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OSMOTIC DEHYDRATION OF GREEN MANGO SAMPLES (*Mangifera indica L., Filipino Var.*) IN TERNARY SOLUTIONS

DESHIDRATACIÓN OSMÓTICA DE MUESTRAS DE MANGO VERDE (*Mangifera indica L.* Var. Filipino) EN SOLUCIONES TERNARIAS

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ABSTRACT

Background: in Colombia the consumption of fresh green mango (also known as mango "*biche*") is quite popular, and is consumed with lemon juice, salt, and honey. However, its high humidity content and high water activity makes of mango a highly perishable fruit, thus requiring processing alternatives. Osmotic dehydration (OD) is an interesting alternative for the conservation of mango. In OD, binary solutions (Solute + water) and ternary solutions (2 Solutes + water), have been traditionally used, however, more water removal can be achieved using ternary solutions, which leads to the improved organoleptic properties of dehydrated products. **Objetives:** to evaluate the kinetic water loss (*WL*), solutes gain (*SG*), weight reduction (WR), water activity (a_w), and volume (*Shrinking Coefficient, SC))* in green mango (*Mangifera indica* L. Filipino variety) osmotically dehydrated (OD). Additionally, to calculate water and solutes diffusivity (D_{ef}) for each treatment. **Methods:** green mango samples, with maturity scale zero, were used. Ternary solutions of sucrose at 40% and NaCl at 3, 6 and 9% were used for OD. The binary solution of sucrose with water as control treatment, was used. In the osmotic process samples were taken out at different times of OD (15, 30, 60, 90, 180, 240, and 300 min). **Results:** the findings show that at a higher concentration of NaCl, the dehydration kinetics was more rapid, a_w and *SC* were smaller and water and solutes D_{ef} were higher. The samples dehydrated with the greatest solutes concentration (40 - 9%) reached the highest *WL, SG*, and *WR* with 89.52, 13.10, and 46.68%, respectively. Coefficients D_{efw} and D_{efs} showed a magnitude order of 10^{-10} m^2/s, which is within the interval of dehydrated foods. **Conclusions:** this research showed that binary (sucrose + water) and ternary (NaCl + sucrose + water) solutions, are suitable for dehydrating green mango, however, the ternary solutions were more effective.

Keywords: Mass transfer, sucrose, NaCl, kinetics.

RESUMEN

Antecedentes: en Colombia el consumo de mango verde fresco (también conocido como mango "*biche*") es popular, y se consume con zumo de limón, sal y miel. Sin embargo, su alto contenido de humedad y alta actividad de agua hace que el mango sea un fruto altamente perecedero, por lo que requiere alternativas de procesamiento. La deshidratación osmótica (OD) es una interesante alternative para la conservación de mango. En OD se utilizan tradicionalmente soluciones binarias (solute + agua) y soluciones ternarias (2 solutos + agua), sin embargo, puede removerse mayor cantidad de agua utilizando soluciones ternarias, las cuales permiten mejorar las propiedades organolépticas de productos deshidratados.

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Objetivos: evaluar las cinéticas de pérdida de agua (*WL*), ganancia de solutos (*SG*), reducción de peso (*WR*), actividad de agua (a_w) y volumen (coeficiente de encogimiento, *SC*) en muestras de mango verde (*Mangifera indica* L. Variedad filipino) deshidratadas osmóticamente (OD). Adicionalmente, calcular la difusividad (D_{ef}) del agua y de solutos, en los distintos tratamientos. **Métodos:** se usaron mangos verdes con escala de madurez cero. En la OD se usaron soluciones ternarias compuestas por sacarosa (40%) y NaCl al 3, 6 y 9%. Como tratamiento control se usó una solución binaria de sacarosa más agua. En el proceso osmótico las muestras fueron tomadas a diferentes tiempos de OD (15, 30, 60, 90, 180, 240, and 300 min). **Resultados:** los resultados mostraron que al incrementar la concentración de NaCl, las *WL* fueron más rápidas, la a_w y el *SC* fueron menores y las de agua y solutos mayores. Las muestras deshidratadas con la máxima concentración de solutos (40-9%), alcanzaron las mayores *WL, SG* y *WR* con valores de 59.82, 13.10 y 46.68%, respectivamente. Los coeficientes D_{efw} and D_{efs} mostraron orden de magnitude de 10^{-10} m^2/s, valor que se encuentra en el intervalo para alimentos deshidratados. **Conclusiones:** esta investigación mostró que soluciones binarias (sacarosa + agua) y ternarias (NaCl + sacarosa + agua) son adecuadas para deshidratar mango verde, sin embargo, las soluciones ternarias fueron más efectivas.

