Global Research Journal of Agricultural and Biological Sciences Vol.3(4) pp.313 –323 October 2012.
Available online http://www.globalresearchjournals.org/?a=journal&id=grjabs

Full length Research.

Antioxidant constituents and chemical properties of 'Tommy atkins' Mango grown in Campeche, México.

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Accepted 15th August 2012.

Mangoes are an important worldwide tropical fruit and are best noted for their color, juicy texture, and sweet flavor, along with important phytochemical constituents. Phenolic compounds influence the organoleptic quality of fruits and provide health benefits thanks to their antioxidant capacity. Mango cultivars differ in their content of antioxidant components due preharvest factors including climatic conditions, agricultural practices, and geographical localization. However, food composition databases never take into consideration the fact that concentrations of nutrients and their activity may change through cooking practices such as blanching. The aim of this research was to investigate the influence of blanching and the geographical growing area on physiological and antioxidant parameters of 'Tommy atkins' mango fruits. They were harvested at the physiologically ripe stage in two regions. Two groups were established: blanching treatment and control fresh fruits. Chemical properties and antioxidant evaluations were determined. The blanching treatment showed positive effect on fruit from both regions increasing the antioxidant constituents. Also, the geographical origin presented influence on the antioxidant parameters. We concluded that hot treatment like blanching is a recommended practice to increase the antioxidant status of mango fresh produces. Therefore, 'Tommy' mango should be considered a good source of these compounds providing important health benefits.

Key words*: Mangifera indica*, Mango, *β*-carotene, Vitamin C, Flavonoids, Phenols, Phytochemical, Antioxidant capacity, Blanching treatment

Introduction

Mango is one of the most important commercial crops worldwide in terms of production, marketing and consumption (Ribeiro *et al.,* 2007). Mango (*Mangifera indica* L.) can be considered a good source of dietary antioxidants, such as ascorbic acid, carotenoids and phenolic compounds (González-Aguilar *et al*., 2008; Ma *et al*., 2011, Palafox-Carlos *et al.,* 2012). Thus, consumption of mango could provide significant amounts of bioactive compounds with antioxidant activity to the human diet (González-Aguilar *et al.,* 2008).

The human body produces reactive oxygen species (ROS), such as superoxide anion radical, hydroxyl radical, and hydrogen peroxide by many enzymatic systems through oxygen consumption (Dina *et al*., 2009). In small amounts, these ROS can be beneficial as signal transducers and growth regulators (Finkel,1998; Hancock *et al.,* 2001). However, during oxidative stress, large amounts of these ROS may favor some human disease conditions such as cancer, cardiovascular diseases, aging, and neurodegenerative diseases (Bagchi *et al*., 2000). Hence, certain amounts of exogenous antioxidants are constantly required to maintain an adequate level of antioxidants in order to balance the ROS (Ma *et al.,* 2011). Several epidemiological studies have suggested that the consumption of fruits, vegetables, or teas can have a

protective effect against the aforesaid diseases. This protection has partly been attributed to the presence of several components with antioxidant capacity such as vitamins, flavonoids, anthocyanins, and other phenolic compounds (Klimczak *et al.,* 2007; Serrano *et al.,* 2007). These compounds, which scavenge free radicals, may reduce oxidative stress level and prevent biomolecules oxidation. In this respect, mango has been demonstrated to have some impact on lung, leukemia, prostate cancers, and particularly effective on the most common breast and colon cancers (Kathleen, 2010).

In addition, mango cultivars differ in their content of antioxidant components due to genotypic variation and preharvest factors including climatic conditions, agricultural practices, and ripening stage (Lee and Kader, 2000, Palafox-Carlos *et al*., 2012). Early studies showed the main phenolic compounds found in mango are leucocyanidin, catechin, epicatechin, chlorogenic acid, quercitrin and quercetin (Berardini *et al*, 2005, Palafox-Carlos *et al*., 2012). It also contains significant amounts of pigments including chlorophylls and carotenoids (Grundhofer *et al*., 2001).

However, many food composition databases never take into consideration the fact that concentrations of nutrients and their activity may change through cooking practices such as blanching. This is of great importance, considering that only a small amount of vegetables is consumed in the raw state, while most need to be processed for safety and quality (Amin *et al.,* 2006).

This article describes the results of a study focused on the chemical characteristics and the contents of total flavonoid, total phenolic compounds, *β*-carotene, vitamin C, and antioxidant capacity in fresh and blanched 'Tommy atkins' mango pulp cultivated in Campeche, México.

