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Full Length Research Paper

Quality of three sizes of prickly pear cactus stems (*Opuntia ficus indica* L. 'ATLIXCO')

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Nowadays, the prickly pear cactus stem has become an important part of the human diet due to its nutraceutical properties. Consumers show different preferences in the size of prickly pear cactus stems. The objective of this study was to evaluate some quality changes due to the effect of prickly pear cactus stem size in refrigeration (8 ± 2°C) for six days. The hypothesis was that the quality parameters vary according to the size and the storage time. Cut resistance, weight loss, color, titratable acidity, ascorbic acid and chlorophyll were evaluated in three prickly pear cactus stem sizes (5.0 to 10.5; 10.6 to 16.9 y 17.0 to 22 cm) of *Opuntia ficus indica* L. 'Atlixco' (thorns were removed), kept refrigerated at 8 ± 2°C for six days. The smallest size showed the highest weight lost (3.22%). Content of chlorophyll a, b, and total was directly proportional to the size and it increased with the storage time during the evaluated days. Also, the ascorbic acid content decreased significantly with the storage time.

Key words: *Opuntia ficus indica*, postharvest, chlorophyll, ascorbic acid content.

INTRODUCTION

Nowadays, the prickly pear cactus stem has become very relevant in Mexico due to its nutraceutical properties (Stintzing and Reinhold, 2005; Guevara, 2009), cutting down on erosion, adaptability to poor soils, and adaptability to drought conditions (Saénz et al., 2006; Guevara, 2009). It contains important amounts of potassium (K), calcium (Ca) and vitamins, among other elements such as selenium (Se) and phosphorous (P) which make it an important food for humans (Rodríguez-García et al., 2007).

The consumption and production of prickly pear cactus stems in the world is primarily located in Mexico. Mexico has a production of around 728, 940 t, and the consumption per capita is 3.27 kg per year (Claridades, 2001; SIAP, 2009). Other countries with considerable nopal cultivated lands use nopal plant exclusively for its fruit exploitation, for example, countries such as Italy (3,000 ha) (Basile, 2001); Argentina (2,000 ha) (Ochoa and Uhart, 2004) and Chile (1,100 ha) (ODEPA-CIREN, 2003).

The prickly pear cactus stems are defined as young cladode originating from genders of *Opuntia* spp and *Nopalea* spp plants from the family of the Cactaceae; it also has variable sizes (7 to 30 cm in length) according to the nopal codex norm (CODEX, 1993) and the Mexican norm NMX-FF-068-SCFI-2006 (SAGARPA, 2006). The prickly pear cactus stems when slightly processed (no thorns and cut) have a storage life of just one or two days under environment temperature and such life could be extended up to seven days if stored at a 5°C (Fortiz-Hernández and Rodríguez-Félix, 2010). The slight process causes cell breaking. This breaking increases the breathing speed, and ethylene production, as well as,

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the synthesis of secondary metabolites (Artés et al., 2007). Such synthesis processes are considered as reactions that reduce the storage life of the product and cause enzymatic darkening, mucilage secretion, firmness loss, color change from shiny green to olive green, water loss, vitamin C loss, and acidity lack of control (Aguilar-Sánchez et al., 2007; Artés et al., 2007; Oms-Oliu et al., 2010).

The varieties: 'Milpa Alta', 'Atlixco', 'Copena VI', 'Copena F1', 'White', 'Black', 'White with Thorns' and 'Polotitlán' of *O. ficus indica* L. are used in the prickly pear cactus stems (Claridades, 2001). The prickly pear cactus stems *O. ficus indica* L. 'Atlixco' are cultivated over wide areas in Mexico, and part of its production is exported to the United States (Gallegos et al., 2006). However, the available databases show very little information about this variety and the variability of quality parameters due to the size of the harvested prickly pear cactus stems. Some studies have shown that some quality parameters vary according to this size (Betancourt et al., 2006; Hernández-Urbiola et al., 2011).

Aguilar-Sánchez et al. (2007) reported on differences in titratable acidity, pH, firmness, shininess, purity, tone angle, among other variables, in 19 varieties of *O. ficus indica* L. Betancourt-Domínguez et al. (2006) found variability in the content of soluble solids, texture, titratable acidity, and pH in relation to the size of the tested cladodes (14, 17 and 22 cm) in prickly pear cactus stems of *Opuntia* 'White with no thorns', 'Verde Valtierra', and a wild variety. The objective of this study was to evaluate some changes in quality by the effect of the prickly pear cactus stems (*O. ficus indica* L. 'Atlixco') size (1=5.0 to 10.5 cm, 2=10.6 to 16.9 cm and 3=17.0 to 22.0 cm) for six days of refrigeration storage (8 ± 2°C).The hypothesis was that the quality parameters vary according to the harvested prickly pear cactus stems size and the storage time.

