Institute of Food Science and Biotechnology
Chair of Plant Foodstuff Technology
Prof. Dr. habil. Dr. h. c. Reinhold Carle

Influence of selected pre- and postharvest factors on the quality and peel properties of fresh litchi fruits (*Litchi chinensis* Sonn.)

Master Thesis

in course of studies

Environmental Protection and Agricultural Food Production

Submitted by

Rini Triani

Stuttgart - Hohenheim, October 2008

This work was financially supported by the Eiselen Foundation Ulm.

6. Summary

Pericarp browning is one of the key factors affecting the quality and shelf-life of fresh litchi fruit. Browning in litchi peel occurs when cells lose their compartmentalization so that enzymes, such as polyphenoloxidases or peroxidase, can oxidize o-diphenolic compounds, whose products then polymerize to melanins. New steps for an integrated concept to stabilize the appearance and thus prolong the shelf-life of litchi fruits had been tested in this thesis.

Preharvest boron and zinc application to litchi trees via soil as well as fruit and foliar spray, was intended to achieve better litchi peel membrane stability, which was assumed to result in a delay of browning. However, according to the results of a two-week storage experiment at 5 °C, 90% RH and analyses of a broad range of outer and inner fruit quality parameters (color, firmness, total soluble solids [TSS], titratable acids [TA], moisture, relative weight loss) there was no beneficial effect found for the fruits of the treated trees compared to fruits of control trees. Moreover, spraying of the fruits and leaves with zinc formulations was assumed to cause dark spots. Nevertheless, to complete the study, data of mineral analyses have to be taken into account to assure the state of boron and zinc within the plant tissues and to find out whether these minerals had sufficiently been absorbed.

Post-harvest inhibition of browning processes in the pericarp of litchi fruits was tested in a cascaded evaluation procedure. Four subsequent screenings of browning inhibitor agents (BIs) on litchi fruits *in-vivo* were performed. Browning was evaluated based on CIELab color measurements.The red-brightness of the peel was expressed in terms of the Litchi Color Index (LCI) calculated from the L* and a* values. For a better description of color loss, LCI values were harmonized, setting the initial red-brightness as 100%.

In the first screening experiment, 11 single inhibitor agents were tested on litchis cv. Hong Huey during three weeks of fruit storage in and without polyamide foil pouches. The pouches were used to avoid desiccation of the fruit peels. The inhibitors were not efficacious, when the peel lost high amounts of moisture. Moreover, peel browning became evident after 3 days of storage, irrespective of the variant, with the LCI already declining to 74%. Within this storage period, 89% of the initial LCI value was retained by the foil-protected control fruits. In fruits treated with malic acid, oxalic acid, citric acid as well as potassium citrate (5, 25, and 50 mM), 4-hexylresorcinol (1, 2.5, and 5 mM) and diphenylamine (2.5, 5, and 10 mM) mixtures, significantly higher LCI levels (~94%) were retained relative to the control fruits. On the whole, the fruits treated with citric acid (25 mM), diphenylamine (2.5 mM) or 4-hexylresorcinol (1 mM) showed remarkable LCI stability compared to control or other fruits treated. In contrast, fruits tested with ascorbic acid (5, 25, and 50 mM), ascorbic acid 2-phosphate (1, 5, and 10 mM),

and chloride solutions, i.e. NaCl, $CaCl_2$, and HCl (50, 100, and 200 mM) revealed indifferent results. Among the chloride solutions, only NaCl (100 mM) showed some positive effects on LCI. To verify these observations in view of the limitations due to the inhomogeneous fruit appearance, all BIs mentioned above, in addition to combinations out of them, were included in screening 2 with litchi fruits of the same cultivar.

In screening 2, L-cysteine (1, 5, and 10 mM) was additionally introduced as a single BI. It was efficacious at all concentrations tested, better retaining the red-brightness of the litchi peel (LCI: 95-99% at 5-10 mM) relative to the control or other single BI agents of screening 1 (LCI: ~ 92% vs. 89% for the control). Hence, L-cystein (5 mM) proved promising for further verification. Various combinations containing diphenylamine were inefficient.

Screening 3 focused on combinations mainly based on L-cysteine (5 mM), citric acid (25 mM), and ascorbic acid (50 mM), using another litchi variety (cv. Chaccapat). The mixture of L-cysteine (5 mM), citric acid (25 mM), and ascorbic acid (50 mM) showed synergistic effects and high efficacy compared to other solutions, particularly in the third week of storage. Furthermore, all combinations of two out of these three agents, displayed a suitable anti-browning potential. Solely the formulation of 4-hexylrecorcinol (1 mM) and citric acid (25 mM) led to comparable color stability.

For the fourth BI screening, also using litchi cv. Chaccapat, L-cystein was chosen as basic component for all solutions, since it enabled the most uniform color stabilization on litchi, both as a single component and in mixtures. Hence, L-cysteine (5 mM) was evaluated alone, in combination with ascorbic acid (50 mM) and in comparison to the promising triple combination of the latter two with citric acid (25 mM) and a control. Further evaluation of citric acid alone and together with ascorbic acid or 4-hexylresorcinol would also have been indicated, but could not be realized because of limiting factors like expiration of the litchi season and resource availability.

Accordingly, screening 4 confirmed the previous observations, eventhough improved color retention was insignificant during storage in pouches for 21 days. However, on day 23, when the pouches had already been removed for two days, the combination of L-cysteine (5 mM), ascorbic acid (50 mM) and citric acid (25 mM) was significantly superior (LCI: 70%) to the other BI solutions (LCI: 62-65% vs. 63% for the control). As evidenced by additional analyses of fruit quality (aril color, firmness, TSS, TA, moisture, relative weight loss), the BI treatments did not cause any further quality changes. Accordingly, the immersion of litchi fruits directly after harvest in the solution recommended above, combined with measures assuring moisture retention, could be a suitable step in an integrated concept to prolong litchi shelf-life.