Shelf life of banana, orange and mango in polystyrene containers within refrigerated chamber

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The objective of this research was to determine the shelf life of bananas, oranges and mangoes stored in sealed polystyrene containers within a refrigerated chamber with temperature 3-9 °C for oranges and 10-12 °C for bananas and mangoes, high relative humidity (85%) and renovation frequent of the air by the chamber compressor. Oranges were harvested directly from the orchard and washed with water with 150 mg L^{-1} sodium hypochlorite. The bananas were collected at the Culiacan market in Sinaloa, Mexico, with maturity indexes 1, 2, 3 and 4, and they were then washed with chlorinated water at 5 mg L^{-1} and dried manually. Mangoes were acquired when they were in the index of physiological maturity. When bananas with maturity index 1 were stored in polystyrene containers closed, their shelf life was 21 days until showed the maturity index four, but control who were confined in the bottom tray of the refrigerated chamber were badly damaged. Oranges quality was preserved and shelf life was extended for more than 100 days without symptoms of deterioration. Mangoes had shelf life of 70 days to submit the sensory maturity index, while controls were badly damaged.

Keywords: Postharvest; Quality; Color; Firmness; Soluble Solids

1. Introduction

One of the most popular fruits in Mexico is orange, of which one of the most cultivated varieties is ‘Valencia’, which goes into production in May, is juicy, sweet and its production is oriented to the production of juice. During the last ten years, 341 thousand hectares were allocated for this crop, with an average annual growth of 0.2 percent. In 2007 the orange harvest was just over four million tons, which placed the country in the fourth place in the world, surpassed only by Brazil, the United States of America and India. Veracruz is the leading state in orange production in Mexico, followed by Tamaulipas, San Luis Potosí, Puebla and Nuevo León, although in Sonora it is where the highest national yield has been recorded, with 25 t ha^{-1}, which has allowed exporting to the United States of America, Japan, the United Kingdom and other European countries [1]. Banana (*Musa paradisiaca*) is a fruit of general consumption in Mexico due to its nutritional value, availability all year round and its relatively low price. The average production from 2000 to 2010 was 2'111,800 t and the respective total and per capita consumption were 2'037,909 t and 19.7 kg. [2], while mango (*Mangifera indica* L.) in 2006 produced 1.7 million tons in 172,000 hectares, and the main producing states were Sinaloa, Guerrero, Nayarit, Oaxaca, Chiapas, Veracruz and Michoacán, which contributed 90% of the production [3].

There is an increasing consumer demand for high quality fruits and vegetables. Locally–sourced produce that visually appeals to the buyer at the time of purchase and is still attractive and tasty upon consumption is considered to be high quality. The ideal solution is to preserve the overall quality (organoleptic, commercial, microbiological and nutritional) of horticultural products and to meet the demands of the market by to improving post-harvest storage life [4][5][6]. Improving post-harvest handling and therefore, the quality and shelf life of oranges, the Mexican producers will be better able to take advantage of market windows and increased profitability in its production system.

Post-harvest storage techniques, employed once the fruits have been packed for fresh marketing, are intended to preserve the fruit quality by maintaining ideal environmental conditions. These conditions reduce respiration and promote a longer shelf-life which allows for shipments to distant markets with reduced loss. Among the techniques used for preserving fruits and vegetables are cooling, the use of controlled atmospheres, ethylene absorbers, application of opaque films, and exogenous application of plant growth regulators [7].

Respiration is the main physiological process that leads to the deterioration of the fruit. Respiration is attenuated by low temperatures that reduce the respiratory rate, reduce excessive loss of water, and slow biochemical and enzymatic reactions. Maturity is a physiological and biochemical process that is under genetic and hormonal controls, is a process that is accompanied by multiple changes at the cellular level, rather than an increase in size [8]. The respiration rate of the fruit is reduced by half for every 10 °C reduction in temperature [9]. In climacteric fruits such as mango, temperatures above 40 °C cause an increase in respiratory activity; by contrast, temperatures below 13 °C decrease respiration and prolong shelf life [10]. Respiration-induced water losses in fruits cause a reduction of fruit weight, leading to a decrease in the fruit quality and acceptability [11], these losses often lead to higher losses than 5% during marketing, up to 7% in cold storage for three months and commercialization [11]. The low humidity conditions lead to increased transpiration and therefore a high loss of water, which accelerates fruit senescence and a marked loss of quality, both wrinkles in the cortex as shrinkage and softening [9].