Palabras clave: Transferencia de masa, sacarosa, cloruro de sodio, cinética.

INTRODUCTION

Mango (*Mangifera indica L.* Filipino variety) is one of the most likeable tropical fruits around the world, due to its taste, smell, color, and nutritional value. It is widely used as a fresh fruit, ripe, and in processed products as ingredient in fruit salad, ice cream, jam, yoghurt, and cakes, among others (1). However, green mango is also used as a fresh and processed product. In some countries, mango is used to prepare different processed products as drinks, cocktails, candy, processed meats and vinegar (chutney) and powered products (2, 3).

In Colombia the consumption of fresh green mango (also known as mango "*biche*") is quite popular, and is consumed with lemon juice, salt, and honey. The acidity, color, and texture of the green fruit, provides to the consumers, agreeable taste. However, its high humidity content (0.83 ± 0.03 wb) and high water activity (a_w), (0.983 ± 0.005) (4), makes of mango a highly perishable fruit, thus requiring conservation alternatives (5). Osmotic dehydration (OD) is an interesting alternative for the conservation of diverse vegetal products, since it is a non-thermal and low-cost process (6). The technique consists in partial water removal from a product soaked in a hypertonic solution; this removal is due to the driving force resulting from the difference of osmotic pressure and a_w existing between the medium and the product to be dehydrated (7, 8). Along OD, three simultaneous current flows take place: a water flow from the product's interior toward the surrounding medium, a flow of solids, from the osmotic solution (OS) toward the product, and a third flow from inherent solutes of product (sugars, organic acids, minerals, and vitamins) toward the OS, which is quantitatively smaller (9). In OD, binary OS have been traditionally used (solute + water) and ternary OS (2 solutes + water), however, more water removal can be achieved using ternary OS, which leads to the improved organoleptic properties of dehydrated products (10-12). Sucrose and NaCl are widely used in binary and ternary solutions to osmotically dehydrated products such as apple (13), melon (14), tomato (12), carrot (15), and banana (16). Scientific literature reports several studies with different conditions of process of OD of ripe mango (1, 7, 9, 17-19). However, no research about green mango OD has yet been reported. The purpose of this study was to evaluate the dehydration kinetics (in terms of water loss, solutes gain, and weight reduction) and the quality parameters, a_w and volume in green mango samples (*Mangifera indica* L.), along the OD process, using ternary solutions of sucrose at 40% and NaCl at 3, 6, and 9%.

MATERIALS AND METHODS

Samples preparation

Green mango samples (*Mangifera indica* L. Filipino variety), with maturity scale zero, and with similar characteristics (color, and size) were used. The fruit was purchased at a local market in the municipality of Palmira (Valle del Cauca Department – Colombia), washed with potable water, peeled with a stainless steel knife, and cut into cylindrical samples (15mm diameter and 15mm height), perpendicular to the axial axis of the fruit by using a cylindrical stainless steel punch.

The OD process

Ternary OS were prepared in distilled water, NaCl, and commercial sucrose, with a volume of 10 L each. Four OS, one sucrose solution at 40% (40°Brix) (w/w) without the addition of NaCl, and three sucrose OS at 40% (w/w) with NaCl addition (w/w) in concentrations of 3, 6, and 9% were used. OS of 40ºBrix + 0% NaCl (40-0), 40ºBrix + 3% NaCl (40-3), 40ºBrix + 6% NaCl (40-6), and 40ºBrix + 9% NaCl (40-9) were obtained. The samples were immersed in the different OS at 30 ± 0.5ºC which had been prepared in plastic container. Then OS were constantly shaken at 800 rpm by using a mechanical shaker (Ika Labortech Nik, US), in order to prevent crusting resulting from the presence of the solutes in the surface of the samples. The ratio fruit – OS, in terms of weight, was 1:20 to guarantee a constant concentration of the OS along OS (20, 21), thus avoiding reduction in the driving force of the osmotic process (22).

