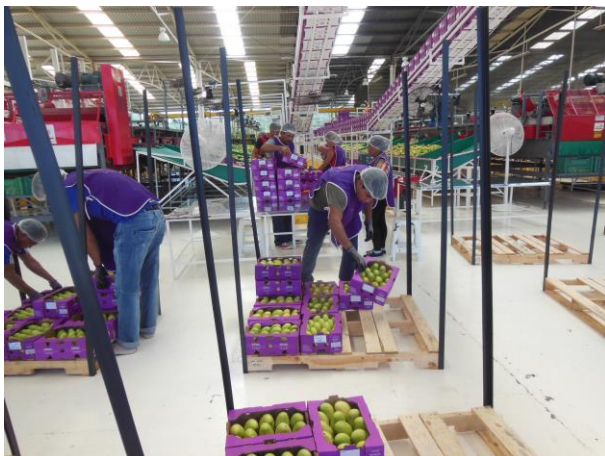
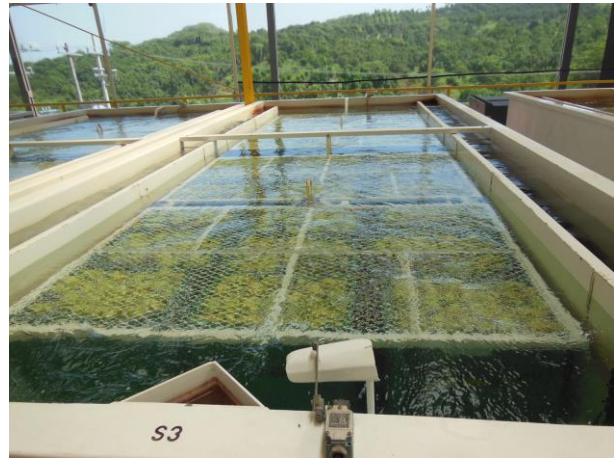


**AGREEMENT INIFAP-NATIONAL MANGO BOARD**

**PROTOCOL OF THE BEST PRACTICES TO BE CARRIED OUT TO DELIVER  
MANGO WITH HIGH AND CONSISTENT QUALITY**

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**DR. JORGE A. OSUNA GARCIA**

**RESEARCHER AT INIFAP-C.E. SANTIAGO IXCUINTLA**

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**Author**

**Ph. D. Jorge Alberto Osuna García**

**Researcher of the Postharvest and Food Safety Program -  
Experimental Site Santiago Ixcuintla – INIFAP**



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## **ABSTRACT**

The United States imports mango from Brazil, Peru, Ecuador, Haiti, Guatemala, and Mexico with an approximate volume of 120 million boxes, which implies diverse management and, therefore, different levels in the initial quality, shelf life and quality at consumption. The objectives of this study were to make a diagnosis of the practices that are carried out from harvest to the refrigerated shipment, including all the practices done in the packinghouse. As well as, to develop a protocol on the best recognized practices in the packinghouse to deliver a mango of excellent and consistent quality. A survey was designed including all operations from harvest to loading the truck or container for shipment to the United States. This survey was applied to 19 partners of EMEX, A.C. in Mexico, four packers in Guatemala, one in Ecuador and one in Peru. The survey (which consisted of 67 questions), was conducted in electronic format with specific questions and multiple-choice answers, through the Internet and when necessary, a few were made face-to-face. It was found that the relevant points that most impact on the initial quality, shelf life and quality at consumption of fresh mango fruit are the following: 1. Flowering and harvest, 2. Placement of the boxes during harvest, 3. Washing of fruit in orchard to prevent latex injury, 4. Washing of fruit in the packinghouse, 5. The quarantine hot water treatment (QHWT) and the hydrocooling, 6. The rest after QHWT and hydrocooling, and 7. Cooling temperatures in cold room and / or refrigerated shipping. For each of them, recommendations and suggestions are given, which are reflected in the Manual on the best practices of exporting mango from harvest to trailer or ship container.

## **BACKGROUND**

The United States imports mango from Brazil, Peru, Ecuador, Haiti, Guatemala, and Mexico with an approximate volume of 120 million boxes. Mexico is the main exporter with 65% of the traded volume (USDA-FAS, 2018).

