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Osmotic dehydration of mango with impregnation of inulin and piquin-pepper oleoresin

Javier Jiménez-Hernández [b], Erick B. Estrada-Bahena [b], Yanik I. Maldonado-Astudillo [b], Óscar Talavera-Mendoza [b], Gerónimo Arámbula-Villa [c], Ebner Azuara [d], Patricia Álvarez-Fitz [a], Mónica Ramírez [a], Ricardo Salazar [a, *]

[a] CONACyT,-Universidad Autónoma de Guerrero, Av. Javier Méndez Aponte No. 1, Fracc. Servidor Agrario, 39070 Chilpancingo de los Bravo, Guerrero, Mexico
[b] Facultad de Ciencias Químico Biológicas, Universidad Autónoma de Guerrero, Av. Lázaro Cárdenas s/n, Ciudad Universitaria Sur, Col. La Haciendita, 39090, Chilpancingo de los Bravo, Guerrero, Mexico
[c] Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional (CINVESTAV-IPN), Unidad Querétaro, Libramiento Norponiente # 2000, Fraccionamiento Real de Juriquilla, 76230, Querétaro, Querétaro, Mexico
[d] Instituto de Ciencias Básicas, Universidad Veracruzana, Av. Dr. Rafael Sánchez Altamirano s/n, Col. Industrial Animas, Carretera Xalapa-Las Trancas Km. 3.5, 91192 Xalapa, Veracruz, Mexico

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ABSTRACT

This study assesses the effect of the osmotic dehydration (OD) of mango slices in an emulsion (600 g solids kg^{-1} emulsion) prepared with inulin and piquin-pepper oleoresin. In addition, mango was osmodehydrated in a sucrose solution for comparative purposes. The influence on water loss (WL) and solids gain (SG) during the OD process was analyzed. Furthermore, color change, oil gain, ascorbic acid, β-carotene, and total free phenolic content, as well as 1,1-diphenyl-2-picrylnydrazyl (DPPH) radical scavenging activity and the antiproliferative effect on breast cancer cell line MDA-MB-231 in mango slices after 120 min, were studied. Samples treated with the emulsion at 40 °C showed highest oil gain and bioactive compound retention. In addition, their ethanolic extract exhibited significant radical scavenging activity and antiproliferative effect against the cancer cell line tested, compared with that of fresh- and sucrose-treated sample extracts, in a dose-dependent manner. Images of mango slices treated in emulsion revealed the presence of inulin microcapsules with oil embedded in mango microstructure. Based on these results, this technique can be used to impregnate mango slices with oils and polymers with functional attributes to produce nutritious foods, which may serve as a potential source of phenolic with anticancer activity.

1. Introduction

Mango (*Mangifera indica* L.) fruits are commercially cultivated in >103 countries worldwide and production is increasing each year due to increasing consumer demand (Jahurul et al., 2015). Approximately 5.5% of the world's mangoes are produced in Mexico. However, the mango is scarcely commercialized, when compared with the quantity produced due to the lack of storage and processing facilities, as well as to a limited knowledge of processing technologies. In Mexico, 40% of mango production is wasted (Sumaya-Martínez, Sánchez-Herrera, Torres-García, & García Paredes, 2012).

Dehydration to a low moisture content can extend the fruit's shelf life and add value to the mango chain. Mango is appreciated by consumers, not only as fresh fruit, but also as an ingredient in processed products such as dairy products, ice creams, fruit salads or snacks. Mango processing that maintains the product's freshness characteristics and stabilizes the product, thus lengthening its shelf life on the market, would be very convenient for increasing the fruit's commercialization in non-producing countries (Giraldo, Talens, Fito, & Chiralt, 2003). In this context, osmotic dehydration (OD) is one of the most employed techniques to improve the organoleptic and nutritional properties of foods, and it has been utilized to improve mango quality (e.g., color, texture, flavor, and nutrients) (Azam, Haq, & Hasnain, 2013; Chakraborty & Samanta, 2015).

OD gives rise to at least two simultaneous major counter-current flows: substantial water flow out of the food into the solution, and

* Corresponding author.
E-mail address: rsalazarlo@conacyt.mx (R. Salazar).

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simultaneous transfer of the solute from the solution into the food, elevating the solid content (Torreggiani & Bertolo, 2001). Sucrose, fructose or sodium chloride comprise the main dehydrating agent of fruits. In addition, other solutes-of-interest such as antioxidants or preservatives could be added to the osmotic solution (Nagai, Santos, Faria, Boscolo, & Mauro, 2014).