During postharvest storage, fruit senescence can lead to a loss of fruit quality, including flesh softening, loss of acidity, reduction of vitamin C and changes in organoleptic characteristics (taste and palatability) [12]. The reaction rate of metabolic processes, which lead to loss of quality, doubles for every 10 °C increase in temperature, and in the range of 0 to 10 °C may even six-fold [12].

There are limitations as to the minimum temperatures that can be applied in cold storage. Some tropical and subtropical fruit show sensitivity to low temperatures, which is manifested by different alterations and spots on the skin, usually known as injury or chilling injury and can cause significant loss of merchantable quality [12]. Fruits should not be frozen while in storage. Fruits and vegetables for fresh consumption must maintain an active metabolism, which can only be achieved in the liquid phase, so they cannot be subjected to temperatures below freezing between 0 and -1.5 °C [12].

Fruits in cold storage should be stored under high humidity to avoid dehydration [9]. The appropriate relative humidity for a given product depends on the surface to volume ratio. As this ratio increases, respiration increases as well. A relative humidity level between 85 and 95% is advisable to achieve the goal of conservation [9]. Postharvest Giant Cavendish bananas (AAA) have been shown to increase shelf life when stored it's in polystyrene containers closed within a refrigerated chamber at temperatures of 10-12 °C [13].

The objective of this research was to determine the efficacy of polystyrene containers sealed to increase the shelf life bananas, oranges and mangoes stored inside a refrigerated chamber with temperature 3-9 °C for oranges and 10-12 °C for bananas and mangoes, high relative humidity (85%) and renovation frequent of the air by the chamber compressor.

2. Bananas

After that the bananas with maturity index three were confined in closed polystyrene containers inside the refrigerated chamber with a temperature of 10-12 and 8-10 °C inside the containers, they expressed the characteristic yellow color of the maturity index four, up to five days after the packaging, until that date (March 10, 2015) showed typical symptoms of organoleptic or sensorial maturity, consisting of brown spots on the epicarp of the bananas. The above indicates that biochemical reactions such as respiration were diminished by the controlled atmosphere (little oxygen and CO_2, cold environment and no air circulation) in the polystyrene containers; That is to say, in the conditions of the mentioned atmosphere the concentration of oxygen was very little and, consequently, the generations of CO_2 and ethylene also were very limited, since in conditions closed, cold and to exist little oxygen, as mentioned Salisbury and Ross [14], metabolic reactions of methionine may also have been very rare to generate ethylene, a hormone that induces maturation of climacteric fruits such as banana. Furthermore, according to Martinez [12], in cold fruits it tends to decrease respiration and, therefore, the consumption of O_2 and the production of CO_2.

When the bananas (control) were stored in the lower tray of the refrigerated chamber (Figure 1), at the end of the same period (March 6-10, 2015) it was observed that the fruits showed very pronounced signs of organoleptic or sensory maturity (brown spots on the pericarp); however, through the touch and the manual pressure it was perceived that the firmness of the pulp of the fruits was similar to that of those that were packaged in the containers of polystyrene. The flavor was another of the characteristics similar to that of the fruits packaged in the mentioned containers. However, the appearance of bananas with brown spots on a large part of the pericarp, would surely inhibit their acquisition or purchase by the consumer.

Figure 1 shows how the bananas with the maturity index two were stored in the polystyrene containers, with a temperature of 10-12 °C inside the refrigerated chamber and 8-10 ˚C inside the containers, had a life of shelf of 12 days until March 31, date in which they presented the index of maturity four. This also confirms that in bananas confined to this type of containers (controlled atmosphere) placed inside the cooler with cold environment, breathing decreased and, as a consequence, also decreased the production of ethylene. However, in the same figure it can be observed that when the bananas were confined in the lower tray of the refrigerated chamber with a temperature of 10-12 °C, by March 31, 2015, they had brown-colored pericarp, although with consistency and flavor acceptable for consumption.

