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# Comparison of practical methods for postharvest preservation of loquat fruit

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ABSTRACT

To create a rational basis for reducing postharvest commercial loss of loquat fruit, we compare six methods of preservation. These include: i) wrapping with sterile non-woven gauze, ii) wrapping with expanded polyethylene, iii) enclosing in a paper bag, iv) wrapping with polyethylene foam fruit net, v) coating with 0.5% aqueous konjac glucomannan, and vi) coating with 1% aqueous konjac glucomannan. Untreated fruit served as controls and all fruit were stored at $4 \pm 1$ °C and about 95% relative humidity for up to 42 d. Compared with the controls, all six treatments significantly reduced the rate of fruit decay and extended fruit shelf life. They also reduced weight loss, and slowed the losses of total soluble solids, titratable acidity and ascorbic acid. Higher levels of superoxide dismutase (SOD) and catalase (CAT) were associated with treatments that had better sensory quality. In general, konjac glucomannan coatings showed lower rates of decay and maintained higher levels of total soluble solids, titratable acidity and ascorbic acid over the first 21 d. Wrapping in sterile non-woven gauze (food grade) was suggested as the most convenient method and its effect on storage was also very significant. Polyethylene foam fruit net was best for preventing fruit decay. On the whole, wrapping fruits with polyethylene foam fruit net, or sterile non-woven gauze and coatings with konjac glucomannan are all promising and practical ways in which to extend the postharvest shelf life of loquat fruit.



## 1. Introduction

*Ninghaibai* is a white-fleshed loquat cultivar. Due to its excellent sensory quality, *Ninghaibai* cultivation at present covers more than 2.8 million ha in China. However, compared with some of the yellow-fleshed loquats, *Ninghaibai* has relatively poor keeping qualities and it is also rather susceptible to postharvest pathogenic microorganisms.

There are a number of methods for extending the postharvest life of fruit. Protective packaging has shown promise with various packaging being combined with low storage temperatures and high humidities both to extend shelf life and also to maintain sensory quality (Jacobsson et al., 2004; Esturk et al., 2012; Pareek et al., 2014; Candir et al., 2011; Ding et al., 2002). For example, pears packed in corrugated cardboard boxes with high-density polyethylene or un-perforated polypropylene liners can give good results in terms both of sensory quality and also of shelf-life extension (Kaur et al., 2013, 2014; Nath et al., 2012).

An alternative is the use of edible coatings, and these have received greater attention in recent years due to their environmental friendliness, effectiveness and enhanced consumer acceptance (Han 2014). Examples of coating materials available are: carnauba and mineral oil coatings on tomatoes (storage for 28 d at 10 °C; Dávila-Aviña et al., 2014), composite coatings of 2% sodium alginate, 0.2% olive oil and 1% ascorbic acid on Chinese dates (*Ziziphus mauritiana*) (10 d at 25 °C; Rao et al., 2016). In addition, shrimp shell chitosan and *N,O*-carboxymethyl chitosan can extend the shelf life of tomatoes (Benhabiles et al., 2013a). A double-layer coating with 600 nm droplet size +1.0% conventional chitosan has a good effect on keeping quality of dragon fruit for up to 28 d at 10 °C (Ali et al., 2014).

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A number methods have been evaluated for extending the shelf-life of loquats. Controlled atmospheres with 10% $O_2$ +1% $CO_2$ was effective in maintaining loquat quality for more than 50 d at 1 °C (Ding et al., 2006). The fruit quality of the loquat *Mogi* could be maintained for up to 30 d at the low temperature of 1 °C or 5 °C (Ding et al., 1998). Cai et al. (2006a) found that low-temperature conditioning alleviates chilling injury in loquat and extends storage time for up to 60 d. The loquat *Luoyangqing* treated with 5 μL $L^{-1}$ 1-methylcyclopropene showed excellent postharvest quality of firmness and reduced browning (Cai et al., 2006b). Shao et al. (2013) found that after short-term, hot-air treatment (45 °C for 3 h) loquats showed reduced chilling injury after stored at 5 °C for 35 d. Loquats treated with 1 mmol $L^{-1}$ aqueous acetylsalicylic acid prevented chilling injury and decreased lignification (Cai et al., 2006c). Ding et al. (Ding et al., 2002) found that a combination of controlled atmosphere (approximately 4 kPa $O_2$ and 5 kPa $CO_2$) and 20 μm thick PE film at 5 °C allowed loquats to be stored for 60 d with a higher quality and minimal risk of disorder development. Coating with 0.75% chitosan was an effective method of maintaining loquat quality attributes for 28 d at 7 °C (Ghasemnezhad et al., 2011).

In this study, we compare six convenient methods for postharvest preservation of the white-fleshed loquat cultivar *Ninghaibai*. These methods have not previously been reported and include four different packaging materials and one film coating agent at two different thicknesses.

## 2. Materials and methods

### 2.1. Fruit material and treatment

Mature fruit of loquat *Eriobotrya japonica* Lindl. cv. *Ninghaibai* were harvested from ten-year-old trees in Ninghai, Zhejiang, China. A total of 6300 fruit were selected for the experiment. These were of uniform size and color, and on visual inspection were free of disease and mechanical damage.