High intake of osmotic solutes during OD cannot be desirable, except when the osmotic solution employed possesses beneficial health properties. The use of an emulsion as osmotic solution to prepare dehydrated fruit products enriched with bioactive compounds provides a new approach for developing functional foods aimed at meeting consumer needs (Salazar-López, Jiménez, Salazar, & Azuara, 2015) but, to date, there is little information in the literature on the effect of these osmotic agents on the drying kinetics or quality (e.g., color, phenolic content, antioxidant capacity) of fruits that are highly appreciated by consumers. The demand for fruit has increased due to the greater interest of persons in taking care of their bodies and preventing diseases. Currently, choosing fruit is carried out according to its nutritional benefits instead of its sensory characteristics (Dias, Luzia, & Jorge, 2013).

Considering the previously mentioned material, the objective of the present study was to determine the influence of osmotic solution (sucrose or emulsion) and the temperature of the OD on water loss (WL), solids gain (SG), oil content, color, antioxidant capacity, bioactive compound retention, and the antiproliferative effect on breast cancer cell line MDA-MB-231 of processed mango slices in order to explore novel methodologies for the enrichment and improvement of fruits thorough inulin and piquin-pepper oleoresin fortification.

2. Materials and methods

2.1. Materials

Mangoes (*Mangifera indica* L.) of the creole mango cultivar of similar ripening degree were collected in the region of Atoyac de Álvarez (Guerrero, Mexico). Sucrose, soy bean oil, Tween 80®, and piquin-pepper (*Capsicum annum* L. var. *Aviculare*) were purchased at a local supermarket in Guerrero, Mexico. Inulin derived from agave was obtained from Inulina y Miel de Agave, S.A. de C.V.

3. Methods

3.1. Preparation of oleoresin

Piquin-pepper was ground and mixed with soy bean oil at a ratio of 1:3 (w/w) in an amber-colored glass bottle and maintained for 48 h in order to obtain the oleoresin (oily extract). Oleoresin was decanted by gravity, filtered using a sieve (0.5-mm screen), and stored under a nitrogen atmosphere and protected from light at 4 °C for further use.

3.2. Preparation of osmotic solutions

A solution of inulin (120 g) and Tween 80® (20 g) in deionized water (380 g) was prepared. Emulsion was performed by dispersing piquin-pepper oleoresin (30 g) in the inulin solution to obtain an oil/inulin ratio of 0.25 utilizing a high-speed homogenizer at 3500 × *g* and 25 °C for 30 min. Then, the solids concentration of the emulsion was adjusted to a 600 g solids kg^{-1} emulsion with sucrose (450 g). Subsequently, the emulsion was agitated for 60 min before use. On the other hand, sucrose osmotic solution was prepared dissolving 600 g of sucrose in deionized water (400 g) to obtain a concentration of 600 g solids kg^{-1} solution.

3.3. Impregnation-dehydration procedure

The mangoes were washed thoroughly and peeled manually utilizing a stainless steel peeler. Two slices parallel to the seed were cut from each fruit and were then further sliced into 30 × 25 × 5 mm pieces employing a sharp slicer.

Mango slices were osmo-dehydrated in both the emulsion and the sucrose solution, using a fruit: solution ratio of 1:30 (w/w) during 120 min at 30, 40 and 50 °C. Samples were withdrawn at 10, 20, 30, 40, 60, 80, 100 and 120 min and the excess solution from the surface was blot-dried utilizing paper towels. WL and SG during OD were calculated according to Azuara, Beristain, and Gutiérrez (1998).

After the OD process, the water activity of the treated mango was reduced from 0.97 to 0.87–0.90. Osmodehydrated mango and fresh mango samples were dried at 80 °C in for 24 h in an oven (Luzeren, DHG-9070A with forced convection; Beijing, China). The final water activity of fresh and treated mango was 0.49 and 0.47, respectively.

3.4. Analysis of osmo-dehydrated mango slices

Moisture and total oil content were evaluated by the 934.01 and 960.39 (AOAC) methods, (1997) at the beginning and ending of the OD process, respectively. Sample water activity was determined using a dew-point water activity meter (Decagon Devices, Inc., Pullman, WA, USA) at 25 °C. During the OD process, osmodehydrated mango samples in emulsion and sucrose solution were removed at different times (10, 20, 30, 40, 60, 80, 100 and 120 min) to measure color changes by employing a portable colorimeter (X-Rite Spectrophotometer Model Ci62, X-Rite Incorporated, Grandville, MI, USA). The Hue angle (H*) at different time periods was calculated from the determined CIELAB L* a* b* values: $H^* = \tan^{-1}(b^*/a^*)$, where a* = [negative (green) to positive (red)], b* = [negative (blue) to positive (yellow)]. The illuminant employed was D65 and the standard observer position was 10°.