Materials and Methods

Sample preparation

Fresh mango fruits (average weight of 393 g and 31 cm of length) (*Mangifera indica* L., cv. Tommy atkins) were harvested at the intermediary ripening stage in two growing areas of Campeche, Mexico: Bacabchén (L1) and Nunkiní (L2) from April to June 2010. The mangoes were stored at room temperature (25 °C) until complete ripening by subjective observation considering softness and peel color (Crisoto, 1994).

Fruits were sanitized with chlorinated water (0.01%) for 10 min and left dry at room temperature and subsequently divided into two sub-lots of 15 fruits. The first lot (fresh fruits) was taken and the peel was removed with a sharp knife and cut as quickly as possible to obtain the pulp that was cut into small pieces. The second lot was subjected to a blanching treatment by immersing the fruit in water at 95 °C until the core temperature was reached at 60 °C and maintained for 5 min. Then mangoes were cooled in water at 12 °C for 20 min until the core temperature was reached at 25 °C and rinsed three times with water (Sakho *et al.,* 1998). Both temperatures were monitored with a puncture thermometer. Thereafter fresh and blanched fruits were stored at -20 °C until chemical and proximate analysis were performed. Finally, representative samples of frozen pulp from fresh and blanched mangoes were homogenized in an Osterizer blender and dehydrated in a freeze dryer Lab-conco Model 6 (Labconco-corp, Kansas City, MO) at 0.04 MBar and -56 °C for 48 h and stored at -20 °C until bioactive compounds and antioxidant capacity analyses were carried out. All the process was carried out at room temperature under subdued light.

Physicochemical and Proximate Analysis

Blanched and fresh pulp samples, previously defrosted under refrigeration overnight, were evaluated in chemical parameters and proximate analysis.

Chemical analysis was performed to determine color, total soluble solids (TSS), pH and titratable acidity. Color measurements were carried out using a colorimeter HunterLab, Mini Scan Ez model (Hunter Lab, Reston, VA) and values were obtained in CIELAB scale (L*, a*, b*). TSS was determined with an Abbe refractometer Atago, NAR-1T model (Atago U.S.A., Inc., WA) and the results were expressed as °Brix. The pH measurements were made using a portable potentiometer Oakton, RS 232 Meter model (Eutech Instruments, Singapore). Titratable acidity was measured by volumetric titration with NaOH 0.1 N up to pH 8.1 and was expressed in g of citric acid per 100 g of fresh weight (FW).

The proximate analysis (moisture, ash, fat, crude protein and crude fiber) were performed according to the methodology proposed by AOAC International (2005).

Bioactive compounds

All the antioxidant extractions for total phenols, flavonoids content, and antioxidant capacity were performed according to Robles-Sanchez *et al*., (2009). Total phenols were measured by the method described by Singleton and Rossi (1965) with some modifications. Extracts (50 µL) were mixed with 3 mL of H_2O and 250 µL of Folin and Ciocalteau phenol reagent 1 N. After 750 µL of Na_2CO_3 (20%) and 950 µL of H_2O were added to the extracts, previous incubation for 30 min at room temperature, finally, the absorbance was read at 765 nm using a UV–VIS VARIAN CARY 50 BIO spectrophotometer (Varian, Italy). Total phenolic compounds were calculated using a standard curve of gallic acid and expressed as mg per 100 g of FW.

Total Flavonoids content was determined based on the methods described by Zhishen *et al.,* (1999) with slight modifications. 1 mL of extract was mixed with 4 mL of deionized H_2O and 300 µL $NaNO_2$ (5%). Then 300 µL of $AlCl_3$ (10%) were added and extracts were reposed 1 min and 2 mL of NaOH (1 M) were added. The volume was made up to 10 mL with deionized water, stirred, and absorbance determined at 415 nm, using a UV–Vis

VARIAN CARY 50 BIO spectrophotometer (Varian, Italy). Total flavonoids were expressed as mg of quercetin equivalents per 100 g of FW.

