Anoxia Treatment for Delaying Skin Browning, Inhibiting Disease Development and Maintaining the Quality of Litchi Fruit

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Summary

Litchi fruit has a very short shelf life after harvest, so marketers and consumers alike desire longer periods of storage, transportation and distribution. To extend shelf life, anoxia treatments were used for the fruit. Litchi fruit were exposed to pure N₂ for 0, 3, 6, 12 or 24 h. They were then kept individually in closed but vented containers for 6 days in the dark at 20 °C and 95–100 % relative humidity. Exposure of litchi fruit to N₂ for 3 or 6 h markedly delayed skin browning, reduced rot development and maintained higher concentrations of total soluble solids, titratable acidity and ascorbic acid after 6 days of storage. Anoxia treatment for 24 h reduced browning index, but it accelerated disease development, compared to the control. Thus, a pre-storage pure N₂ treatment for 3 or 6 h can be an effective means of reducing rotting while maintaining the physical quality of the fruit.

Key words: anoxia, Litchi chinensis, quality, storage treatment

Introduction

Litchi (Litchi chinensis Sonn.) is a tropical and subtropical fruit of high commercial value for its white, translucent aril and attractive red colour. The major limitations in litchi marketing are the rapid loss of red colour and the decay of the fruit after harvest (1,2). Postharvest treatments, such as sulphur fumigation and acid dip, in combination with low temperature storage, can effectively delay the loss of red colour of the skin of litchi fruit, while the application of fungicides, such as thiabendazole and prochloraz, exerts effective control of spoilage pathogens (2,3). However, because of the concerns for food safety and restrictions in the use of chemicals, alternative means of colour and decay control in litchi fruit are needed (4,5).

Storage of fruit and vegetables under very low O₂ pressures may have beneficial effects, such as reducing respiration rate, inhibiting ethylene production and action, and reducing the incidence of some physiological disorders (6–8). Pretreatment of various fruit with anoxia can delay ripening (7,9). Fallik et al. (10) reported that a short-term anoxia treatment (for 24 h) significantly reduced rot development in tomato fruit inoculated with Botrytis cinerea, compared to non-treated fruit. In our preliminary investigations, however, the anoxia treatment was not very effective in inhibiting disease development of harvested banana fruit. Thus, the beneficial effects on the control of spoilage pathogens varied depending on different types of fruits.
Unlike climacteric fruits such as tomato and banana, litchi fruit are non-climacteric, and will not continue to ripen once removed from the tree (11). The objective of this study was to evaluate the effect of a short pre-storage anoxia treatment on the development of decay and physical and sensory traits of litchi fruit.

Material and Methods

Litchi fruit (Litchi chinensis Sonn.) cv. Huaizhi at 80 % maturation was obtained from a commercial orchard in Guangzhou, China. The fruit was selected for uniformity of shape and colour and lack of blemished or diseased fruits. The fruit was placed inside a 4.2-L glass jar and flushed with 100 % N2 gas, which was purified by the supplier (Guangzhou Gas Factory) and used specially for this laboratory experiment, until the O2 concentration in the jar was ≤0.05 % measured by an O2 and CO2 detector (Model CYES-II, Shanghai Scientific Instruments). Then, the fruits were kept for 3, 6, 12 and 24 h under humidified pure N2 flow at 100 mL/min, described previously by Jiang and Fu (12). Fruit kept in humidified air for 24 h at the same flow rate as N2 gas was used as control. In this study, 15 kg with approx. 1000 fruits was the jar was used for each treatment with three replications while all control. In this study, 15 kg with approx. 1000 fruits was used for this laboratory experiment, until the O2 concentration in the jar was ≤0.05 % measured by an O2 and CO2 detector (Model CYES-II, Shanghai Scientific Instruments).