When the bananas had the maturity index three and on April 16 were stored in the polystyrene containers inside the refrigerated chamber with the temperatures mentioned above, they took nine days to present the maturity index four, without in the epicarp appeared the symptoms of sensory maturity. According to Wills *et al*. [8], it can be deduced that of the two systems responsible for the synthesis of ethylene, system 1 initiated the synthesis of ethylene but failed to trigger the operation of system 2 to allow the synthesis of large quantities of ethylene necessary for full integration of maturation processes and acceleration of the maturity of bananas.

Contrary to what was observed in the bananas placed in the closed polystyrene containers and the same temperature inside the refrigerated chamber (10-12 °C), the fruits that were deposited in the lower tray of the same chamber showed the symptoms of sensory maturity (brown spots on the epicarp) six days after storage, indicating that, according to Wills *et al*. [8], system 1 triggered the synthesis of ethylene in greater quantities which made the bananas have a faster maturation process compared to the one in the closed polystyrene containers.

Within the closed polystyrene containers with a temperature of 10-12 °C inside, the bananas with four maturity index were stored and after 10 days they showed the symptoms of sensory maturity or brown spots. Contrary to what happened with the bananas inside the polystyrene containers, in the control that were deposited in the lower tray of the refrigerated chamber, to the ten days the epicarp was of dark color which made that the bananas no longer would look good for marketing. Fruits with maturity index one, which were also stored inside the containers with 8-10 °C of temperature inside, and 21 days later reached the index of maturity four, becoming well known that the ethylene production system 1 did not trigger the generation of this hormone in the large amounts typical of system 2, which according to Wills *et al*. [8] delayed the ripening of the fruits.

Color, firmness and taste deteriorate as time passes, and as the Brix grades increase from 26.1, 39.6 and 87.4%, reaching the indexes two, three and four, respectively, in comparison with index one; but while reaching the index two bananas surpassed with 26.1% in Brix degrees to the average of the index one (green), those that reached index three surpassed in those of the index two and those that reached index four surpassed in 34.2% to those of index three. However, when the bananas began to show brown spots on the cover, the Brix degrees decreased and the fruits already presented ethanolic condition or with some fermentation.

The results in the change of color, firmness, flavor and degrees Brix had to be product of phenomena like the action of the ethylene, the perspiration and the breathing, that although they were diminished by the low temperatures and the null circulation of air inside the containers of polystyrene, did not cease to appear during the life of the bananas.

Fig. 1 Bananas with maturity index two that were stored on March 20, 2015 in polyestyrene containers (a), same fruits on day 24 (b), 30 (c), 31 (d) and control on day 30 (e).

Table 1 shows how the color, firmness and taste deteriorate as time passes, and as the Brix degrees increased from 26.1, 39.6 and 87.4%, reaching indexes two, three and four, respectively, in comparison with index one; but while reaching the index two the bananas outperformed in 26.1% degrees Brix to the average of the index one (green), those that reached index three exceeded in 10.7% to those of the index two and those that reached the index four exceeded in 34.2% to those of index three. However, when the bananas began to show brown color spots on the cover, Brix degrees decreased and the fruits already presented ethanolic condition or with some fermentation. The results in the change of color, firmness, flavor and degrees Brix had to be product of phenomena as the action of the ethylene, the perspiration and the respiration, that although they were diminished by the low temperatures and the null circulation of air inside of the polystyrene containers closed, they did not stop presenting during the life of the bananas.

Table 1 Sensorial characteristics in four maturity indexes of the banana 'Giant Cavendish' (AAA).

Maturity index	Color	Firmness	Flavor	°Brix
Index 1	G	Strong	Tasteless	11.1 e*
Index 2	GY	Strong	Little sweet	14.0 d
Index 3	YPG	Strong	Sweet	15.5 b
Index 4	YT	Half	Strong sweet	20.8 a
Brown spots on cuticle	YB	Weak	Ethanolic	14.4 c
DMSH	----	----	----	0.24

*Means with different letter in the same column are statistically different (Tukey, α=0.05). G=green, GY=yellow green, YPG=yellow with green peduncle, YT=total yellow, YB=yellow with brown spots. DMSH=Honest Significant Minimal Difference.