This diversity of mango exporting countries causes different degrees of fruit quality and even happens for exporters in Mexico. In Mexico, the packers are organized through the association of mango packers for export (EMEX A.C., 2018) with 64 packers nationwide. Although they are grouped and administered by their own regulations, most packers carry out different activities for packing the exporting mango, which affects the initial quality, shelf life and quality at consumption.

There are different harvest criteria, influenced by market demand and competition between growers and packers. After harvesting, there are different mechanisms for moving fruit from orchard to the packinghouse. There are from double-wheeled trucks with a capacity of 250 to 300 boxes, up to a trailer with a capacity of 1000 boxes. Of course, the moving times vary from a few hours to 2-3 days. In most cases, the fruit arrives at the packinghouse on the same day of harvest; it is washed and the next day is subjected to QHWT, hydrocooled and packed.

However, in fruit washing there are also many differences, some people use washing by immersion or by sprinkling recycled water from a tank. There are those who use detergents or disinfectants and the times of water use of the water varies a lot. There are those who change the water after washing some 600 boxes, but some people wash up to 3000 boxes with the same water.

In relation to the QHWT, all of them follow the USDA-APHIS (2010) rule in the lower limits (115 ° F), but there are differences in the upper limits, which can vary up to 3 °F. Regarding hydrocooling, there are packinghouses that do not have hydrocooled tanks, but those that have it vary in hydrocooling times from 10 to 40 minutes with or without disinfectants. Then comes the selection process and

packaging, there are those who have automatic sorters by size and color, and those who do it manually.

All these differences cause different degrees of quality, which have not been systematized or quantified. Thus, the objectives of this study were to make a diagnosis of the practices that are carried out from harvest to the refrigerated shipment, including all the practices done in the packinghouse. As well as, to develop a protocol on the best recognized practices in the packinghouse to deliver a mango of excellent and consistent quality.

### **OBJECTIVES**

- A diagnosis of the practices that are carried out from the harvest to the refrigerated shipment, including all the practices that are carried out in the packinghouse. **See full report here: <https://buff.ly/2UUz3Si>**
- develop a protocol on the best practices that are performed in the baler to deliver mango of excellent quality and that is consistent.

### **HYPOTHESIS**

- The diagnosis will allow us to observe deviations and propose solutions to improve the handling of exporting mango.
- The Manual on the best practices of exporting mango from harvest to trailer or ship container will allow packers and growers to harvest the fruit in its optimal quality state, to prevent contamination risks, to maintain the quality during packing and shipping, as well as, to satisfy consumer demands and increase mango consumption.

**See complete manual here: <https://buff.ly/2OSmcfW> (*Spanish version only*)**

## **METHODOLOGY**

A survey was designed including all operations from harvest to loading the truck or container for shipment to the United States (Annex 1). This survey was applied to 19 partners of EMEX, A.C. in Mexico, four packers in Guatemala, one in Ecuador and one in Peru. The survey (which consisted of 67 questions), was conducted in electronic format with specific questions and multiple-choice answers, through the Internet and when necessary, a few of them were made face-to-face. Once the surveys were obtained, the information was analyzed using descriptive statistics using measures of central tendency (mean, mode), dispersion measures (maximum, minimum, coefficient of variation) and description of data by relative frequency histograms. It is expected that the analysis of the information will provide data to detect deviations and the comparisons will help to establish recommended practices in order to improve the whole chain.

## **PROTOCOL OF THE BEST PRACTICES TO BE CARRIED OUT TO DELIVER MANGO WITH HIGH AND CONSISTENT QUALITY**

The most transcendental and impressive practice to have initial quality, good shelf life and excellent flavor, color and aroma at the time of consumption is to harvest the mango fruit in ripe stage (color 3, according to EMEX, AC), as well as a Total soluble solids content > 8.0 °Bx in Ataulfo, Haden, Keitt, Kent and Tommy Atkins varieties.