In each osmotic process samples were taken out at different times of OD (15, 30, 60, 90, 180, 240, and 300 m.), in other to verify weight (*m*), soluble solids (x_s), humidity mass fraction (x_w), a_w, and volume (*V*). Once the samples were taken out of the OS, they were quickly washed with distilled water, in order to eliminate external remnants of OS, and immediately dried, using absorbent paper. Three replicates of each treatment were performed.

Mass transfer kinetics

The weight reduction (*WR)*, water loss (*WL*), and solutes gain (*SG*) of the samples by means of Equations 1, 2, and 3, respectively were calculated.

$$WR = \frac{(m_t - m_0)}{m_0} \times 100 \qquad \text{(Equation 1)}$$

$$WL = \frac{(m_t - m_{wt}) - (m_0 - m_{w0})}{m_0} \times 100 \qquad \text{(Equation 2)}$$

$$SG = \frac{(m_t - x_{st}) - (m_0 - m_{s0})}{m_0} \times 100 \qquad \text{(Equation 3)}$$

Where *m* is the mass of the sample, and x_w and x_s are the humidity mass fraction and soluble solids fraction of green mango, respectively. Subindexes *0* and *t* refer to the initial condition of the fruit (fresh state) and to its condition after certain time *t* of OD, respectively. For each osmotic treatment, mass balances were performed using equation 4, in which the summation of the net losses and gains of water and solutes (Equations 2 and 3, respectively) are compared with the weight reduction of the samples (Equation 1).

$$WR = WL + SG \qquad \text{(Equation 4)}$$

Effective diffusion (D_{ef})

In order to calculate water D_{efw} and solid D_{efs}, the analytic solution of Fick's second law was used. The Fick's second law was applied to finite cylindrical geometry, diameter *2r* and height *2l*, which is solved by means of Newman's rule, considering the juxtaposition of a finite cylinder (Equation 5) and finite plane plate (Equation 6) (23):

$$\frac{x_{jt} - x_{je}}{x_{j0} - x_{je}} = \frac{4}{\pi^2} \sum_{n=1}^{\infty} \frac{\pi^2}{r^2 \delta_n^2} \exp\left(-r^2 \delta_n^2 Fo_j\right) \qquad \text{(Equation 5)}$$

$$\frac{x_{jt} - x_{je}}{x_{j0} - x_{je}} = \frac{8}{\pi^2} \sum_{n=1}^{\infty} \frac{1}{(2n+1)} \exp\left(\frac{(2n+1)^2 \pi^2}{4} F0_j\right) \qquad \text{(Equation 6)}$$

Where x_{jt}; x_{j0}, and x_{je} are the humidity content (x_{wt}; x_{w0} and x_{we}) or solutes contents (x_{st}; $x_{s0, \text{and}}$ x_{se}) of the samples. Subindixes *0, t*, and *e* are the initial time of the fruit (fresh fruit), at a time *t* of *OD* and the equilibrium condition, respectively. *r* is the radio of the cylinders. δ are the roots of Bessel function, first class, and zero order. And *Foj* is number of Furrier to mass transfer, for water (Fo_w) and solids (Fo_s) (Equation 7). D_{efj} is the effective diffusivity(m^2/s) of each component (D_{efw} y D_{efs}) and *l* is half the height of thecylinders studied.

$$F0j_j = \frac{D_{ef}t}{l^2} \quad \text{(Equation 7)}$$

From the conjugation of 5 and 6 Equations, the number of Fourrier, for each OD time, was calculated. And by means of a *Fo* vs. *t* graph, D_{ef} was determined. D_{ef} was isolated from the slope of straight line (16, 24).

Analytical determinations

In order to calculate *WR*, the samples were weighed before and after OD, using an analytical balance (Mettler Toledo AB204 Model, 0.001g precision). The humidity content *(MC)* through the gravimetric method 20.013 of the AOAC for sugar-rich fruits was measured. x_s were determined by measuring the refractive index of the liquid phase extracted from the samples, using a refractometer (Attago RX-7000) at 20° C, with a ± 0.5° precision. The a_w was measured with a Dew Point Hygrometer (AquaLab 4TE), with a 0.0003 sensibility. The volume of the samples was calculated by using a digital gauge. With the gauge the height and diameter in three points at 120° of the circumference of the samples were measured. The measure of the volume was used to determine the Shrinking Coefficient (*SC*), based on Equation 8, which relates the volume of the cylindrical samples before (V_o) and after a time *t* of OD (V_t) (25).

$$SC = \frac{V_t}{V_0} \quad \text{(Equation 8)}$$

Statistical analysis

The effects of the concentration of the osmotic solutions on OD kinetics, a_w and volume of green mango samples was found by means of a fully random variance analysis (ANOVA), with 95% confidence. The analyses were run by using the SPSS 18.0.0 (PASW Statistics 18) statistics program.