3. Orange

The skin color of freshly harvested oranges (0 days) was light yellow, but after 90 and 100 days of storage the color was bright yellow or bright orange (Figure 3). After 90 and 100 days of refrigerated storage in polystyrene containers, the peel luminosity increased. After 90 and 100 days of refrigerated storage in polystyrene containers, there was a significant increase in the peel luminosity. Peel luminosity increased by 4.2 and 4.4 respectively, compared to the freshly harvested fruit (Figure 2). This corresponded to a 6.1 and 6.4% increase. Similarly, there was significant increase in peel luminosity of the stored fruit compared with the refrigerated controls, 6.1 and 6.4% respectively, compared to the freshly harvested fruit (Table 2), and it increased by 4.6 and 4.8% respectively, compared with the refrigerated control. The hue angle, which defines the color, decreased by 0.8% in oranges stored for 90 days, and 9.3% in those with 100 days of stored and 2.0% in the freshly harvested oranges, compared with the refrigerated controls (Table 2), but the trend was toward the yellow (<90). The chromaticity, indicating the color purity, is increased by 2.0 and 5.0%, respectively, in oranges stored at 90 and 100 days, compared to the chromaticity of the controls, but for oranges freshly harvested increases the increase was 7.3 and 10.4%, respectively. The hue angle, which defines the color, only had a statistically significant difference in oranges stored for 100 days in polystyrene containers, decreased 7.3 in those with 100 days of storage and 0.6 in oranges stored for 90 days and 1.6 in oranges freshly harvested, compared with the refrigerated controls (Table 1), but the trend was towards yellow (<90). This corresponds to a decrease of 0.8% Hue angle oranges stored for 90 days, 9.3% those with 100 days of storage and 2.0% in the freshly harvested oranges.

Fig. 2 Orange cv. Valencia harvested on 04/02/2015 in Culiacan, Sinaloa, Mexico.

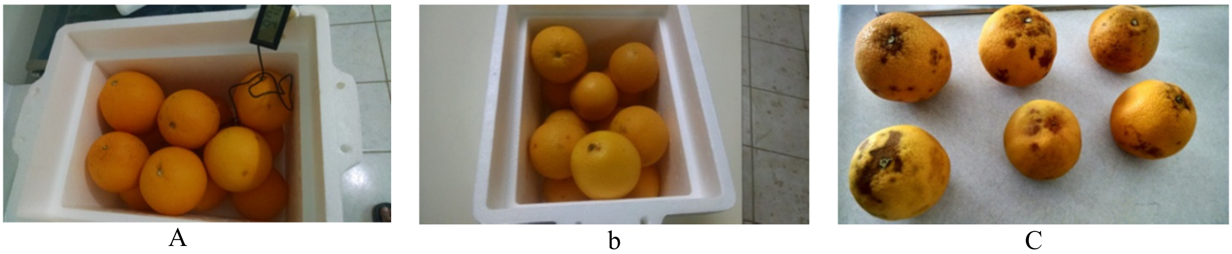

Fig. 3 Condition of orange cv. Valencia stored for 90 (a) and 100 (b) days in sealed polystyrene containers under refrigeration, or stored and refrigerated for 100 days (c) in the tray of refrigerated chamber.

Table 2 Components of color (L, °Hue and C) in orange peel 'Valencia' freshly harvested, stored for 90 and 100 days in polystyrene containers or 100 days in the bottom tray of the refrigerated chamber (control).

Treatments	Luminosity (L)	Hue angle (°Hue)	Chromaticity (C)
0 days	69.1 b*	77.0 a	70.1 c
90 days	73.3 a	78.0 a	75.2 b
100 days	73.5 a	71.3 b	77.4 a
Control	70.1 b	78.6 a	73.7 b

*Means with the same letter in each column are statistically equal (Tukey, $\alpha \leq 0.05$).

