Experiments on Extended Controlled Atmosphere Storage of Heidi Mango:1998

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ABSTRACT
Heidi mangoes were harvested at the recommended stage of maturation. Following the commercial packline treatment, the fruits were placed in cool-storage at 9.5C, a temperature which usually causes chilling injury. After 3 days, some of the fruits were placed under controlled atmosphere storage. Two differing atmospheres were evaluated (Atmos. A - similar CO_2 and O_2 concentrations; Atmos. B - high CO_2 and low O_2 concentration). Conventional storage and controlled atmosphere storage occurred in the same cool-storage room. After a further 18 days, all of the fruits were removed from their storage environments and were placed in a well ventilated laboratory at 20C to ripen fully. Quality evaluation was performed on a fruit when it attained the firm-ripe stage. Both atmospheres reduced the manifestation of disease. Atmos. B reduced the incidence surface scald (low temperature damage to the skin). Ground skin colouration and taste were slightly elevated by atmosphere storage. Total soluble solids content was greater following storage under Atmos. A. Differences in skin corking (russet), lenticel damage incidence, internal disorder incidence or pH in relation to treatment were not apparent. The results confirm a benefit of controlled atmosphere storage for Heidi mango.

UITTREKSEL
Heidi-mangoes is op die korrekte stadium van volwassenheid gepluk. Nadat die vrugte die pakhuisbehandeling gekry het, is dit in 'n koelkamer teen 9.5C, 'n temperatuur wat gewoonlik koueskade veroorsaak, geberg. Na drie dae is sommige vrugte in gekontroleerde atmosfeer (toestande) geberg. Twee verskillende atmosfere is getoets (Atmos. A - gelykwaardige CO_2 en O_2 konsentrasies; Atmos. B - hoog CO_2 en laag O_2 konsentrasie). Konvensionele berging en gekontroleerde atmosfeer berging het in dieselfde koelkamer voorgekom. Na 'n verdere 18 dae is al die vrugte uit hul bergingsplekke verwyder en in 'n goedgeventileerde laboratorium by 20C geplaas om ten volle ryp te word. Kwaliteitsbeoordeling is gedoen toe die vrugte in 'n ferm-rypstadium was. Beide atmosfere het die manifesstasie van siektes verminder. Atmos. B het die voorkoms van oppervlaktebrand verminder (lae temperatuur-skade aan die skil). Verkleuring en smaak is effens verhoog deur atmosferiese berging. Die totale oplosbare vaste inhoud was groter onder Atmos. A-berging. Verskille in lentiselskade, interne problem voorkoms of pH met betrekking tot behandeling was nie ynsigbaar nie. Die resultate bevestig die voordeel van gekontroleerde atmosferiese berging vir Heidi-mangoes.

INTRODUCTION

Heidi mangoes develop skin and pulp injury when placed in cool-storage for prolonged periods. The pulp becomes brown and the skin develops darkened indentations which are referred to as surface scald (Fig. 1).

In a previous study (Oosthuyse, 1997), no benefit of controlled atmosphere storage of Heidi mangoes harvested at an advanced stage of maturation was found. The out-turn of good quality fruits was generally poor. However, when fruits were harvested at the conventional maturation stage, atmosphere storage reduced the incidence of surface scald, pulp browning and internal breakdown, and enhanced shelf-life and taste. The out-turn of good quality fruits was relatively good. The fruits were stored at 12.5C.

The aim of the present study was to confirm the prior benefits of controlled atmosphere storage found, and to assess atmosphere storage at 9.5C, a temperature which usually causes surface scald.

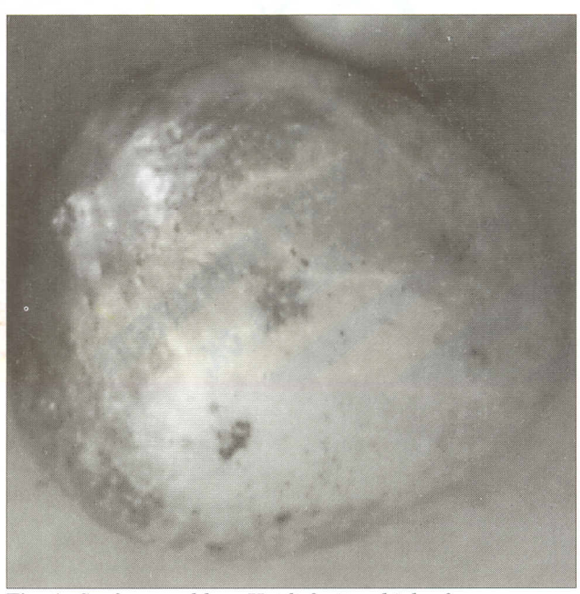

Fig. 1 *Surface scald on Heidi fruits which often occurs as a result of low temperature storage.*