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The principal disease of litchi fruit was caused by Peronophythora litchi (5). The disease development was markedly reduced by exposure to N2 for 3 and 6 h (Fig. 2). Exposure to N2 for 12 or 24 h, however, accelerated the rate of disease development of the fruit during storage, as opposed to the exposure for 3 or 6 h. Thus, increasing anoxia treatment time from 0 to 6 h tended to progressively enhance the postharvest life, judged by skin browning index, without the development of disease (Fig. 3). One of the hypotheses for the mode of action of the anoxia treatment on decay is that the resistance of harvested litchi fruit to pathogens increased or decreased mainly by regulating physiological processes. Bonghi et al. (19) and Pesis et al. (20) reported that keeping fruit and vegetables in very low oxygen atmospheres reduced some physiological disorders and disease development. Longer exposure to anoxia environment resulted in an accelerated rot development of tomato in the late period of storage (10). Thus, the mode of action is still unclear and needs to be further investigated.

Total soluble solids, titratable acidity and ascorbic acid are important factors in flavour and nutritive quality of litchi fruit (21). As shown in Table 1, the contents of total soluble solids, titratable acidity and ascorbic acid of litchi fruit pulp at harvest were 16.8 %, 0.14 % and 41.82 mg/100 g, respectively. The mean values within a column followed by the same letter are not significantly different at the 5 % level.

Table 1. Effects of anoxia treatments of litchi fruit after 6 days of storage at 25 °C

<table>
<thead>
<tr>
<th>t(N2 treatment)</th>
<th>w(total soluble solids)</th>
<th>w (total titratable acidity)</th>
<th>w(ascorbic acid in pulp)</th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>%</td>
<td>%</td>
<td>(mg/100 g)</td>
</tr>
<tr>
<td>0</td>
<td>13.0b</td>
<td>0.09a</td>
<td>21.90b</td>
</tr>
<tr>
<td>3</td>
<td>13.2b</td>
<td>0.09a</td>
<td>23.72b</td>
</tr>
<tr>
<td>6</td>
<td>13.5a</td>
<td>0.10a</td>
<td>24.85b</td>
</tr>
<tr>
<td>12</td>
<td>13.5a</td>
<td>0.10a</td>
<td>23.42b</td>
</tr>
<tr>
<td>24</td>
<td>13.6a</td>
<td>0.11a</td>
<td>23.32b</td>
</tr>
</tbody>
</table>

Each value is the mean value and standard error for three replicates. The contents of total soluble solids, titratable acidity and ascorbic acid of litchi fruit pulp at harvest were 16.8 %, 0.14 % and 41.82 mg/100 g, respectively. The mean values within a column followed by the same letter are not significantly different at the 5 % level.

In conclusion, the efficacy of the anoxia treatment evidently depends on the length of the application. A pre-storage pure N2 treatment for 6 h can be an effective means of reducing rots while maintaining the physical quality and overall taste of the fruit. However, the mode of action of the treatment is still unclear and, thus, needs further investigation. As a non-chemical and inexpensive postharvest technology, the anoxia treatment deserves further development, especially under commercial distribution conditions or in developing countries such as China where refrigeration is inadequate.

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References

Anoksična obrada radi usporavanja posmeđivanja kore, inhibiranja razvoja bolesti i održavanja kakvoće ploda liči

Sažetak

Plodovi liči nakon branja vrlo se kratko održavaju pa prodavači i potrošači traže duži vijek trajanja za njihovo skladištenje, transport i prodaju. Da bi se produljilo to trajanje, plodovi liči su bili izloženi čistom dušiku tijekom 0, 3, 6, 12 ili 24 sata (anoksična obrada). Voće je čuvano individualno u zatvorenim kontejnerima s otvorima tijekom 6 dana u tami pri 20 °C i 95–100 % relativne vlažnosti. Izlaganje ploda liči dušiku tijekom 3 ili 6 sati bitno je usporilo posmeđivanje kore, smanjilo truljenje ploda i zadržalo veliku koncentraciju ukupnih topljivih tvari, kiselosti i askrbinske kiseline nakon 6 dana skladištenja. Anoksična obrada tijekom 24 sata snizila je indeks posmeđivanja, ali je u usporedbi s kontrolnim uzorkom ubrzala razvoj bolesti. Stoga je obrada čistim dušikom tijekom 3 ili 6 sati prije skladištenja djelotvoran način smanjivanja truleži zadržavajući svojstva svježega voća.