Chromaticity, indicating the color purity is increased by 1.5 and 3.7 respectively in oranges stored at 90 and 100 days, compared to the chromaticity control but over freshly harvested oranges the increase was 5.1 and 7.3, respectively, there was statistically significant difference between the control and stored for 100 days and as well as with the freshly harvested, however no significant difference with stored for 90 days and control refrigerated. It increased 2.0% in 90 days and 5.0% 100 days storage in polystyrene containers, compared to control chromaticity, but with respect to freshly harvested oranges the increase was 7.3% 90 days and 10.4% 100 days of storage. The pulp (endocarp) luminosity increased significantly by 10.0% in the oranges stored for 100 days compared with the refrigerated controls, by 8.8% compared with the freshly harvested fruit (Table 3). However, °Hue decreased 11.2 and 12.5% compared with those obtained in the freshly harvested and in control; however, the color hue (°Hue) oranges stored up to 90 days was not different from that of the freshly harvested and refrigerated control fruit.

Table 3 Components of the color (L, °Hue and C) pulp of oranges 'Valencia' freshly harvested, stored for 90 and 100 days in polystyrene containers or 100 days in the bottom tray of the refrigerated chamber (control).

Treatments	Luminosity (L)	Hue angle (°Hue)	Chromaticity (C)
0 days	45.4 b*	85.4 b	26.7 a
90 days	43.6 c	86.0 ab	21.9 b
100 days	49.4 a	75.8 c	23.2 b
Control	44.9 b	86.6 a	23.3 b

*Means with the same letter in each column are statistically equal (Tukey, $\alpha \leq 0.05$).

The chromaticity of oranges stored up to 90 and 100 days in polystyrene containers also varied with respect to the refrigerated control, although it should be noted that their values were lower by 18.0, 13.1 and 12.7%, respectively, compared with freshly harvested fruit. Considering that the negative or positive value of a* indicates color from green to red and the negative or positive values of b* indicate color from blue to yellow, Table 4 shows that the values of a* were positive but much lower than those of b*, which also confirms the bright yellow in the peel (epicarp) and pulp (endocarp) of oranges.

These results indicate that the increase in the yellow of the oranges stored in polystyrene containers increased sensory perception, since according to Schvab *et al*. [15], there is a relationship between sensory perception of sweet and acid flavors with the intensity of color, yellow and green in oranges. In addition, with the use of closed polystyrene containers at an internal temperature of 6-7 °C in refrigerated chambers operated at temperatures 3-9 °C, peel coloration increased, which coincides with the work of Ariza *et al*. [16], who found that the yellow hue intensifies with increasing low temperatures because of the promotion of carotenoid synthesis that leads to the coloring of the orange. Ariza *et al*. [16], also stated that there was a need for post-harvest technologies that degreening the fruit without the use of chemicals. In our work, it was the use of polystyrene containers and low temperatures that cause the degreening, yet do not contaminate the fruit and, consequently, do not harm the health of consumers or harm the environment.

Table 4 Color parameters (a* and b*) of oranges ('Valencia') freshly harvested, stored for 90 and 100 days in polystyrene containers or refrigerated chamber control.

Temperature	Parameter a* Peel	Parameter b* Peel	Parameter a* Pulp	Parameter b* Pulp
0 days	16.0 b*	68.2 b	2.1 b	26.7 a
90 days	15.6 bc	73.5 a	1.5 c	21.8 b
100 days	25.4 a	73.3 a	5.7 a	22.5 b
Control	14.1 c	66.4 b	1.4 c	23.3 b

*Means with the same letter in each column are statistically equal (Tukey, $\alpha \leq 0.05$).

Results from Table 5 show that the polar diameter of the oranges were affected by the process of random selection, however, also it shows that the polar diameter of the refrigerated control fruit decreased by 7.9% compared to the fruit stored for 90 days, and by 10.0% compared to the fruit stored for 100 days in containers. The equatorial diameter of the refrigerated control fruit decreased by a respective 9.4 and 8.3% compared with oranges stored for with 90 or 100 days. This indicates that the refrigerated control oranges experienced a significant loss of water through transpiration.