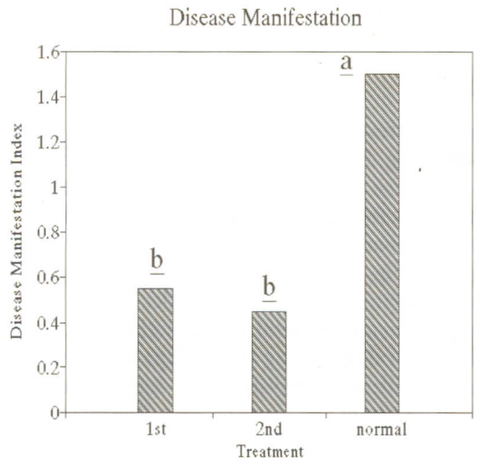

Fig. 2 *Differences in disease manifestation in relation to treatment. Bars headed by differing letters differ significantly (P<0.05).*

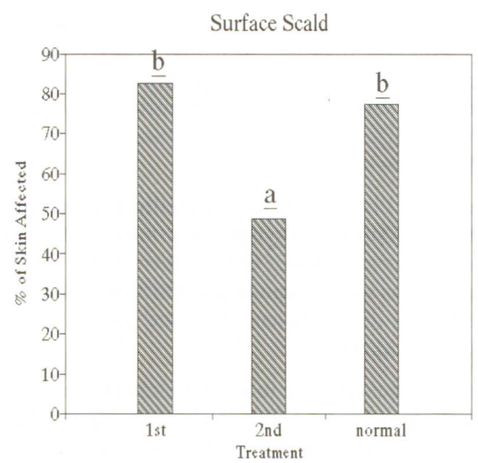

Fig. 3 *Differences in scald severity in relation to treatment. Bars headed by differing letters differ significantly*

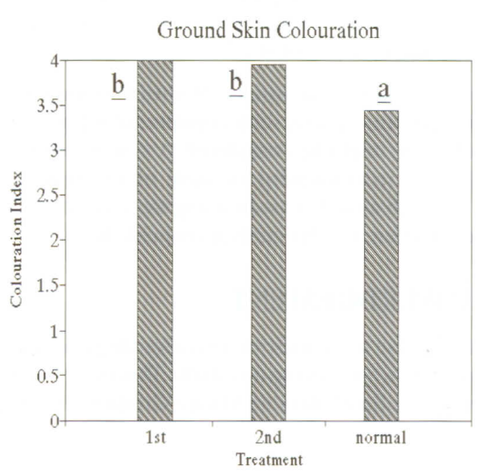

Fig. 4 *Differences in ground skin colouration in relation to treatment. Bars headed by differing letters differ significantly (P<0.05).*

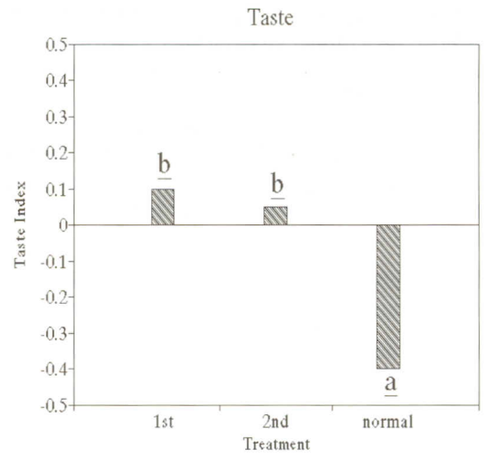

Fig. 5 *Differences in taste in relation to treatment. Bars headed by differing letters differ significantly (P<0.05).*

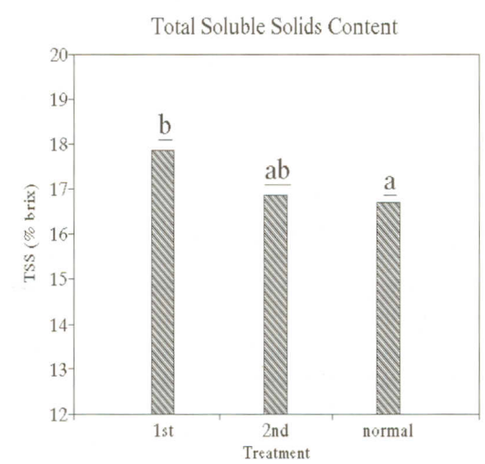

Fig. 6 *Differences in total soluble solids content in relation to treatment. Bars headed by differing letters differ significantly (P<0.05).*

MATERIALS AND METHODS

150 Heidi fruits were harvested from an orchard in the Tzaneen region. Average degree of pulp colouration was 0.2 (± 0.1; Heidi pulp colouration chart). The fruits were subjected to the commercially adopted packline treatment [fruit respectively washed in a 1% soap solution (ByProx), dipped in hot-water at 50C for 5 minutes, dipped in prochloraz (180 ml Omega/100l H_2O) for 20 seconds, and hand waxed with TAG], and were placed in cool-storage at 9.5C for three days [storage under normal atmosphere for three days prior to storage under atmosphere was done to effect commercial representation, i.e., pre-storage at a packhouse, followed by refrigerated trucking to Cape Town harbour, followed by cool-storage until ship loading when controlled atmosphere storage would commence]. After this period, 50 randomly selected fruits were placed in air containing CO_2 and O_2 at similar concentrations (Atmos. A), and 50 randomly selected fruits were placed in air containing CO_2 at a high concentration relative to that of O_2 (Atmos. B). The remaining fruits were stored in normal air (controls). All of the

fruits were placed in cool-storage [in a cool-storage room, the fruit under atmosphere being in especially designed Transfresh bins] for a further 18 days, after which they were placed, under normal atmosphere, in a well ventilated laboratory maintained at 20C (±1C) to continue ripening. During the latter period, the stage of ripening of each fruit was assessed daily with a densimeter (Heinrich Bareiss, Oberdischingen, Germany). Each fruit was evaluated when it was firm-ripe (densimeter reading of less than 60 and greater than 40).