β-carotene and ascorbic acid (AA) content were measured at the beginning and the end of the OD process with the spectrophotometric method reported by Biswas, Sahoo, and Chatli (2011) and Pfendt, Vukašinović, Blagojević, and Radojević (2003), respectively.

Total free phenolic content in mango samples was extracted according to the procedure described by De la Parra, Serna-Saldivar, and Liu (2007) and modified in our laboratory. Briefly, one gram of sample was blended with 10 mL of 95% chilled ethanol for 10 min and then centrifuged at 2000 × g for 15 min. The supernatant was removed and stored at −20 °C until use. Total free phenolic content in mango samples was quantified utilizing the Folin-Ciocalteau method. The standard was gallic acid (GA) and the results were expressed in μg of GA equivalents per g of dry weight (DW) of sample.

Total free flavonoid content was determined from the previously mentioned extracts employing a colorimetric method that was described previously (Adom & Liu, 2002). The standard was (+)-catechin and results were expressed in μg of catechin equivalents per g of DW of sample.

The free-radical scavenging activity by the DPPH free-radical scavenging assay of the sample extracts was analyzed according to the method of Sulaiman and Ooi (2012). The unique modifications of the described method included the reference employed in this assay. A standard curve was obtained using different concentrations (0–1 mg/mL) of ascorbic acid standard solution. The absorbance of the extract was compared with that of the ascorbic acid standard to obtain median effective concentration (EC50) values, which are the concentrations of the extract required to scavenge 50% of DPPH radical. The results of the ethanolic extracts

were expressed as μg of AA equivalents per g of DW of sample.

The microstructure of osmodehydrated mango samples after oven-drying was observed in an Electron Probe Micro Analyzer (EPMA) (JEOL JXA - 8530 F) at 6 kV in the backscatter electron imaging mode. Oven-dried mango was utilized as control. A transversal section from a slice of mango taken from the middle section of a sample was excised, mounted on stainless steel stubs, and coated with graphite using a JFC-1100 Sputter Coater (JEOL, Akishima, Japan).

3.5. Cell proliferation assay

MDA-MB-231 cell cultures were maintained in Culture Collection (ATCC)-recommended DMEM-F12 growth media (GIBCO) containing 10 mL/100 mL fetal bovine serum, streptomycin (0.1 mg/mL), and penicillin (100 U/mL), all from GIBCO, at 37 °C in a 5% CO_2 humidified atmosphere. Inhibition of cell proliferation by mango-flesh ethanolic extracts was measured by the 3–4,5-DiMethylThiazol-2-yl)-2,5-diphenylTetrazolium Bromide (MTT) assay. MDA-MB-231 cells were plated in 96-well culture plates at a density of 4×10^3 and incubated for 24 h. Then the cells were exposed to different concentrations of mango extract for 48 h. After that, MTT (Molecular Probes, Invitrogen), which was dissolved in phosphate-buffered saline (PBS) solution at a dose of 5 mg/mL, was added. After incubation for 4 h at 37 °C, the purple formazan crystals were dissolved with 100 μL dimethyl sulfoxide and absorbance was measured at 545 nm on a plate reader (Stat-fax-100; Awareness Technology, Inc.). Cytotoxicity was expressed using the IC50 value, defined as the concentration of mango extract inhibiting cell proliferation by 50%.

3.6. Statistical analysis

All results were expressed as mean ± standard deviation values (n = 3). When significant F values were obtained, group differences were evaluated by the Tukey's test. All statistical procedures were carried out using the JMP 9.0 statistical software package (SAS Institute Inc., Cary, NC, USA). A significance level of $\alpha = 0.05$ was used.

4. Results and discussion

Fig. 1 displays the effects of osmotic solutions employed on mass transfer of mango slices during OD after 120 min. The OD time applied to the fruit is also important because mass transfer occurs with greater intensity during the first 120 min of the process (Raoult-Wack, 1994). The increasing effect of temperature on water loss (WL) as observed in Fig. 1A and B might be due to swelling cells, a plasticizing effect, and an increase in thermal energy due to high temperature that enhanced moisture diffusion. In the same context, the change in cell membrane permeability due to the increase in temperature might be the reason for the increase in solids gain (SG) with the increase in temperature. WL values for mango slices treated in sucrose solution and emulsion at 30, 40 and 50 °C were 0.37 ± 0.02, 0.46 ± 0.01, 0.57 ± 0.02 and 0.35 ± 0.03, 0.47 ± 0.02, 0.57 ± 0.01 g water g^{-1} fresh fruit, respectively, after 120 min of OD, whereas SG values for mango slices treated in sucrose solution and emulsion at 30, 40 and 50 °C were 0.06 ± 0.00, 0.08 ± 0.00, 0.09 ± 0.01 and 0.03 ± 0.00, 0.05 ± 0.01, 0.06 ± 0.01 g solids g^{-1} fresh fruit, respectively. Each type of osmotic solution possessed similar potentials ($p < 0.05$) for removing water (Fig. 1A and B). In contrast, during the OD step with emulsion, the amount of SG exhibited different behavior from that described by OD with sucrose solution. As can be observed, when sucrose solution was used, similar WL and higher SG values were obtained (Fig. 1B) at all temperatures assayed. This difference may be due to the large molecules of inulin employed in the emulsion, which block the pores on the surface of the mango slices, diminishing solids impregnation and producing lower internal resistance, which favors WL by diffusion.