Ascorbic acid (AA) was analyzed using a Varian Solvent Delivery System pump Model 9012 and a Rheodyne Model 7125 injector (Rheodyne Inc., Cotati, CA, USA) fitted with a 10 µL loop and a Varian Model 9020 UV-Vis absorbance detector. AA was determined according to Doner and Hicks (1981) with slight modifications. Lyophilized fruit tissue (0.2 g) was homogenized Ultra Turrax®T25 basic homogenizer (IKA Works, Willmington, NC, USA) for 1 min with 10 mL of an aqueous solution containing 30 g/L metaphosphoric acid and 80 mL/L acetic acid. The homogenate was filtered and centrifuged for 15 min at 9 400 g using an Allegra 64R Centrifuge (Beckman Coulter, Fullerton, CA, USA). The supernatant was filtered through 0.22 µm filter and analysed by HPLC with a waters–NH_2 type µBondapak (Waters Corporation, Milford, MA, USA) analytical column (3.9 x 300 mm, 10 µm) and a mobile phase of acetonitrile/KH_2PO4 (75:25 v/v) with a flow rate of 1.5 mL/min. AA was detected by ultraviolet absorption at 268 nm and concentrations were calculated using a standard curve and expressed as mg of ascorbic acid per Kg of FW.

β-Carotene was measured as previously described by Mejía *et al*., (1988). Lyophilized fruit tissue (0.2 g) was homogenized by an Ultra Turrax®T25 basic homogenizer IKA Works (Willmington, NC, USA) for 1 min with 10 mL of tetrahydrofuran, containing 0.4% Butylated Hydroxytoluene (BHT). The mixture was centrifuged for 15 min at 6 700 g with an Allegra 64R Centrifuge; Beckman Coulter (Fullerton, CA, USA), filtered through a 0.22 µm filter and analysed by HPLC using a Microsorb RP-C_{18}, 3 µm (4.6 mm x 10 cm) column with a 3 cm guard column Supelco (Sigma Aldrich Co., Bellefonte State, PA, USA) with acetonitrile/methanol/tetrahydrofuran HPLC grade (58:35:7) as the mobile phase at a flow rate of 1.0 mL/min. β-Carotene was detected by visible absorption at 460 nm and identified by retention time comparison with standards. Quantification was done by use of external standards and expressed as mg of β-carotene per 100 g of FW.

Antioxidant capacity assays

$DPPH^{\bullet}$ assay was determined according to the Brand-Williams *et al*., (1995) technique with some modifications. The stock solution was prepared by mixing 2.5 mg of $DPPH^{\bullet}$ radical with 100 mL of pure methanol. The solution was adjusted at an absorbance of 0.7 ± 0.02 at 515 nm. 3.9 mL of $DPPH^{\bullet}$ radical were placed in a test tube and 100 µL of the extract (0.33 g/mL) were added (methanol was used as control). The mixture was shaken in a vortex and kept 30 min in the dark. Absorbance was then read in an UV–Vis VARIAN CARY 50 BIO spectrophotometer (Varian, Italy) at a wavelength of 515 nm. Radical scavenging activity (RSA) was expressed as the inhibition percentage and calculated using the following equation:

%RSA = (control Abs – sample Abs/control Abs) ∗ 100.

TEAC value was determined according to Miller *et al*. (1996) and Re *et al*., (1999). $ABTS^{\bullet+}$ cation was generated through the interaction of 19.2 mg of $ABTS^{\bullet+}$ (2′2-azino-bis(3-ethylbenzotriazoline-6-sulfonic acid)), dissolved in 5 mL of water HPLC-grade and 88 µL of potassium persulfate ($K_2S_2O_8$) (0.0378 g/mL). It was incubated in the dark at room temperature for 16 h; then 1 mL of $ABTS^{\bullet+}$ activated radical was taken and 88 mL of ethanol was added. The radical was adjusted at an absorbance of 0.7 ± 0.02 at 734 nm. The reaction was initiated by adding 2970 µL of $ABTS^{\bullet+}$ and 30 µL of the extract or trolox standard solution in methanol and absorbance was monitored at 734 nm after 1 and 6 min. The percentage of inhibition was calculated and the results were expressed as µmol of trolox equivalents/100 g of FW.

Statistical analysis

The statistical software package Statgraphics® Plus, version 2.1 (Manugistic, Inc., Rockville, Md., USA) was used for ANOVA and Tukey multiple comparison test (p<0.05). Correlations at 95% confidence intervals were determined between bioactive compounds and antioxidant assays. Each treatment was performed in duplicate and the analyses were conducted in triplicate.

