). Kiwifruit did not show significant differences in SSC among treatments till 180 days of storage. At the end of the storage period kiwifruits dipped in 2% CaCl\(_2\) postharvest showed slightly lower SSC.

Kiwifruit softened though storage (Fig. 3). There were not significant differences in kiwifruit firmness among treatments at harvest. Through storage was noticeable that fruits dipped in 2% CaCl\(_2\) retained more their firmness. The benefit of kiwifruit calcium dipping on retaining firmness was higher after 180 days storage.
4. Discussion

It has been reported that calcium application pre and postharvest in fruit tissues, delays softening rate and ripening, by retarding the loss of disintegration of cell walls (Roy et al., 1994).

In the present work the marketable production was not affected by treatments. Also we found not important differences in ripening parameters among kiwifruit commercial sizes.

There was not a statistical significant effect on keeping fruit firmness through storage by the application on the vine of 0.03% CaO or 0.03% CaCl\textsubscript{2}. Antunes et al. (2005) reported that kiwifruit with the same treatment were slightly more firm than control fruits. Gerasopoulos et al. (1996) found higher firmness through storage in fruits sprayed three times on the vine with 0.375% CaCl\textsubscript{2}. Xie et al. (2003) also reported a benefit on kiwifruit firmness through storage by preharvest application of 200ppm Ca-chelate. It was our aim to try the smallest recommended manufacturer concentrations for Chelal and Antistip, to see their effect on kiwifruit keeping quality through storage. However, it seems that is too low and their concentrations have to be increased to retard ripening of kiwifruit through storage.

Antunes et al. (2005) reported that fruits dipped in 1% CaCl\textsubscript{2} softened slower than fruits not treated. In the present research it was found a better effect in keeping fruit firmness through storage by dipping kiwifruit in 2% CaCl\textsubscript{2}. Hopkirk et al. (1999) tried concentrations from 2 to 5% with benefit on kiwifruit firmness, but found severe pitting on fruits dipped on 5% CaCl\textsubscript{2}. In our research quality was not affected by 2% CaCl\textsubscript{2} what means that this concentration can be used. It was found that the benefit on keeping firmness was better at the end of storage period what is important for the marketing of the fruits.

This work suggests that immersion of kiwifruit in 2% CaCl\textsubscript{2} postharvest benefits storage life capacity. The concentrations of 0.03% CaCl\textsubscript{2} (Antistip) or 0.03% CaO (Chelal) for kiwifruit vine spraying seem to be too low and higher concentrations should be tried.

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References


Figure 1. Marketable production of kiwifruit subjected to the treatments: T1 and T4 = control (no Ca spraying); T2 and T5 = preharvest kiwifruit spraying with 0.03% CaCl$_2$; T3 and T6 = preharvest kiwifruit spraying with 0.03% CaO.
Figure. Soluble solids content of ‘Hayward’ kiwifruit (size 85-105g) during storage at 0ºC, subjected to the treatments: Treat. 1 = control (no Ca spraying); Treat. 2 = kiwifruit sprayed with 0.03% CaCl\(_2\); Treat. 3 = kiwifruit sprayed with 0.03% CaO; Treat. 4 = Kiwifruit without any Ca spraying + dipping in 2% CaCl\(_2\) postharvest; Treat. 5 = Kiwifruit sprayed with 0.03% CaCl\(_2\) + dipping in 2% CaCl\(_2\) postharvest; Treat. 6 = Kiwifruit sprayed with 0.03% CaO + dipping in 2% CaCl\(_2\) postharvest.
Figure 3. Firmness of ‘Hayward’ kiwifruit (size 85-105g) during storage at 0°C, subjected to the treatments: Treat. 1 = control (no Ca spraying); Treat. 2 = kiwifruit sprayed with 0.03% CaCl\(_2\); Treat. 3 = kiwifruit sprayed with 0.03% CaO; Treat. 4 = Kiwifruit without any Ca spraying + dipping in 2% CaCl\(_2\) postharvest; Treat. 5 = Kiwifruit sprayed with 0.03% CaCl\(_2\) + dipping in 2% CaCl\(_2\) postharvest; Treat. 6 = Kiwifruit sprayed with 0.03% CaO + dipping in 2% CaCl\(_2\) postharvest.