RESULTS

The fresh green mango samples showed an average 90.27 ± 1.10% *MC*; soluble solids of 7.33 ± 0.43% and a_w of 0.9969 ± 0.0022. The values correspond to the average of 12 lots.

Mass transfer kinetics

The evolution of *WL* and *SG* in dehydrated green mango samples subject to different osmotic treatments is depicted in Figure 1. For a better visual effect of the curves, error bars in each point are not shown. Yet, the standard deviation fluctuated from 0.05 to 2.04% for *WL* and 0.10 to 1.91% for *SG*.

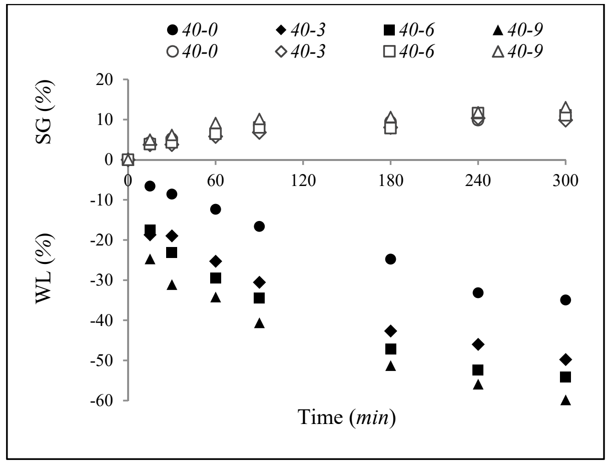

Figure 1. Water loss kinetics (Black symbols) and solutes gain (white symbols) of dehydrated green mango samples treated in different osmotic solutions.

Figure 2, depicts the evolution of *WR* in the different treatments along the osmotic process. As can be noted, there was weight loss in all the treatments along OD time. The ANOVA showed a significant effect *(p*<0.05) of NaCl addition on *WR*.

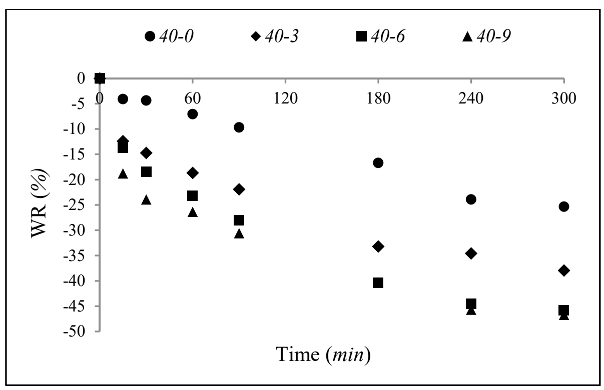

Figure 2. Weight reduction as a function of *OD* time for green mango samples in different ternary solutions.

Figure 3, depicts the relationship between *WR* and (*WL*+*SG*) (material balance). The curve slopes adjusted to the experimental points showed values close to one in the different treatments (varying from 0.9006 to 1.0067).

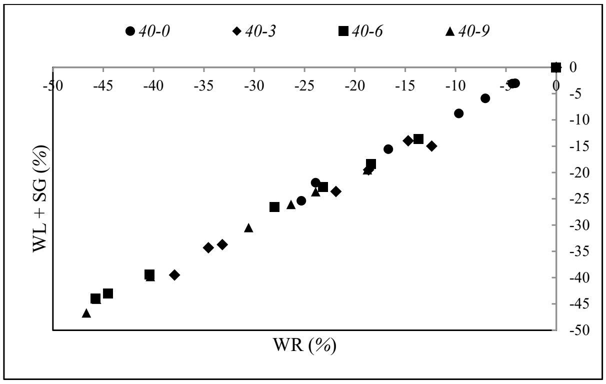

Figure 3. Material's balance for all treatments of green mango samples.