Results and discussion

Physicochemical and Proximate Characteristics

The physicochemical characteristics of fresh and blanched 'Tommy atkins' mangoes from both regions (L1 and L2) showed similar values with no significant difference (P≥0.05) in the content of total soluble solids (16.0-16.80 °Brix) or in the value of b* (61.15-66.44) which indicates yellow color of pulp (Table 1). Lower values of total soluble solids have been found (14.2-15.16 °Brix) in the same variety of mango (Fonseca *et al*., 1994), while the parameter b*, associated with the presence of carotenoids in mango pulp, was higher than that obtained by Ribeiro *et al*. (2007). The results obtained in °Brix indicate that the fruits from both regions showed a higher value in comparison with the minimum accepted (13.5 °Brix) for the obtention of puree and juice (Codex Stan, 247-2005).

Table 1. Physicochemical characteristics of fresh and blanched mango in two growing area of Campeche.

		Color					
Growing Area	Treatment	L*	a*	b*	°Brix	pH	Acidity (g/100 g)
	Fresh	60.38a	21.99a	66.44a	16.0a	4.48a	0.65a
L1	Blanched	55.40b	18.34b	63.0a	16.70a	4.62b	0.33b
	Fresh	58.95a	21.57a	61.89a	16.80a	4.82a	0.32a
L2	Blanched	53.34b	17.86 b	61.15a	16.80a	5.40b	0.22b

L1= Bacabchén y L2= Nunkiní, [a, b] Different letters in the column within each growing area show significant statistical difference with P≤ 0.05 (Tukey Test). The values are the means of 30 fruits.

After the blanching treatment, parameters as luminosity L* (53.34-55.40), the value of a* (red) (17.86-18.34), and acidity (0.22-0.33 g/100 g of citric acid) of the mangoes from both regions were all significantly lower (P≤0.05) than those observed in the fresh fruit, while the pH value was higher (4.62-5.40). These results pointed out the effect of the blanching treatment on the quality parameters of mangoes. The reduction in luminosity and the value of a* suggest an increase in brown pigments as a result of caramelization and/or Maillard reactions due to the heat (Ameny and Wilson, 1997). The reduction in acidity has been associated with the degradation of citric acid by heat, which in turn can be attributed to increased respiratory activity in the fruit using organic acids as substrate (Lurie and Klein, 1991; Esquivel *et al.,* 2006).

Regarding to the proximate characteristics of fresh and blanched mango from both regions, no significant differences (P≥0.05) were observed in humidity (80.55-82.18%) and crude protein (0.85-0.93%); however, the contents of ash (0.30-0.38%), fat (0.15-0.21%), and crude fiber (0.55-0.66%) were reduced (P≤0.05) due to the effect of the blanching treatment (Table 2). In this sense, the results obtained in the proximate composition were similar to those found by Laohasongkram *et al*. (1995), Kansci *et al.* ,(2008) and Akhtar *et al.,* (2010) in different varieties of mango (Améliorée, Keitt, Mango, Palmer, Kaew and Chaunsa). This would suggest that the 'Tommy atkins' mango cultivar under study, fresh or blanched, represents an important source of nutrients for the consumer.

Table 2. Proximate characteristics of fresh and blanched mango in two growing area of Campeche.

growing area	Treatment	Moisture (%)	Ash (%)	Crude fat (%)	Crude fiber (%)	Crude protein (%)
	Fresh	80.55a	0.41a	0.32a	0.69a	0.90a
L1	Blanched	81.67a	0.38b	0.15b	0.66b	0.85a
	Fresh	82.18a	0.34a	0.26a	0.64a	0.93a
L2	Blanched	81.50a	0.30b	0.21b	0.55b	0.85a

L1= Bacabchén y L2= Nunkiní. [a, b] Different letters in the column within each growing area show significant statistical difference with P≤ 0.05 (Tukey Test). The values are the means of 30 fruits.

Bioactive compounds

The effect of blanching treatment and growing area were evaluated in mango fruits. In general, the blanching treatment affected (P≤0.05) total flavonoids, vitamin C, and total phenols, while region also influenced content of the antioxidants constituents. Total flavonoids content was determined in fresh and blanched mango fruits. Also, fruits from two different regions (L1 and L2) were evaluated. Figure 1 shows that the blanching increased the flavonoid content, in fruits from both regions L1 and L2 the flavonoid content increased (12 and 15.3 mg QE/100 g FW, respectively) in comparison to fresh fruits. However, the region seems to affect the flavonoid content in fresh mango fruits. Fruits from region L2 presented higher values than fruits from L1 (11 and 15 mg QE/100 g FW, respectively). A similar pattern was observed for vitamin C content (figure 2), where fruits with blanching treatment from both regions presented higher Vitamin C content (10 and15 mg/100 g FW). Regarding to total phenol (figure 3) there is not significantly differences (P≥0.05) between fresh fruits from both regions (20 and 21 mg GAE/100 g FW). The blanching treatment only affected positively the total phenol content of mango from growing area L2 (23 mg GAE/100 mg FW).