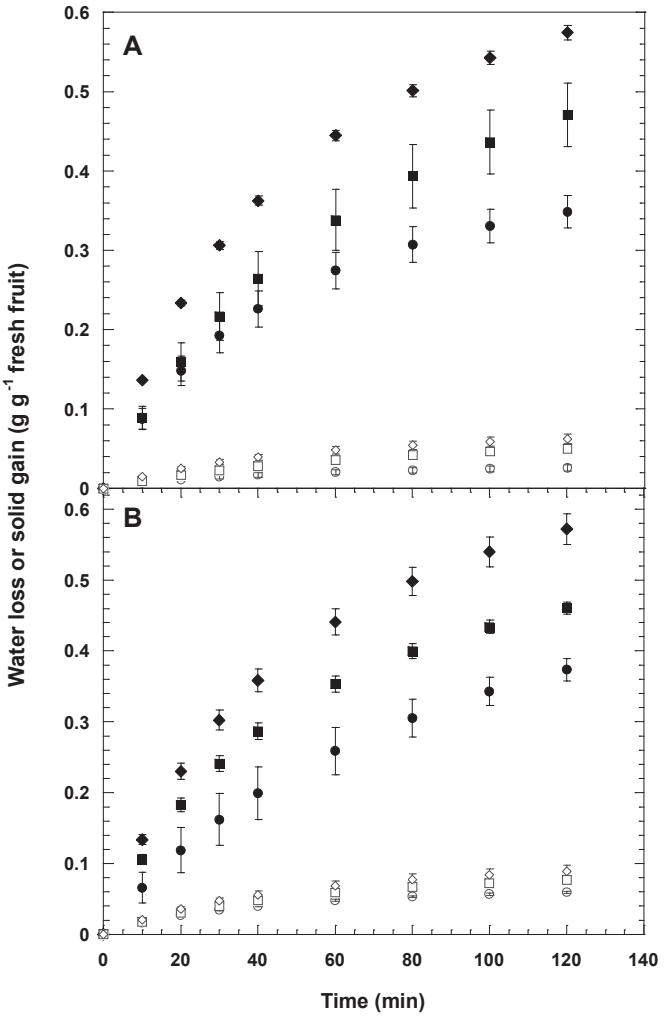

Fig. 1. Water Loss (WL) and Solids Gain (SG) changes during osmotic dehydration of mango slices at 30 (●, ○), 40 (■, □) and 50 °C (◆, ◊). Emulsion **(A)**; Sucrose solution **(B)**.

Impregnation of oleoresin into mango tissue from emulsion and changes in the AA and β-carotene content at the end of the OD process can be observed in Table 1. Total oil content in fresh mango slices was 1.03 ± 0.04 g oil 100 g^{-1} dry basis. The use of emulsion significantly increased ($p < 0.05$) the oil content in mango slices upon OD. These results were obtained independently of the temperature employed. The sole significant difference was the amount of oil impregnated. Thus, after 120 min of OD at 40 °C, the emulsion produced mango slices with greatest oil content (2.22 ± 0.15 g oil 100 g^{-1} dry basis). An increase of 116% in oil content was observed. A proportional increase of impregnated oleoresin with temperature was expected; however, when mango slices were treated at 50 °C, a phase separation in the emulsion after 60 min was observed, affecting oleoresin impregnation. Despite the low SG from emulsion (Fig. 1A), these results suggest that emulsion was able to penetrate mango tissue and, probably, sucrose acts as a carrier of inulin-oleoresin microcapsules (Salazar-López et al., 2015).

AA is routinely employed as a quality index due to that it easily

Table 1
Changes in ascorbic acid, β-carotene and oil content [a] of mango slices after 120 min under the osmotic dehydration process [b].