The fruits were randomly divided into seven treatments with three repetitions per treatment and 300 fruits per repetition. The control and the six treatments were: (T1) fruit were wrapped in sterile non-woven gauze (food grade), before being placed in styrofoam boxess in a coolstore at 4 ± 1 °C. (T2) A sheet of expanded polyethylene (food grade) was placed on the floor of a styrofoam box in a coolstore at 4 ± 1 °C. Fruit were then added and covered with another sheet of expanded polyethylene. (T3) The fruit were bagged after the last fruit thinning, about the beginning of fruit expansion. At harvest, fruit were picked and stored, still in their bags, in styrofoam boxes in a coolstore at 4 ± 1 °C. (T4) Fruit were individually wrapped in polyethylene foam fruit net (food grade), before placing in styrofoam boxes at 4 ± 1 °C. (T5) Pure konjac glucomannan (KGM) was dissolved in distilled water (0.5%, w/v). Fruit were dipped in the solution for 60 s to wet the entire surface, then drained and dried at room temperature to create a thin film of KGM over the fruit, which were then placed in styrofoam boxes at 4 ± 1 °C. (T6) The same as T5 but the KGM concentration was doubled (1%, w/v), so the film was thicker. The treatments are shown in Fig. 1.

At weekly intervals, 20 fruits of each replicate were cut and mixed to obtain homogeneous samples for measurements of total soluble solid (TSS), titratable acidity (TA), ascorbic acid, and the activities of the two enzymes, superoxide dismutase (SOD, EC 1.15.1.1) and catalase (CAT, EC 1.11.1.6).

### 2.2. Determination of weight loss

Fruit weight loss (%) was the reduction in weight expressed as a percentage of the initial weight as: weight loss (%) = $(W_1 - W_2)/W_1 \times 100$, where $W_1$ was the fruit weighted at the time of harvest and $W_2$ the weight after storage.

### 2.3. Measurement of TSS

The TSS content (%) of the flesh juice was measured with a portable refractometer (ATAGO N-50E, Japan). Zero adjustment was always carried out prior to use.

### 2.4. Measurement of TA

The pH of the juice was first recorded and then the TA was determined in duplicate by potentiometric titration with 0.1 N NaOH up to pH 8.1 and expressed as g $kg^{-1}$ malic acid, using phenolphthalein as indicator. Samples of 1 mL of juice were first diluted in 20 mL distilled $H_2O$. The TA results are expressed as means ± SE g $kg^{-1}$ FW malic acid.

### 2.5. Determination of decay rate

Decay rate (%) was determined as: decay rate (%) = $(A - B)/B \times 100$, where A is the number of perfect fruits at the start and B the number of decayed fruit after storage at weekly intervals.

### 2.6. Determination of ascorbic acid content

Flesh tissue samples of 5 g were homogenized and brought to a volume of 20 mL by the addition of approximately 15 mL of 3% metaphosphoric acid and then centrifuged at 10,000*g* for 10 min to settle the solids. The ascorbic acid content was determined by titration of 15 mL of the supernatant liquid against $NaHCO_3$, using 2, 6-dichlorophenol indophenol as indicator. Results are expressed as mg $kg^{-1}$ of ascorbic acid on a fresh weight basis.

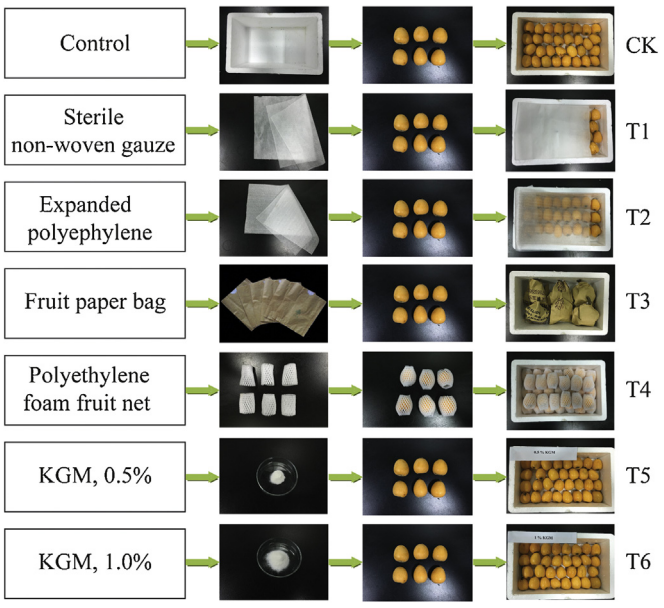


**Fig. 1.** Various preservative treatments for postharvest *Ninghaibai* loquat fruit. T1, wrapping with sterile non-woven gauze (food grade); T2, expanded polyethylene; T3, fruit paper bags; T4, polyethylene foam fruit net; T5, konjac glucomannan (KGM) coating (0.5%); T6, KGM coating (1%); CK, controls. The loquat fruit were placed in styrofoam boxes at 4 ± 1 °C immediately after harvest and stored at the same temperature after treatment.