In general, our results indicated that the blanching treatment increased the content of flavonoid, vitamin C and total phenols. However, this behavior is more evident in flavonoid and vitamin C content. The hot water effects

observed were in agreement with Kim *et al*. (2009; 2007), who reported that hot water immersion was an important factor influencing hidrophilic antioxidant concentration in mangoes 'Tommy atkins'. Similarly, Oboh (2005) observed an increase in total phenolic content up to 200% after blanching treatment in green leafy vegetables while Kim et al., (2009) found an increase of 30 % in gallic acid following heat treatment. Both authors suggest that the increment of phenolics may be due to the disruption of the cell membranes and cell walls making it more available during extraction. In addition, according to González *et al*. (2010), high temperatures have been used as a stress treatment to active the phenylpropanoids pathway in fruits and fresh produce, in order to increase the biosynthesis of phenolic compounds. Therefore, the heat applied during the blanching treatment could induce the phenylpropanoid pathway increasing the phenolic content in mango. These statements may explain why the flavonoid and phenol content was higher than fresh mangos with no treatment. In the case of vitamin C, similar phenomenon may be taking place due to that the vitamin C biosynthesis is activated by high temperature stress as reported by González-Aguilar *et al*. (2010; 2009). Finally, our results are in accordance to Talcott *et al*. (2005), who reported an increase and differences in 'Tommy atkins' mangoes during ripening indicating that appreciable differences may occur among fruit under different geographical regions, growing conditions, or harvest year. This may explain the difference in hydrophilic antioxidant content between mango fruits from both regions.

Figure 4 shows the mean values of β-carotene content of fresh and blanched 'Tommy atkins' mangoes from two different growing areas (L1 and L2). As can be seen, blanching caused a slightly increase on the content of β-carotene in 'Tommy atkins' mangoes reaching a maximum concentration in the L2 with 10.48 mg/100 g FW. However, no significant differences ($P \geq 0.05$) were obtained between the fresh and blanched mangoes and between growing areas. Naturally, carotenoids in plants are bonded with proteins in photosynthetic structures and physical architecture. Blanching is one of the most common methods of increasing availability of carotenoids, by separating the bondage of the natural occurring component in plant tissue (Southon and Faulks, 2001). Therefore, the slightly increase in the content of β-carotene could be due by a better release of the food matrix. These findings are in agreement with those found by Wen *et al*. (2010) who revealed an increase in β-carotene content in different plant tissues such as Four-angled bean, long bean, French bean, snow pea, and snap pea by blanching treatment. In addition, it has been observed that the growing area could affect the content of phytochemicals among cultivars (Kevers *et al*., 2007; Lu *et al*., 2009). However, in the present study this effect was not observed.

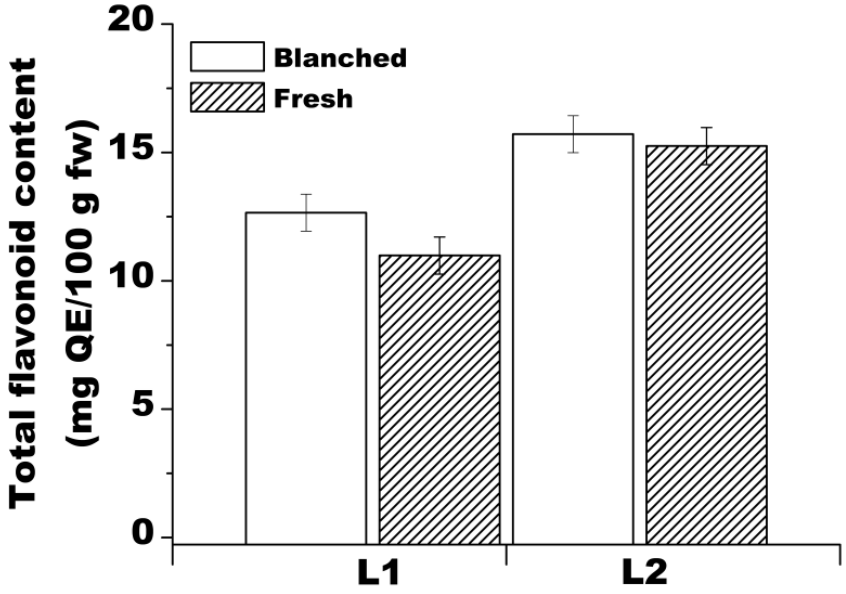

Figure 1. Total flavonoid content in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