Osmotic agent	Temperature (°C)	Ascorbic acid (mg 100 g^{-1})	β-carotene (mg 100 g^{-1})	Oil content (g oil 100 g^{-1})
None [c]	–	1465.79 ± 20.16 a	23.20 ± 0.84 a	1.03 ± 0.04 d
	30	1008.46 ± 25.33 b	22.27 ± 0.71 a	1.59 ± 0.07 c
Emulsion	40	791.38 ± 16.21 d	22.23 ± 0.82 a	2.22 ± 0.15 a
	50	638.50 ± 43.36 e	19.25 ± 0.85 bc	1.78 ± 0.01 b
	30	856.31 ± 34.68 c	21.35 ± 0.73 b	nd
Sucrose	40	771.59 ± 43.94 d	18.94 ± 0.68 c	nd
	50	430.50 ± 21.43 f	14.500.48 d	nd

[a] Dry basis.
[b] Values are the mean ± standard deviation of triplicate analyses. Means values followed of different letters, in the same column, are significantly different ($p < 0.05$). n.d = not determined.
[c] Results for fresh mango slices.

destroyed during processing and storage (Wolbang, Fitos, & Treeby, 2008). The AA content in fresh mango slices was 1465.79 ± 20.16 mg 100 g^{-1} dry basis. This value was higher than those previously reported by Rincón and Kerr (2010) and Nagai et al. (2014) for Tommy Atkins and Palmer mangoes, respectively. The use of either emulsion or sucrose as osmotic solution significantly ($p < 0.05$) reduced AA content in mango slices upon OD. These results were obtained independently of the temperature employed. The sole significant difference was the amount of AA loss (which increased with the temperature, as expected) and the percentage of AA loss observed. Higher AA losses were observed in samples osmodehydrated in sucrose solutions rather than those in emulsion. Thus, when emulsion was utilized, AA was reduced from 46% (at temperature of 40 °C, the optimal temperature for achieving maximal oil impregnation) and 56% (at temperature of 50 °C) from the initial value. AA loss was directly related with osmotic solution temperature (emulsion, $r = 0.99$; sucrose, $r = 0.93$). During the OD process of kiwi slices, Vial, Guilbert, and Cuq (1991) attributed the loss of AA to its diffusion from the fruit into the solution, and to chemical deterioration. In this study, lowest AA losses from emulsion can be explained based on the sugar- and inulin-concentrated layer formed at the periphery of the sample. This layer may serve as a barrier to AA transfer, resulting in higher AA retention in the final product (Santos & Silva, 2008).

In the same context, the β-carotene retention after the OD of mango was measured. β-carotene content in fresh mango slices was 23.20 ± 0.84 mg 100 g^{-1} dry basis. This value was higher than those previously reported by Manthey and Perkins-Veazie (2009) for Tommy Atkins, Kent, Keitt, and Haden mango varieties. Thus, the high values of AA and β-carotene obtained in this study in fresh fruit suggest that the creole mango could be employed as a potential abundant source of natural antioxidants and that it has great potential for expanding it on the market. Analogously to the previously described material related with AA, mango slices from emulsion exhibited lower β-carotene losses than those from sucrose. In both cases, the amount of β-carotene loss increased with the temperature. Independently of the osmotic solution employed, AA and β-carotene content in samples treated at 50 °C was considerably affected. The use of either 30 or 40 °C did not produce any significant change ($p < 0.05$) in β-carotene loss in osmodehydrated mango slices in emulsion. Thus, when the emulsion was utilized, β-carotene was reduced in 4.00% (at temperature of 30 °C) and 4.46% (at temperature of 40 °C, the optimal temperature for achieving maximal oil impregnation). In contrast, the sucrose solution produced some significant differences at all temperatures assayed. A reduction of 8, 18, and 37% at 30, 40, and 50 °C was observed, respectively. Greatest β-carotene retention from emulsion can be explained by the high amounts of carotenoids present in oleoresins from red pepper fruits (Levy et al., 1995).

As indicated in Table 2, variation in total free phenolic, flavonoids and DPPH radical scavenging activity was observed among the fresh mango slices processed with different osmotic agents/temperatures. Independently of the osmotic solution and the temperature employed, total free phenol and flavonoid content were affected. However, this reduction was less pronounced in samples treated with the emulsion at 40 °C. These results are correlated with the highest oil gain observed in the samples. In addition, osmotic drying with sucrose resulted in a significant decline of the antioxidant activity exhibited by the reduction in DPPH free-radical scavenging activity. Contrariwise, the oil gain in samples treated with the emulsion at 30 and 40 °C increased the DPPH free-radical scavenging activity. Data obtained from this study indicate that the use of emulsion as osmotic solution during the OD process is a useful method for producing dehydrated fruit products enriched with bioactive compounds and higher DPPH free-radical scavenging activity. It is well-documented that *Capsicum annuum* L. pericarp extracts exhibit strong antioxidant activity, strong ferrous chelating activity, high scavenging activity against free radicals, and high total phenolic and flavonoid contents (Sim & Sil, 2008).