Water activity variation

Figure 4, shows the changes in a_w in osmotically dehydrated green mango samples in different treatments. The statistical analysis showed a significant effect ($p<0.05$) of NaCl solution concentration on a_w. At the end of the OD process (300 min.), the samples binary treatment (40-0) reached a_w value of 0.9828 ± 0.0008, while the ternary samples (40-3, 40-6 and 40-9) reached values of 0.9709 ± 0.0007, 0.9309 ± 0.0052 and 0.9063 ± 0.0001, respectively.

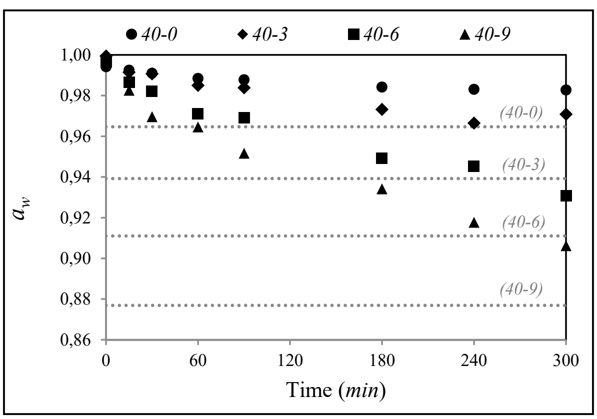

Figure 4. Evolution of a_w in green mango samples along the OD process (Dotted lines correspond to a_w of the OS).

Determination of Shrinking Coefficient (SC)

In Figure 5 the *SC* of the green mango samples at different times of OD in binary and ternary solutions are depicted.

When comparing the different treatments, significant differences ($p<0.05$) are found between treatments 40-0 and 40-3, and between treatments 40-3 and 40-9, while there was no statistically significant difference ($p>0.05$) between the other treatments. Although there was no difference between the ternary and the binary treatments, binary treatment *40-0* (dotted line in Figure 5.) shows slightly lower values of *SC* when compared with ternary treatments, thus reaching a value of 0.3137 ± 0.0067 at the end of the process, while ternary treatments reach values higher than 0.3638.

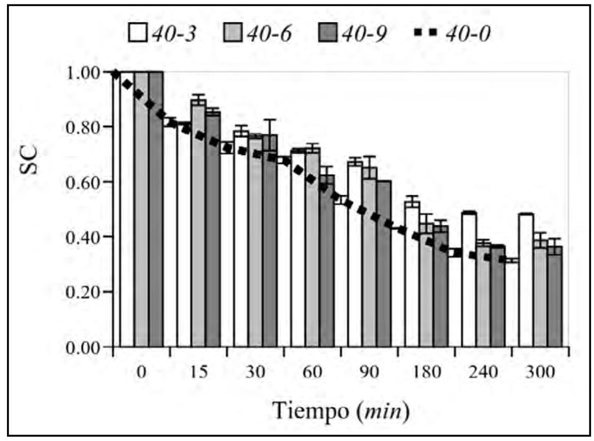

Figure 5. Shrinking coefficient of the cylindrical green mango samples osmotically dehydrated in ternary solutions.

Estimation of Effective Diffusitivity (D_{ef})

Table 1, depicts the values of the effective diffusion coefficients in the osmotic processes, for water transport (D_{efw}) and solids transport (D_{efs}). In calculating these coefficients, the first five terms in each series were considered (Equations 5 and 6), in order to obtain greater convergence of model convergence (33). The mass fractions of water and/or soluble solids of the different *OS* were used (since when $t \to \infty$; $x_{w\,fruit} = x_{w\,OS}$ and $x_{s\,fruit} = x_{s\,OS}$).

Table 1. Humidity diffusion coefficients (D_{efw}) and solutes diffusion coefficients (D_{efs}) along OD of green mango samples in different ternary solutions.

Tratamiento	D_{ef} [10^{-10} m²/s]			
	D_{efw}	R^2	D_{efs}	R^2
40-0	1.003	0.9907	1.106	0.9878
40-3	3.026	0.9787	1.912	0.9817
40-6	4.133	0.9918	2.985	0.9729
40-9	6.356	0.9428	4.487	0.9416

The diffusion coefficients for water varied from 1.003 to 6.356 x10^{-10} m²/s and from1.006 to 4.487 x10^{-10} m²/s for solids. Both coefficients (D_{efw} and D_{efs}) showed a magnitude order of 10^{-10} m²/s. The

ANOVA showed a statistically significant effect ($p<0.05$) of the NaCl concentration of the *OS* on the D_{efw} and D_{efs}.