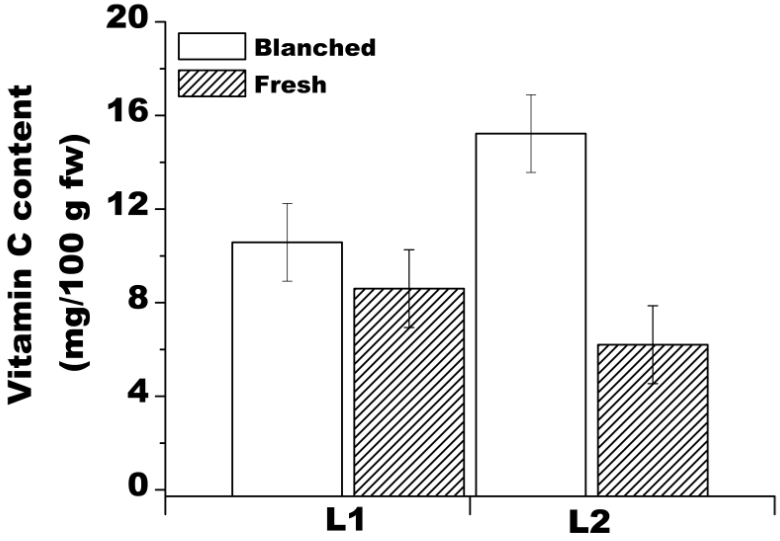

Figure 2. Vitamin C content in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

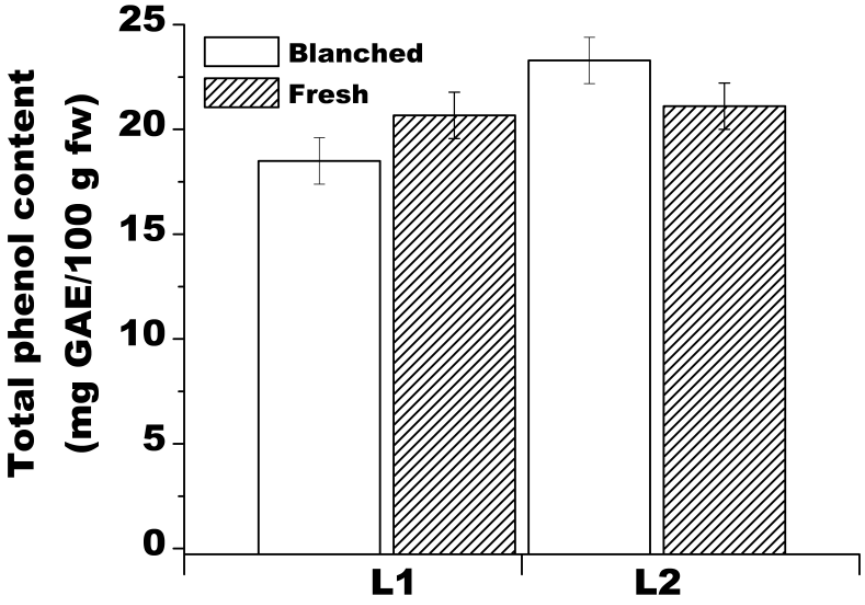

Figure 3. Total phenol content in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

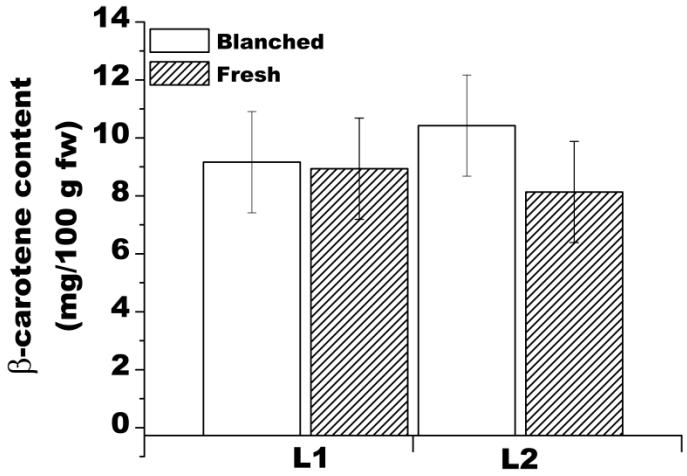

Figure 4. β-carotene content in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

