ナノミストを用いた青果物の品質保持法

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https://doi.org/10.15017/21681

出版情報：九州大学, 2011, 博士（農学）, 課程博士
バージョン：
権利関係：

Application of nanomist for preserving postharvest quality of fresh produce

Abstract

The objectives of this study were to investigate the particle size distribution of nanomist and ultrasonic mist and to find out their effects on preserving the strength of corrugated cardboard boxes and on improving the shelf life and quality of fresh produce under high relative humidity environment during cold storage. The thesis consists of introduction, four main chapters and conclusion.

In chapter 1, the background of the thesis is presented.

In chapter 2, particle size distributions of nano- and ultrasonic-mists were measured under storage environments with high humidity. Mists generated using nanomist humidifiers and have average particle diameters of 65.5 nm. Mists produced by ultrasonic humidifiers have mean particle diameters of 210 nm. Nanomist humidifier is thought to be able to provide improved capability for generating ultrafine mists for high humidification. Experiments were performed inside the container equipped with humidifiers, a refrigerator and a system controller. A scanning mobility particle sizer and a light-scattering spectrometer were employed to measure particle sizes. Size distributions were measured under ambient air and controlled temperature and humidity (5 ^{o}C and 80%, 90% RH), at time intervals of 2, 4 and 18 h. A modified nanomist generator operated at frequencies of 40, 50, 60 Hz. Results showed that the number mode of the particle size distribution produced by the nanomist humidifier was 65.5 nm at generator frequency of 60 Hz, about 3 times smaller than that of ultrasonic mist. The particle concentration of the nanomist humidifier was about 4 times lower than that of ultrasonic mist. The number concentration of the nanomist humidifier depended greatly on the generator frequency and humidity. Moreover, the Nukiyama-Tanasawa equation estimated the size distribution better than the Rosin-Rammler equation

In chapter 3, the adsorption of water vapor and compression strength of three types of commercially made corrugated cardboard boxes for packing strawberry, mizuna and broccoli were evaluated. The experiments were conducted on the specimens prepared according to JIS Z0403 and empty cardboard boxes. The samples were stored under the environments of two

types of mists, namely nanomist and ultrasonic-mist over a period of 7 days at constant temperature of 6 ^{o}C and 95% relative humidity (RH). The change in moisture content of the samples was first measured at intervals of 6, 12 and 24 hours and then daily over 7 days. Compressive strength test was measured by the means of using a tensile and compression testing machine. The results revealed that moisture content of both specimen and cardboard box tests exposed to the nanomist and ultrasonic-mist at the end of experiments was 19.9% d.b. and 30.4% d.b., respectively (dry basis: g-water in material/ g-dry weight) although temperature and relative humidity were almost the same for both cases. Furthermore, the strength of cardboard specimens conditioned with nanomist after 7 days at 5.8 ^{o}C and 94.2% RH decreased by 44.3% - 56.9% whilst under ultrasonic-mist condition it reduced by 66.5% - 70% depending on the types of cardboards. Similarly, maximum compressive load of corrugated cardboard boxes exposed to nanomist and ultrasonic-mist decreased gradually over the time. It was analytically predicted that the boxes exposed to nanomist maintained its maximum compressive load at 28%, whereas those exposed to ultrasonic-mist remained at 14% after 7 days. The maximum compressive load of corrugated cardboards exponentially decreased with an increase in moisture content.

In chapter 4, the postharvest quality of three types of horticultural produce, eggplant fruit (*Solanum melongena*), mizuna (*Brassica rapa)* and fig fruit (*Ficus carica*), was investigated under storage environments of two kinds of fine mists producing relative humidity as high as 95% at 5.5 ^{o}C and 7 ^{o}C for 10, 6 and 8 days, respectively. The results show that the weight loss rates of the samples stored under nanomist humidifiers were 3.7%, 5.3% and 8.8% for mizuna, eggplant and fig, respectively, while those stored under ultrasonic mist were 7.3%, 8.5% and 14.7%, respectively. The eggplant fruits stored in the nanomist chamber had a lower index of chilling injury than those stored in ultrasonic mist. The stomatal pores of the samples exposed to the nanomists closed by 34.7 μm^2 and 51.5 μm^2 for mizuna and fig, respectively, compared with their initial openings, while in the ultrasonic mists, they closed by 15.8 μm^2 and 25.5 μm^2, respectively. This discrepancy in stomatal opening induces the difference in water transpiration of produce stored in nanomist and ultrasonic mist. The color of mizuna stored in the nanomist was greener than those placed in the ultrasonic mist during the postharvest storage period.

In chapter 5, the postharvest quality of fresh fig (*Ficus carica* L., cv Toyomitsu-Hime) was investigated under storage environments of two kinds of fine mists producing relative humidity as high as 95% at 7 ^{o}C for 8 days. Several quality parameters were monitored during the storage period. The results show that fig fruit stored under nanomist had a firmer fresh than those stored in ultrasonic mist. In addition, decay incidence of the fruit exposed to the nanomist was significantly reduced as compared to those stored in the ultrasonic-mists. The overall quality index of nanomist-exposed fruit was also improved. Moreover, other attributes of the postharvest quality such as color, total soluble solids and titratable acidity were better maintained by the nanomist during postharvest storage period.

In chapter 6, conclusion of the whole study was proposed.