MATERIALS AND METHODS

The prickly pear cactus stems 'Atlixco' were obtained in the community of San Pablo Ixquitlán, in a Town called "San Martín de las Pirámides", State of Mexico; its geographical location is 19° 46' 20" North Latitude, and 98° 38' 48" West Longitude, and an altitude of 2300 m. The harvest was carried out by hand, between 8:00 and 10:00 a.m. The prickly pear cactus stems of three different sizes were collected (1= 5.5 to 10.5 cm, 2=10.6 to 16.9 cm and 3=17.0 to 21.6 cm). They were carried in brown paper bags to the Postharvest Laboratory of the Fruit culture Program of "Colegio de Posgraduados" Institution. 18 h before the determinations, the thorns were removed, using a knife. Then, they were washed with running water from the faucet. The humidity excess was removed, and they were classified according to their size. They were stored in open plastic bags for six days at 8 ± 2°C. One bag was used for every five cladodes. The cut resistance, weight loss, color (brightness, hue angle, and chroma), titratable acidity, chlorophyll content (a, b, and total), and ascorbic acid content were evaluated. The harvest day was considered to be the day number zero. Evaluations took place in days one, three, and six. Cut resistance was evaluated only on days one, and six.

Assessed variables

The cut resistance

It was determined in three specific points of the prickly pear cactus stems (base, center, and tip), in the longitudinal central section, using a texture meter (FDV-30, Warner Instrument®, USA), which has a 0 to 13.6 kg force sensibility, and a cutting tip in a 30 mm chisel shape. The data was recorded in Newton (N).

Weight loss (%)

It was calculated using the equation:

Weight loss % = ((initial weight – final weight) / initial weight) ×100

For such operation, the cladodes were measured in days one, three, and six on an electronic scale (A and D Co Model EY-2200A®), with a 2 kg capacity.

Color

The color measurement was carried out using the color meter Hunter-Lab D 25®, which has an openness of 1.25 cm; the values L*, a* and b* were evaluated in the middle part of one of the sides of each assessed cladode. The L* value refers to the clearness of the tone in color, and its value is represented on a scale from 0 to 100. The hue angle or angle tone $\left(\tan^{-1} b^*/a^*\right)$ and chroma or color saturation $\left(\sqrt{(a^*)^2+(b^*)^2}\right)$were determined. Chroma represents the tone intensity. L* value was directly interpreted as luminosity or brightness.

Titratable acidity

The quantification of the titratable acidity was carried out in comply with the AOAC (1990). A sample of 10 g was homogenized in 50 ml of distillate water. The total volume of the mixture was measured using a test tube. Then, a filtering process using gauze took place in order to eliminate solid elements. A 2 ml aliquot was used and titrated with NaOH (0.01 N), using phenolphthalein as an indicator. The results are expressed as % of malic acid (Fortiz-Hernández and Rodríguez-Félix, 2010) and calculated using the equation:

$$\text{Titratable acidity (\%)} = \frac{\text{(ml NaOH) (N NaOH) (Milieqivalent malic acid) (total volume)}}{\text{(Sample weight) × (aliquot)}} \times 100$$

Chlorophyll content

The chlorophyll was extracted using acetone at 80% in water, based on the methodology 942.04 as proposed by AOAC (1970). Chlorophyll a, b, and total were determined by spectrophotometry. Absorbance in the visible wave length of 663 and 645 nm were measured. Estimations were made using the following equations: Total chlorophyll = 8.05(A663) + 20.2(A645)

Table 1. Determination of cut resistance (N) in days one and six of the three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

Size	Day 01			
	Base	**Middle**	**Tip**	**Total**
1[z]	6.6 ± 2.74[a]*	7.2 ± 2.45[a]	6.5 ± 0.54[b]	6.8 ± 1.54[a]
2	5.8 ± 2.47[a]	7.9 ± 2.36[a]	8.7 ± 2.39[a]	7.5 ± 2.18[a]
3	7.0 ± 1.23[a]	8.4 ± 2.56[a]	7.1 ± 0.90[b]	7.5 ± 0.68[a]
Means	6.46 ± 2.19	7.83±2.43	7.43±1.73	7.27±1.57
		Day 06		
1	7.4 ± 1.58[a]	8.1 ± 1.66[b]	6.5 ± 0.95[b]	7.3 ± 1.16[b]
2	7.9 ± 1.73[a]	9.0 ± 2.4[ab]	7.3 ± 0.85[ab]	8.1 ± 1.04[ab]
3	8.0 ± 2.96[a]	10.6 ± 2.19[a]	8.6 ± 0.99[a]	9.1 ± 1.47[a]
Means	7.76 ± 2.15	9.23 ± 2.48	7.46 ± 1.19	8.17 ± 1.43
Total means	7.11 ± 2.27	8.53 ± 2.51	7.45 ± 1.48	7.72 ± 1.56

*Means with the same letter in columns are statistically equal (Tukey P≤0.05). [z]1=5.5 to10.5 cm; 2=10.6 to 16.9 cm; 3=17 to 21.6 cm. [y]standard deviation.