Antioxidant capacity assays

The effects of blanching on DPPH• radical scavenging activity of 'Tommy atkins' mangoes from two different growing areas is presented in Figure 5. Results showed that there are significance differences (P≤0.05) among fresh and blanched fruits and growing areas. The blanched fruits had the highest DPPH• radical scavenging activity in both growing areas. However, L2 presented the highest DPPH• radical scavenging activity for both blanched and fresh mangoes. L2 had about 20% higher DPPH• radical scavenging activity for blanched and for fresh mangoes. The DPPH• method has been recently used by Jaiswal *et al*. (2012) and Wen *et al*., (2010), they observed that antioxidant capacity measured as radical scavenging activity was lower compared with non-treated produce. In contrast, Vina *et al*. (2007) found an increase in radical scavenging activity in Brussels sprouts after blanching treatment which is in agreement with our results. Previous reports have shown contradictory findings on the effect of blanching on antioxidant capacity of plant tissues. Recent studies reported by several groups have showed that blanching influence antioxidant capacity of vegetables and the effects were not consistent in different foods. Some studies reported an increase in antioxidant capacity while others showed otherwise (Turkmen *et al*., 2005; Vina *et al*., 2007; Xu and Chang, 2008). González-Aguilar *et al*. (2010) mention that the stress caused by heat can trigger the synthesis of antioxidant compounds, nevertheless, inadequate doses can result in an irreversible change of cellular homeostasis leading low concentrations of antioxidants and therefore lower antioxidant capacity. This could partially explain the inconsistencies in the literature.

Commonly, antioxidant capacity of plant foods is related with the content of phenolic compounds since these compounds showed a better correlation in most of the cases. In general, DPPH• radical scavenging activity values coincide with an increase in total flavonoids, phenols (Figure 1 and 3), and vitamin C (Figure 2). Therefore, it could be assume that hydrophilic antioxidants are the major contributors to the antioxidant activity measured by DPPH• assay. This result was expected and is in agreement with previous studies (Robles-Sanchez *et al*., 2009; Gayosso-García *et al*., 2010; Ma *et al*., 2011).

Figure 6 shows the TEAC values of fresh and blanched 'Tommy atkins' mangoes from two different growing areas. In general, results point out that there are slightly differences (P≥0.05) among fresh and blanched fruits and growing areas. Fresh fruits had the highest TEAC values in both growing areas. L2 presented the highest TEAC values for both blanched and fresh mangoes with 175 and 190 µmol ET/100 g FW respectively. L2 had about 5% higher TEAC values for blanched and for fresh mangoes. There are many methods used to determine total antioxidant capacity. It has been observed that some antioxidant assays give different trends as can be seen in Figure 5 and 6 for DPPH• and TEAC assay. The Pearson's correlation coefficients between total phenolics, flavonoids, and antioxidant activity (using TEAC and DPPH) are presented in Table 3. The flavonoids and total phenolics were highly correlated with the total antioxidant activity from TEAC (R=0.73 and 0.64, P≤0.05) and DPPH (R=0.83 and 0.73, P≤0.05) assays. The results suggest that these bioactive compounds may be the most important contributors to the antioxidant activity in the fruits studied in this work.

Our results are in contrast for those reported by Gayosso-Garcia *et al*., (2010) who found a good correlation between DPPH• and TEAC assay in peel and pulp of papaya fruit. Regardless to these differences, antioxidant capacity has been closely related to the phenolics, β-carotene, vitamin C, and other compounds. Differences in trends of antioxidant capacity in mango

fruits in DPPH$^{\bullet}$ and TEAC methods could be attributed to the characteristics of antioxidant components and by the differences in substrates, reaction kinetics, and analytical methods to evaluate antioxidant activity between both assays (Huang *et al*., 2005). These results imply that a correlation may partly result from a similar reaction mechanism but it is not always in complete agreement due to the different radicals in the respective assays and diverse group of antioxidants found in fruits. These findings support the statement that a single method is not adequate for evaluating the antioxidant capacity of foods which has been widely recognized by several authors (Frankel and Meyer, 2000; Heo *et al*., 2007; Huang *et al*., 2005; Robles-Sanchez *et al*., 2009; Tabart *et al*., 2009).