Table 2
Changes in the content of phenolic compounds and DPPH radical scavenging activity [a] in the ethanolic extracts of mango slices after 120 min under the osmotic dehydration process [b].

Osmotic agent	Temperature (°C)	Free phenols (μg g^{-1})	Free flavonoids (μg g^{-1})	EC50 (mg g^{-1})
None[c]	–	310.54 ± 6.59 a	20.54 ± 0.13 a	21.33 ± 0.61 cd
	30	266.85 ± 4.83 c	10.63 ± 1.25 c	17.84 ± 0.55 d
Emulsion	40	284.47 ± 3.49 b	18.27 ± 0.65 b	12.67 ± 0.97 e
	50	248.10 ± 0.35 de	12.14 ± 1.73 c	33.52 ± 1.66 a
	30	249.43 ± 6.97 de	10.68 ± 0.59 c	19.28 ± 0.47 cd
Sucrose	40	253.04 ± 8.67 cd	9.89 ± 0.40 c	23.24 ± 1.56 c
	50	233.49 ± 5.71 e	6.53 ± 1.61 d	28.93 ± 2.74 b

[a] Dry basis.
[b] Values are the mean ± standard deviation of triplicate analyses. Means values followed of different letters, in the same column, are significantly different ($p < 0.05$).
[c] Results for fresh mango slices.

It is noteworthy to point out that inulin possesses much lower caloric values than typical carbohydrates, acts as dietary fiber, and aids in stimulating the growth of beneficial bacteria (e.g., bifidobacteria) in the colon, thereby inhibiting the growth of pathogenic microorganisms and potentially threatening colonic dysfunctions, thus acting as a prebiotic (Nair, Kharb, & Thompkinson, 2010).

During the osmotic dehydration process, the loss of color is one of the most significant changes. However, as can be observed in Fig. 2 after 120 min, samples were not significantly ($p < 0.05$) different from fresh fruit. These results were obtained independently of the osmotic solution and temperature employed. Contrary to what was expected, emulsion impregnation did not exert any effect on the color produced in the mango slices (Fig. 2A). On the other hand, after 120 min, mango treated in sucrose at 50 °C was more yellowish in color than the fresh fruit due to higher WL (Fig. 2B). Hue angle ranged from 77 (0 min) to 75–78° (120 min). These observations were similar to the findings of Mandala, Anagnostaras, and Oikonomou (2005) and Silva, Fernandez & Mauro, (2014), in which the authors found that solute impregnation did not influence the product's color.

Structural changes after OD and oven drying of samples treated at 40 °C were observed by an Electron Probe Micro Analyzer (EPMA) and are presented in Fig. 3A–F. The microstructure of fresh convectively dried mango (Fig. 3A and B) was affected strongly by oven-drying. Within the same context, during the OD process, the cells changed their shape and reduced their size due to the liquid loss. After oven-drying, great collapse and tissue disruption were observed in all samples. These results were obtained independently of the osmotic solution employed. Osmo-convectively dried mango in sucrose samples (Fig. 3C and D) exhibited extensive tissue collapse, loss of the three-dimensional form and a flattened surface. Despite tissue shrinkage, the application of OD with emulsions and oven-drying made it possible to incorporate microcapsules and microparticles of inulin and piquin-pepper oleoresin into mango tissue (Fig. 3E and F). Conversely, Salazar-López et al. (2015) demonstrated well-defined microcapsules in the intercellular spaces of pineapple tissue after OD processing. These differences can be explained partially by the freeze-drying processes after the application of OD employed by these authors. In this study, oven-drying gave rise to important damage in cellular tissue and microcapsules.