Once the fruit are harvested at the appropriate ripeness, they follow several steps in the orchard and packinghouse that are important to maintain quality, extend shelf life and ensure optimum consumption flavor:

**1. Harvest** When harvesting with a hook and bag, immediately pour away the fruit into empty plastic boxes placed in the shade of the tree canopy and preventing them from touching the ground to prevent microbiological contamination.

**2. Manual harvest.** When making manual harvest, it is practically impossible to avoid latex emission. Ataulfo should be washed immediately after harvest and within a maximum of 2 hours to avoid irreversible damage caused by latex. Floridian varieties can tolerate up to 6 hours in contact with latex without irreversible damage. The washing can be done with simple water or water + washing-dishes liquid detergent (1 l of detergent in 1,000 l of water).

**3. Transportation from the orchard to the packinghouse.** It should not take more than 36 hours for the fruit after harvest to reach the packinghouse. Avoid overfilling the boxes to prevent mechanical damage and compression when they are stowed. Likewise, the suspension of transport vehicles must be in good condition to avoid rubbing, bumps and bruising due to excessive sprouting of the fruit.

#### **4. Operations in the packinghouse:**

**a. Reception, phytosanitary and quality test:** Once in the packinghouse, trucks must remain in the shade and take no longer than 4 hours to unload them.

**b. Washing:** It should be performed as soon as possible, using chlorinated water with an initial chlorine concentration at 200 ppm and wash a maximum of 600 field boxes to proceed to change the water in the washing tank and bring back to a chlorine concentration 200 ppm. It is very important to wash and disinfect the field boxes every time they return to the orchard. Otherwise, they are a significant source of microbiological contamination.

**c. Quarantine Hot Water Treatment (QHWT).** According to the Standard, the QHWT for fruit fly control consists of treating the fruit with hot water (115 °F) for 65 to 110 min depending on the type and weight of the fruit. It is very important to maintain the water temperature between 115.4 and 116.5 °F maximum, otherwise temperatures > 116.5 °F affect firmness and shelf life of the fruit. From a microbiological point of view, it is advisable to change the water in the QHWT tank every 14 baskets (from 180 to 200 boxes each).

**d. Hydrocooling.** Ideally, cool the fruit immediately after QHWT for at least 30 min in cold water at 21.1 °C (70.0 °F). To avoid microbiological contamination, hydrocooling water should be maintained with a free chlorine concentration of 20 to 50 ppm and should be changed when it becomes too cloudy (at least once a week). During the mango packing process there are three critical points: the washing tank, the hot water treatment tanks and the hydrocooling tanks. In addition, the lack of hygiene in transport boxes, bands and banks, can lead to microbial contamination of the fruit. Osuna et al. (2010), recommend the use of rapid microbiological tests as an excellent alternative to establish controls for hygiene monitoring of the entire packaging process.

**e. Rest.** The results are conclusive, resting after hydrocooling does not decrease the presence of sunken shoulders, especially in the Tommy Atkins variety; therefore, the suggestion for packers is that they avoid the practice of putting the fruit at rest and follow the packing process continuously.

**f. Cooling temperature in cold room and/or shipping.** Ataulfo should be handled from 11 to 13 °C (51.8 to 55.4 °F); Floridians varieties like Haden, Keitt,



Kent and Tommy Atkins from 10 to 12 °C (50.0 to 53.6 °F). None of the varieties should be stored or shipped at temperatures < 10.0 ° C (< 50.0 ° F).

Following these recommendations, it is certain that mango of excellent and consistent quality will be delivered, fully satisfying consumer demands and thus increasing mango consumption in the US market.

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## RESEARCH PERSONNEL

### Experimental Site Santiago Ixcuintla

#### Ph. D. Jorge Armando Bonilla Cárdenas

Director of Coordination and Linking of INIFAP in Nayarit and Head of the Office of the Affairs of the Experimental Site Headquarters Santiago Ixcuintla, Nayarit.

<b>Researcher</b>	<b>Program</b>
M.C. Arturo Álvarez Bravo	Agrometeorología y modelaje
M.C. F. Gerardo Balderas Palacios	Plantaciones y sistemas forestales
M.C. José de Jesús Bustamante Guerrero	Carnes de rumiantes
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Ph. D. José Francisco Villanueva Avalos	Pastizales y cultivos forrajeros