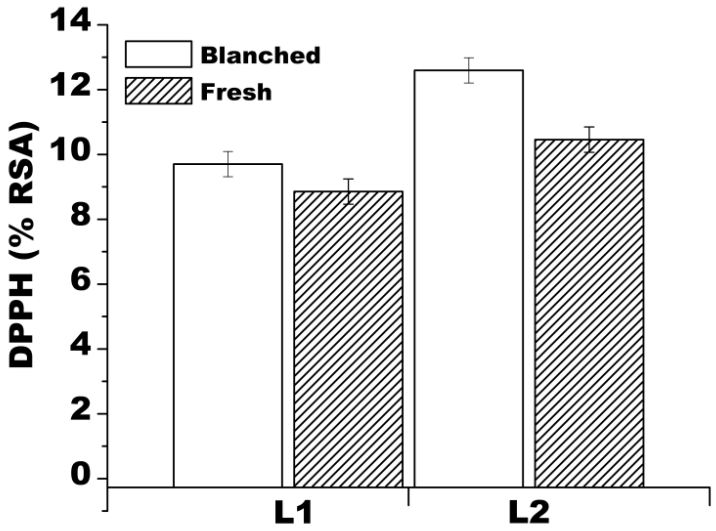

Figure 5. DPPH radical scavenging activity (%RSA) in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

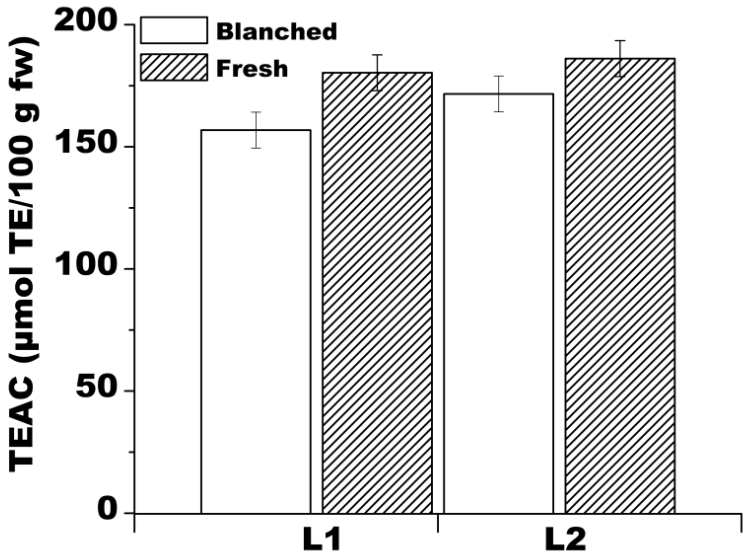

Figure 6. Antioxidant capacity expressed as TEAC in fresh and blanched mangoes grown in Campeche: L1= Bacabchén y L2= Nunkiní. Data shows are means of at least three determinations and error bars indicate the standard deviation.

Table 3. Pearson´s correlation coefficients (R) between bioactive compounds and antioxidant capacity (fresh weight) of fresh and blanched mangoes grown in Campeche.

	Correlation coefficient (R)	
Parameters	TEAC	DPPH
Flavonoids	0.73*	0.83*
Total phenolic	0.64*	0.73*
DPPH	0.72*	

*Significance level at $P \leq 0.05$.

This study reveals in overall that the consumption of mango fruits from the Campeche México growing area, may deliver greater health benefits through the supply of natural antioxidants thanks to their antioxidant potential. The results indicate promising perspectives for the commercial exploitation of the fruit. This investigation will also be useful to consumers as a tool for planning rich antioxidant diets and to nutritionists in estimating the daily intakes of phenolic antioxidants and their impact on health.

Conclusion

In general, our results indicated that the blanching treatment increased the content antioxidant constituents especially phenolic compounds and vitamin C of ´Tommy atkins´ mango. Blanching treatment also improved the quality parameters of mango fruits. On the other hand, there were no consistent differences between mangoes from different regions. Finally, the 'Tommy atkins' mango cultivar under this study, fresh or blanched, represents an important source of nutrients and antioxidant content for the consumer.

Acknowledgments

This study was supported by the CONACYT-FOMIX CAMPECHE Grant nr 97166, México.

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