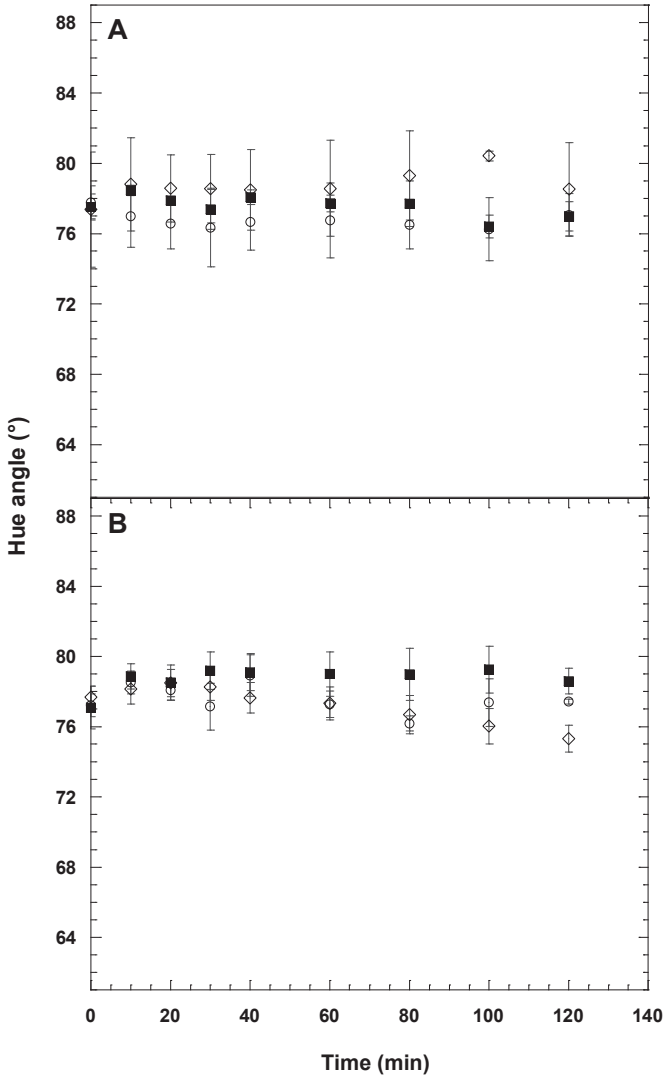

Fig. 2. Variation of the Hue angle during Osmotic Dehydration (OD) at 30 (○), 40 (■) and 50 °C (◊) of mango slices. Emulsion **(A)**; Sucrose solution **(B)**.

The results obtained in this study suggest that OD at 40 °C utilizing emulsions as osmotic agent possessed the greater potential to improve the functional characteristics of mango slices. Therefore, to clarify the potential of the enriched mango samples obtained, a cell proliferation assay was performed on the ethanolic extract of samples treated in emulsion or with sucrose at 40 °C and with mango flesh. The MTT assay method was that employed to study the action of natural products on cell proliferation, viability, and cytotoxicity. This assay is based on the reduction of a tetrazolium salt to a purple insoluble formazan by metabolically active cells. Absorbance of the solubilized formazan is taken as a measurement of the number of living cells. The three extracts evaluated in the MDA-MB-231 cell line caused a reduction in cell proliferation, but a lower cell-viability percentage was observed in samples osmodehydrated in emulsion rather than those in sucrose (Fig. 4). The antiproliferative effect of the extracts analyzed was moderated, in that the IC50 of the extracts was 1190 ± 16, 621 ± 28 and 165 ± 33 μg for mango flesh and samples treated in sucrose or emulsion at 40 °C, respectively. Although the molecular mechanism of the antiproliferative activity was not studied in this work, several studies have demonstrated the antioxidant and antiproliferative activity of mango peel, pulp, and pit (Abdullah, Mohammed, Abdullah, Mirghani, & Al-Qubaisi, 2014; Kim et al., 2010). The ethanol extract derived from the mango seed, peel, and flesh is high in antioxidants, and its antiproliferative properties are attributed to its polyphenols and flavonoids (Kim et al., 2010; Ling et al., 2009). The capsaicin present in the oleoresin also possesses antiproliferative capacity (Diaz-Laviada & Rodrvguez-Henche, 2014). The antioxidant and antiproliferative activities of the ethanolic extracts assayed may be due to the synergistic actions of the bioactive compounds present in the mixture. These findings suggest the potential use of the mango treated with an emulsion prepared with inulin and piquin-pepper oleoresin at 40 °C as an alternative and functional food or value added to satisfy emerging consumer needs and expectations.