Fruit firmness and Brix are two quality characteristics that will decrease with the passage of time, so for the refrigerated control oranges, there was a significant firmness decrease of 18.1% compared to those fruit stored for 90 days and 8.0% compared to fruit stored for 100 days (Table 5). However, the average of total soluble solids (°Brix) was not affected by the storage. Total soluble solids is one of fruit quality parameters most frequently evaluated in citrus, and is seen as a critical indicator of sensory quality [17]. It has been shown that there is a good correlation between sensory attributes of acid and sweet taste with total acidity, expressed as percentage of citric acid and the concentration of total sugars of the juice [15]. According to our work, the Brix of the oranges stored in polystyrene containers, did not decrease compared to the Brix of refrigerated control fruit, as the Brix values were statistically similar. Oranges stored in polystyrene containers better preserved their appearance compared to oranges were only refrigerated, these differences can be seen easy, with this information available preservation appetizing appearance of oranges stored in polystyrene containers is an opportunity for mexican producers of oranges, which may extend their selling season storing oranges in this system, it can reduce losses by accelerated ripening oranges and sell them for more time to market.

Table 5 Polar and equatorial diameter, firmness and °Brix orange 'Valencia' freshly harvested, stored for 90 and 100 days in polystyrene containers or 100 days in the bottom tray of the refrigerated chamber (control).

Treatments	Polar diameter (cm)	Equatorial diameter (cm)	Firmness (N)	°Brix
0 days	8.2 b*	7.2 b	14.0 ab	15.4 a
90 days	8.8 a	8.5 a	15.5 a	12.8 b
100 days	9.0 a	8.4 a	13.8 b	11.9 b
Control	8.1 b	7.7 b	12.7 b	12.7 b

*Means with the same letter in each column are statistically equal (Tukey, $\alpha \leq 0.05$).

4. Mango

In a first experiment it was observed that the fruits of the control sample were ripe and soft in texture at the end of 13 days after they were confined in the lower tray of the refrigerated chamber, since these fruits were stored on June 12 and revised until the 24th of the same month of 2015.

However, the mangoes stored in polystyrene containers had excellent appearance and good pulp consistency. This indicates that biochemical reactions such as respiration were diminished by the modified atmosphere (low oxygen and CO_2, cold environment and no air circulation) in the polystyrene containers; That is to say, in the conditions of the mentioned atmosphere the concentration of oxygen was very little and, consequently, the generations of CO_2 and ethylene also were very limited, since in conditions closed, cold and to exist little oxygen, as mentioned Salisbury and Ross [14], the metabolic reactions of methionine may also have been very rare to generate ethylene, a hormone that induces maturation of climacteric fruits such as mangoes. In addition, according to Martinez [12], in cold fruits tends to decrease respiration and, therefore, the consumption of O_2 and the production of CO_2.

In a second experiment some fruits (control) were also stored in the lower tray of the refrigerated chamber (06/25/2015), and after 19 days the fruits were ripe with a very soft pulp, as the mangoes were checked until the 13th July, 2015. Unlike the appearance of the control mangoes, those that were stored in polystyrene containers had very good appearance in color and consistency of the pulp. This also confirms that in the mangoes confined in this type of containers (modified atmosphere) placed inside the refrigerated chamber with cold environment, breathing decreased and, therefore, the production of ethylene also decreased.

So according to Wills *et al*. [8], it can be deduced that in the mangoes within the polystyrene containers, system 1 of ethylene synthesis started, but failed to trigger the operation of system 2 to produce the synthesis of large quantities of ethylene necessary for the full integration of maturation processes and acceleration of mangoes maturity.

In a third experiment, the refrigerated chamber it was closed during 70 days, and the fruits within of the polystyrene containers, that were placed in inside of the same chamber, were have excellent shelf life (Figure 4), with good color, consistency, maturity grade and flavor.

Fig. 4 Mangoes cv. Kent, 70 days after they stored in polystyrene containers with temperature of 10-12 °C in refrigerated chamber and 8-10 °C inside of the polystyrene containers collocated inside refrigerated chamber.

