Effectiveness of Aqueous 1-Methylcyclopropene (1-MCP) on Mango Fruit with and Without Quarantine Hot Water Treatment

Sea refrigerated shipments can require up to four weeks to arrive to the U.S. The delay on arrival can lead to over ripe fruit since refrigeration is not enough to slow down the ripening process. The problem worsens if packers harvest immature fruit which leads to hot water and chilling injuries, since immature mangos are more susceptible to these disorders. Immature harvesting also prevents fruit from reaching its full flavor potential which can cause lower consumer acceptance.

There are several techniques besides early harvesting that may be used to delay ripening, extend shelf life, and maintain fruit quality. 1-Methylcyclopropene (1-MCP) is a potent ethylene inhibitor that binds to ethylene receptors, blocking its release. Gaseous 1-MCP delays mango fruit ripening, however it requires 12 hours of application in sealed containers. An aqueous solution of 1-MCP that is only applied for one to five minutes has shown similar results to the gaseous 1-MCP method. However, there are adverse effects when 1-MCP is applied to mango fruit that has undergone the hot water treatment.

Dr. Jorge A. Osuna Garcia, postharvest and food safety researcher at INIFAP-Santiago Ixcuintla Experimental Station, conducted a study to: determine the effectiveness of aqueous 1-MCP on delaying the ripening process, extension of shelf life, and maintenance of fruit quality of Ataulfo, Tommy Atkins, Haden, Kent, and Keitt mango fruit with or without quarantine hot water treatment.

Methodology

Two experiments were conducted during the 2013 and 2014 mango season in Nayarit, Mexico.

1) Experiment A Methodology

Samples of 70 mangos were collected for each variety considering only physiologically mature fruit with excellent external appearance and free of mechanical injury, and/or pests and diseases. The mangos were collected after the washing and selection process in the packinghouse, prior to the quarantine hot water treatment. The fruit was then subjected to the following treatments:

1) Absolute control – without hot water treatment and without 1-MCP

2) 1-MCP control – 1-MCP applied to fruit without hot water treatment
3) Hydrothermal control – only hot water treatment without hydrocooling
4) 1-MCP before hot water treatment without hydrocooling
5) 1-MCP after hot water treatment without hydrocooling
6) 1-MCP after hot water treatment and hydrocooling

The aqueous 1-MCP (AFxRD-038; 3.8% 1-MCP, ≤ 5% dextrose, 88-95% ciclodextrine and 1-5% inert material) treatment was conducted as a separate step using a tap water solution of 1-MCP at 625 µg L^{-1} a.i. by dipping the fruit for 5 minutes for all treatments containing 1-MCP.

2) <u>Experiment B Methodology</u>

Samples of 40 mangos were collected for each variety considering only physiologically mature fruit with excellent external appearance and free of mechanical injury, and/or pests and diseases. Fruit was collected after the washing and selection process in the packinghouse, prior to the quarantine hot water treatment. The fruit was divided into two groups: a) fruit with hot water treatment and hydrocooling, and b) fruit without hot water treatment or hydrocooling. The fruit was then subjected to the following treatments:

1) Absolute control – without hot water treatment and without 1-MCP
2) 1-MCP at 400 µg L^{-1} without hot water treatment
3) 1-MCP at 800 µg L^{-1} without hot water treatment
4) 1-MCP at 1,200 µg L^{-1} without hot water treatment
5) Hydrothermal control without 1-MCP, with hot water treatment
6) 1-MCP at 400 µg L^{-1} with hot water treatment
7) 1-MCP at 800 µg L^{-1} with hot water treatment
8) 1-MCP at 1,200 µg L^{-1} with hot water treatment

The 1-MCP was applied before hot water treatment by dipping the fruit in tap water with the appropriate concentration for 3 minutes.

The hot was treatment for both experiments was done by immersion according to the weight of the fruit and the protocol standards set by USDA_APHIS. Ataulfo and Haden (75 minutes), Tommy Atkins, Kent and Keitt (90 minutes). The hydrocooling immersion was done in 70-73 °F water for 30 minutes.

After performing the hot water and the aqueous 1-MCP treatments for both experiments, the fruit was refrigerated (54 ± 1 °F; 90 ± 5 % RH) for three weeks and then transferred to market simulation conditions (72 ± 2 °F; 75 ± 10 % RH) until fully ripe. Sampling was done at the beginning and at the end of the refrigerated storage period, and on days 4 and 7 of market simulation. Statistical analysis was performed to measure the impact of the different treatments. Variables measured during both experiments included: dry matter, weight loss, external appearance, skin and pulp color, total soluble solids (°Bx), and tritatable acidity.

Key Findings

- **Differences among varieties in response to aqueous 1-MCP were detected.** Ataulfo, Tommy Atkins, and Kent, did not show any significant difference for all variables except external appearance.

- **The external appearance was negatively affected for the 1-MCP in combination with the hot water treatment in the five varieties**. Each of the varieties showed surface spots and lenticel blackening. Kent and Keitt retained firmness longer during shipping simulation.

- **At the end of shipping simulation or at consumption stage, fruit treated with 1-MCP before or after hot water showed fair to poor external appearance.** The absolute control (no 1-MCP; no hot water treatment), or the 1-MCP control (1-MCP; no hot water treatment) had excellent to good external appearance.

- **Aqueous 1-MCP had a good performance with the Kent and Keitt variety since it caused delay of fruit ripening.** However, it had a negative interaction with hot water treatment, causing surface spots and lenticel blackening develop during shipping simulation and final ripening.

It seems that 1-MCP is not a good alternative for mangos exported to the U.S. but it may be most useful for mango markets that do not require mandatory hot water treatment.

Looking Ahead

The NMB is researching new alternatives, such us Modified Atmosphere Packaging that can increase the shelf life of mangos and provide U.S. consumers with the best quality mangos.