DISCUSSION

Mass transfer kinetics

As expected, *WL* and *SG* increased in all the osmotic treatments, along process time. A significant effect ($p<0.05$) of NaCl addition to the sucrose solution at 40°Brix on *WL* was observed, because a higher salt concentration yielded a higher *WL*, during all process time. At the end of the OD process (5h), the samples in treatment 40-0 reached *WL* equivalent to 34.94 ± 0.80%, and when adding 3, 6, and 9 of NaCl to the OS of *40-0*, the *WL* increased to 49.80 ± 0.32, 54.16 ± 1.67 and 59.82 ± 1.18%, respectively. Similar findings have been reported for different osmotically dehydrated vegetables (12, 14, 15, 26). This behavior suggests a synergic effect between sucrose and NaCl in the ternary solution, with an osmotic potential greater than that of the binary solution (18). Sacchetti *et al.* (27) report that the chemical potential of ternary solutions increases with the increase of the solutes concentration. Therefore, the addition of NaCl provides a larger gradient of osmotic pressure, which intensifies the driving force necessary for mass transfer in the OD (12). As to the specific influence of NaCl, it can produce some structural changes in the cell membrane of the fruits, raising its permeability (26). Lenart and Flink (28) found that since the molecular weight of NaCl (58.49 g/mol) is lower than that of sucrose (342.29 g/mol), NaCl is easily dissolved through the cytoplasmic membrane of vegetable cells, thus creating concentration gradients in the vacuoles and cytoplasm, which allows for more water extraction from the cells (14, 29). On the other hand, sucrose molecules easily accumulate on the cytoplasm surface, hampering mass transfer (known as "Crusting Phenomenon"). In ternary solutions, however, the presence of NaCl prevents this phenomenon and, consequently, facilitates water flow (27, 28, 29).

In the case of *SG* (Figure 1), all treatments show soluble solids gains along OD. However, and according to the ANOVA and Tukey assay/test, there was a statistically significant different ($p<0.05$) only between the treatment with a more-concentrated OS (40-9) and the other treatments (40-0, 40-3 and 40-6). At the end of the process (300 min), the sucrose treatment (40-0) reached 10.86 ± 0.97% of *SG*, while the ternary treatments 40-3, 40-6 and 40-9 reached *SG* of 9.87 ± 0.62, 11.05 ± 0.56 and 13.10 ± 1.66%, respectively. It can be said that in all treatments there were fast *SG* in the first 90 min of the process. The rapid *SG* at the beginning of the process may be due to the high driving force existing between the OS concentration and the liquid phase concentration of the fresh sample (30). Likewise, the slow *SG* following the first 90 minutes of the process may be caused by the presence of sucrose on the surface of the fruit, which prevents solutes from getting in (31), and probably provokes the crusting phenomenon (28).

WR (Figure 2) is a parameter including the net balance of flow of water loss and solute gains along the osmotic process. Therefore, the sum of these two countercurrent flows leads to the net mass variation of the dehydrated samples (32).

The ANOVA showed a significant effect ($p<0.05$) of NaCl addition on *WR*, which means that the greater the NaCl concentration, the higher the *WR*. At 300 min of OD, binary treatment 40-0 yielded the smallest *WR* of 25.32 ± 0.02%. Rodrigues and Fernandes (14) and Bambicha *et al.* (33) report similar findings in watermelon and pumpkin, respectively. Referring to Figure 3, the values for R^2 (from 0.9927 to 0.9994) indicate the reliability of the experimental data of the osmotic process.

Water activity variation

It is observed that the dehydrated samples with ternary solutions showed greater decrease in a_w, when these are compared with the samples the binary treatment.

The variation in the a_w (Figure 4) are associated with the WL and SG explained in Figure 1, above. According to (34), a_w can be reduced by increasing the concentration of solids in the liquid phase of the samples, be it through water extraction or through the addition of new solutes, and the existence of salt in the hypertonic solution obstructed the formation of compact surface layer, permitting higher rates of solid gain and water loss. The increase in salt concentrations lowered the water activity of the solution with elevated driving (osmotic) force. Similar findings are reported for osmotically-dehydrated potato (30).