In the first experiment the analysis of variance indicated that the weight of the fruits had an average of 427.6 g, standard deviation (S) of 42.7 g, coefficient of variation (CV) equal to 9.9% and a probability (Pr) of committing error of 0.0001. But in Table 1 it can be observed that the weight of the mangoes decreased as the storage days passed, so that the control fruits decreased their weight by 28.6% compared to the fruits that had six days of storage in containers of polystyrene, and 24.7% in relation to the fruits that had 13 days confined in the same containers; however, the weight difference between the fruits reviewed at 6 and 12 days was only 5.2%, which in turn indicates that within the containers the weight loss was very low perhaps due to the scarce air circulation in compared to the air circulation in the bottom tray of the refrigerated chamber.

In the second experiment the mean fruit weight was 394.0 g, S=38.4 g, CV=9.8% and Pr=0.0001; however, the same tendency also occurred in the reduction of fruit weight, and the difference of this was 24.6% of the control fruits compared to those who had six days of storage in the polystyrene containers, while compared with fruits with 13 days stored in the same containers the difference was 12.3%, and the weight difference between those stored for 6 and 13 days was 14.1%.

In the first experiment, mean fruit length was equal to 11.0 cm, S=0.7 cm, CV=6.4% and Pr=0.0006, but perspiration (loss of water) fruits decreased 12.0% in the control mangoes compared to those stored in the closed polystyrene containers (Table 6), while the width of the mangoes had a mean of 7.9 cm, S=0.22 cm, CV=2.8% and Pr=0.0001, with a decrease of 11.9% in the controls compared to those that were stored in the polystyrene containers.

In the second experiment the length of the mangoes was practically unchanged (Table 6), but the mean of the sample was 14.1 cm, S=0.29, CV=0.28 and Pr=0.0726; however, statistical differences were observed in the width of the fruits, with a mean of 3.1 cm, S=0.17 cm, CV=5.6% and Pr=0.0102, such that this character decreased 9.1% in the control fruits, in compared to those stored in polystyrene containers.

According to the analysis of variance, the Brix degrees (°Brix) had a mean of the sample equal to 17.9, S=0.77, CV=4.3% and Pr=0.0001. However, in this case the °Brix increased in the control mangoes (Table 6), since after six days after their storage in the lower tray of the refrigerated chamber, these fruits had 74.0% more total soluble solids than the fruits that were stored in polystyrene containers.

Table 6 Weight, length, width and °Brix observed in the control mangoes and stored in polystyrene containers.

	First experiment			Second experiment			
Days of storage	Weight (g)	Length (cm)	Width (cm)	Weight (g)	Length (cm)	Width (cm)	°Brix
6	482.0 a*	11.7 a	8.4 a	452.3 a	14.3 a	3.3. a	13.1 b
12	456.8 a	-----	-----	388.7 b	-----	-----	-----
Control	344.1 b	10.3 b	7.4 b	340.9 c	14.2 a	3.0 b	22.8 a
DMSH	56.8	0.7095	0.2241	45.5	0.2823	0.1767	0.7785

*Means with different letter in the same column are statistically different (Tukey, α=0.05).

4. Conclusions

The shelf life of bananas increased at the four maturity indices after they were washed with sodium hypochlorite solution (5.0 mg L^{-1}) and stored in closed polystyrene containers and placed in a cool temperature chamber in such a way that the principle of thermal insulation of the polystyrene is fulfilled, so that it can be added as a further technology in the procedure to increase the shelf life of the banana.

The tone and purity of yellowing of the skin and pulp of oranges increased significantly within polystyrene containers and, consequently, its life was extended to more than 100 days, they had symptoms of impairment loss of polar and equatorial diameter or decrease in total soluble solids, compared to those characteristics of oranges from the bottom tray of the refrigerated chamber. Inside containers closed polystyrene temperature decreased to two degrees, with respect to the temperature inside the refrigerated chamber, so that the principle of thermal insulation polystyrene reasserted, and its usefulness for packaging products such as fruits and solve some of their own physiological problems, to prolong its shelf life and enhance your presentation. This technology could be exploited by Mexican citrus producers which have more shelf life in its oranges to store them in polystyrene containers at low temperatures.

The polystyrene containers were efficient in the post-harvest handling and in the prolongation of the shelf life of the mango fruits, so that this type of packaging can be used as a technology added to the hitherto applied ones (fresh temperature, controlled atmosphere and refrigerated chamber) to preserve mango fruits for longer.

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