The Completely Randomised Design, (comprising 50 single fruit replicates of three treatments), was employed.

Fruit evaluation on ripening comprised the following:

Skin corking (russet) in each fruit was rated according its severeness. A rating of 0 was given if symptoms were absent, a rating of 1 if symptoms were present but were localised to a small portion of the fruit's surface, a rating of 2 if approximately 1/3 of the fruit's surface showed symptoms, a rating of 3 if 2/3 of the fruit's surface was affected, or a rating of 4 if the entire fruit's surface was visibly affected.

Skin colour in each fruit was rated. A rating of 0 was given when signs of skin colouration were absent, a rating of 1 if a transition to a lighter green was apparent, a rating of 2 if regions of the skin had become yellow but the total area which was yellow was less than the total area which was green, a rating of 3 if regions of the skin had become yellow and the total area which was yellow exceeded the total area which was green, or a rating of 4 if the skin was completely yellow. The skin area covered with red-blush was not considered.

Disease manifestation in each fruit was rated according its severeness. A rating of 0 was given if a fruit was disease free, a rating of 1 if symptoms were present but were localised to a small portion of the fruit's surface, a rating of 2 if approximately 1/3 of the fruit's surface showed symptoms, a rating of 3 if 2/3 of the fruit's surface was affected, or a rating of 4 if the entire fruit's surface was visibly diseased.

Lenticel damage and surface scald were rated by approximating the percentage of the skin surface over which symptoms could be seen. The percentages designated were either 0, 25, 50, 75 or 100.

To assess internal quality in each fruit, each was first cut through twice; longitudinally along the flattened margins of the seed. In each fruit, juice from the cheeks thus obtained was evaluated by measuring its pH (Mettler Toledo 120 pH meter) and total soluble solids content (Euromex RF 0232 hand held refractometer), and by assessing its taste.

Taste was rated. A rating of 1 was given if taste was deemed appealing, a rating of 0 if taste was deemed satisfactory but not appealing, or a rating of -1 if taste was deemed unsatisfactory.

Physiological disorder manifestation in each fruit was rated as was disease manifestation, except that the degree to which the mesocarp as opposed to the exocarp (skin) was affected, was taken into account.

The date were subjected to non-parametric analysis of variance (Kruskal Wallis).

RESULTS

Disease manifestation was markedly reduced by atmosphere storage (Fig. 2). Storage under Atmos. B reduced the severity of surface scald (Fig. 3). No apparent effect on surface scald was found following storage under Atmos. A. Ground skin colouration was slightly elevated by atmosphere storage (Fig. 4). Taste was markedly elevated by atmosphere storage (Fig. 5). Storage under Atmos. A gave rise to a slight elevation in total soluble solids content (Fig. 6). Differences in skin corking (russet type symptom), lenticel damage incidence or physiological disorder incidence in relation to treatment were not apparent. The incidence of these disorders was acceptably low (10% of fruits affected; data not shown). Differences in pH in relation to treatment were not apparent (data not shown).

DISCUSSION AND CONCLUSION

Atmosphere storage reduced surface scald and the extent of disease manifestation, and increased skin colouration, taste, and total soluble solids content. These results are in agreement with those found in a previous study where reductions in surface scald and increases in taste were observed (Oosthuyse, 1997).

O'Hare, and Prasad (1993) specifically associated the alleviation of chilling injury symptoms to atmospheres having elevated concentrations of CO_2. In their study, reduced O_2 concentrations had no significant effect on chilling injury. The results of the current study are consistent with those of these workers.

An enhancement in taste following atmosphere storage has also been found in fig (Turk *et al.*, 1994), apple (Jankovic and Drobnjak, 1992), kiwifruit (Sawada *et al.*, 1993) and plum (Ben and Gaweda, 1992).

The fungistatic effect of controlled atmosphere storage of fruits has often been documented, and is generally ascribed to the action of the high CO_2 concentrations (Ertan *et al.*, 1990; Skrzynski, 1990; Ben-Arie *et al.*, 1991; Brash *et al.*, 1992; Sugar, *et al.*, 1994).

In view of the beneficial results obtained in storing Heidi mangoes under atmosphere, semi-commercial adoption for export to Europe might be considered. A storage temperature of 11C is recommended in view of the results of previous research aimed at ascertaining the optimum cool-storage temperature for this cultivar (unpublished).

ACKNOWLEDGEMENT

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