Determination of Shrinking Coefficient (SC)

Low values of *SC* indicate a greater volume loss, while high values indicate lower volume changes or lower shrinking associated to higher conservation of the integrity of the dehydrated product.

There is significant decrease of the *SC* in all the treatments along the OD time. This behavior is associated with water loss and solute gains along the osmotic process. Viberg *et al.* (35) indicated that the deformation of the product in the OD process depends on the flows of water and solutes inside the product. Mayor and Sereno (36), argues that the shrinking of a dehydrated product increases with the volume of water extracted from it, since at a greater water extraction there are higher concentration tensions, which weakens the product's structure.

The samples in ternary treatments underwent slightly less volume changes than the ones in binary solutions (40-0). These findings suggest that the combination of NaCl and sucrose in the *OS* leads to a protecting effect of the solid structure of the product, which would imply that a solutes mixture accelerates mass transfer kinetics and reduces a_{w}, without contributing to the shrinking of osmotically dehydrated green mango. Similar findings for have been reported for pumpkin OD (37).

Estimation of Effective Diffusitivity (D_{ef})

Coefficients D_{efw} and D_{efs} showed a magnitude order of 10^{-10} m^2/s, which is within the interval of dehydrated foods (10^{-12} y 10^{-8} m^2/s) (8). Similar results have been reported for other osmotically dehydrated fruits and vegetables, such as pineapple (38), apple (39), yellow pitahaya (6) and banana (16). A good linear adjustment of treatments 40-0, 40-3 and 40-6 is evident, with R^2 values higher than 0.97, as well as a reasonable adjustment of treatment 40-9 which is higher than 0.94. Both diffusion coefficients increase as the NaCl concentration of the *OD* increases, facilitating the mass transfer of water and solutes of the food. In other words, there is a decrease in the matrix resistance of the green mango samples to diffuse water and solutes. Chiralt *et al.* (40) found that a greater concentration of solutes in the *OS* increases the effective diffusion coefficient. At the same time, the synergic effect between sucrose and NaCl to increase the diffusion coefficients of the mango samples treated in the ternary *OS,* noticeable in comparison with what was found when they were dehydrated in a binary solution. Mercali *et al.* (16) contend that the presence of NaCl in the *OD* affects the mechanism involved in the simultaneous elimination flows of water and solutes infiltration, thus affecting the diffusion coefficients.

When comparing the diffusion coefficients of water and solutes in the ternary treatments, it is observed that the ones for D_{efw} higher than those for D_{efs}, which indicates a greater speed (less resistance) in water transport. Qi *et al.* (41) state that the addition of NaCl to the osmotic medium that already contains sucrose reduces the formation of the dense superficial layer that limits water transport. This behavior suggests that in the OD mango matrixes in ternary solutions water transport predominates over solids transport. As to binary treatment (40-0), the D_{efs} coefficient was slightly higher than the D_{efw} coefficient. This may be explained in light findings by Nsonzi y Ramaswamy (42) who think that there may be a progressive formation of sucrose layer on the surface of the food which hampers water exit from the sample along the osmotic process crusting phenomenon.

CONCLUSIONS

This research showed that binary (sucrose + water) and ternary (NaCl + sucrose + water) solutions, are suitable for dehydrating green mango (M*angifera L. Filipino Var.*), however, the ternary solutions were more effective, due to the green mango samples had higher *WL, SG* and *WR*, decreased a_w, less loss of volume, and higher water and solutes diffusion coefficients. In all the treatments, water loss was greater than the solute gains, (maximum 62% loss in treatment 40-9); this suggests that ternary solutions in OD could be a technique for optimum processing of green mango samples, serving as pre-treatment for other agro-industrial process.

CONFLICT OF INTEREST

The authors certify that there is no conflict of interest is this research.

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AUTHORS´CONTRIBUTIONS

Conception and design of study: Ayala-Aponte , A., Molina –Cortés, A. Acquisition of data: Molina –Cortés, A. Writing, Analysis and/or interpretation of data: Ayala-Aponte , A., Molina –Cortés, A., Serna-Cock, L.

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