5. Conclusions

This study explored the potential supplementation of fruits with both bioactive compounds and prebiotics. The results obtained in this study showed that mango osmodehydrated in emulsion prepared with inulin and piquin-pepper oleoresin at 40 °C possessed greatest oil-gain, phenolic compounds, free-radical scavenging activity, and antiproliferative effect on breast cancer cell line MDA-MB-231, a similar color to the fresh fruit, and an acceptable AA and β-carotene loss. Thus, although a detailed sensory and stability

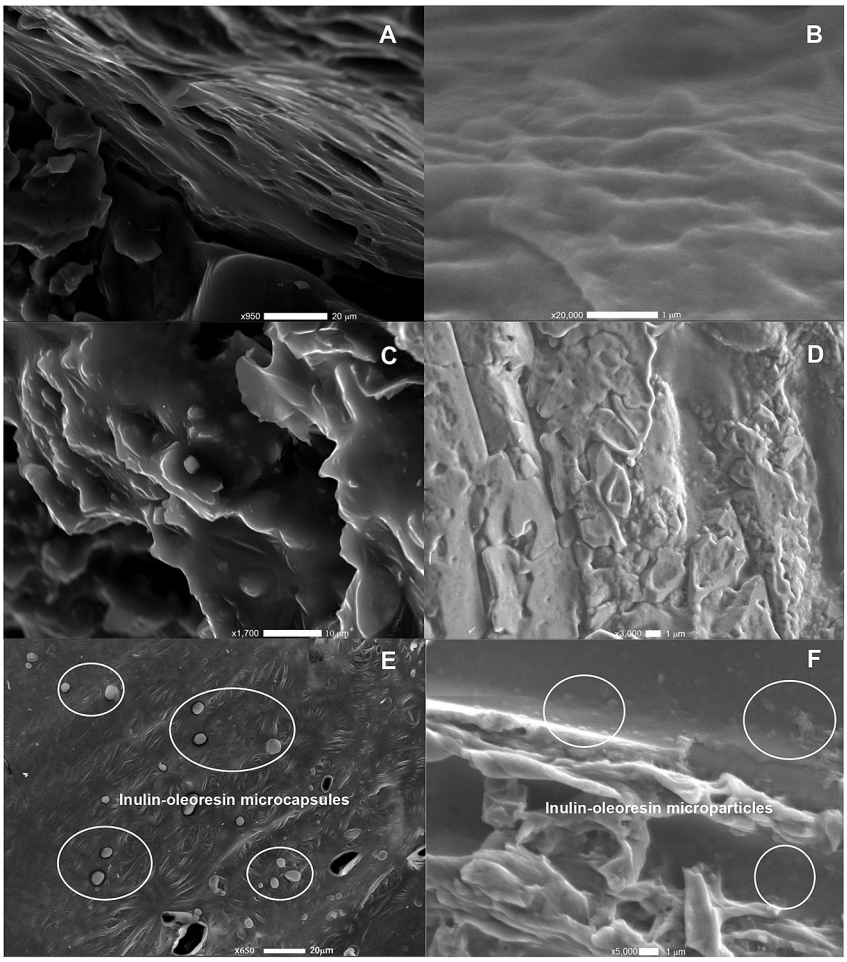

Fig. 3. Electron Probe Micro-Analysis (EPMA) images of mango products. Fresh convectively dried mango **(A, B)**; Osmo-convectively dried mango in sucrose **(C, D)**; Osmo-convectively dried mango in emulsion **(E, F)**. The mango samples were osmodehydrated during 120 min at 40 °C.

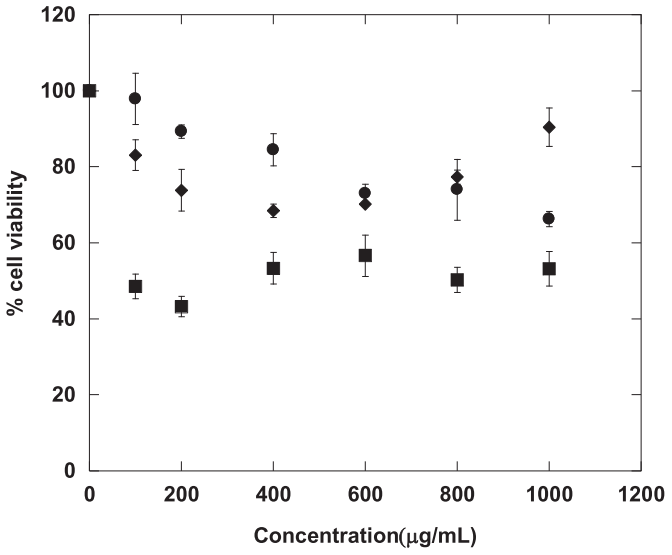

Fig. 4. Inhibition of cancer cell growth by mango extracts measured by the MTT assay of samples treated at 40 °C after 120 min of the osmotic dehydration process. Mango flesh (●); Sucrose (◆); Emulsion (■).

evaluation of the osmodehydrated mango prepared is required, the information obtained using the creole mango as raw material comprises a promising example of the development, simply and effectively, of novel types of functional foods from fruits and vegetables. This methodology can be employed to preserve and enhance mango flavor and color through impregnation with oils and polymers with functional attributes.

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