Chlorophyll a = 12.5(A663) – 2.59(A645)

Chlorophyll b= 22.9 (A645) – 4.68 (A663)

The results were expressed in mg of chlorophyll per 100 g pulp.

Ascorbic acid

The ascorbic acid quantification was carried out through the 2, 6-dichlorophenol indophenol method 967.21 (AOAC, 1990). 5 g from the sample along with 50 ml of oxalic acid (0.5%) were homogenized. A 5 ml aliquot was titrated with Tillman solution (0.02% of 2, 6-dichlorophenol indophenol Merk®), until a pink color was gotten. The concentration of the ascorbic acid was determined with the help of a pattern curve that was generated by titrating samples with known concentrations of ascorbic acid. The results are reported as mg of ascorbic acid per100 g of pulp.

Statistical analyses

The statistical design used was a completely randomized design (CRD) using three treatments (prickly pear cactus stem sizes) with five repetitions. A factorial completely randomized design for determinate significant differences between days was also realized. Analytical determinations were subjected to an analysis of variance (ANOVA) and to identify significant differences among treatments, the Tukey's test was performed at P≤0.05. Pearson correlation was also determined (r<0.05) and statistical analysis was performed using the SAS package version 6.12 for Windows.

RESULTS AND DISCUSSION

Cut resistance

On the average, the initial cut resistance was 7.27 N, and after being stored, it significantly (P≤0.05) increased to 7.72 N (Table 1). The middle part of the cladodes had more cut resistance (P≤0.05) in total overage with 0.853 N, in regards to its base and tip (7.11 N and 0.745 N). The size 1 prickly pear cactus stem recorded (P<0.05) less *cut resistance* in its tip (6.5 N on days 1 and 6), in comparison to the remaining prickly pear cactus stem sizes assessed. In day six, the cut resistance in size 1 was (P<0.05) lower (7.3).

The increases on cut resistance appeared to be contradictory, since it should have decreased due to peeling and storage effects. Such effects should accelerate the softening of the cell walls, and its firmness (Artés et al., 2007). However, the results are in line with the report of Yahia and Arauza (2010), who pointed out a slight increase in the firmness of the 15 cm long prickly pear cactus stem with thorns (*O. ficus indica* L. 'Milpa Alta') within the first seven days in storage at 5°C in semi passive atmospheres which had a 20 % of CO_2. On the other hand, the values obtained in this study are close to the ones reported for the unpacked witness, which was refrigerated at 5°C by Guevara et al. (2001) in *O. ficus indica* L. 'Milpa Alta' after day zero. Probably, the little resistance to cut and the slight increase could be due to a higher refrigeration temperature (8 ± 2°C) and a low relative humidity.

The results obtained on the size of prickly pears cactus stems could imply greater stem water loss, and higher breathing rate (Del Valle et al., 2004). However, no correlations between cut resistance and the weight loss percentage were found. The biggest cut resistance in size 2 and 3 could be caused by the increase in the thickness of the cladode (Betancourt-Domínguez et al., 2006).

Table 2. Determination of weight loss (%) in days one, three and six of the three size of 'Atlixco' prickly pear cactus stem, stored at 8 ± 2°C.

Size	Weight loss (%)		
	Day 01- 03	Day 03- 06	Total
1[z]	1.10 ± 0.77[ya]*	2.14 ± 1.42[a]	3.24 ± 1.66[a]
2	0.36 ± 0.35[a]	0.98 ± 1.28[a]	1.34 ± 1.17[b]
3	0.86 ± 0.83[a]	1.07 ± 0.81[a]	1.93 ± 1.09[ab]
Means	0.77 ± 0.73	1.40 ± 1.28	2.17 ± 1.6

*Means with the same letter in columns are statistically equal (Tukey P≤0.05). [z]1= 5.5-10.5 cm; 2= 10.6-16.9 cm; 3= 17-21.6 cm. [y]Standard deviation.

Weight loss

The weight loss was expressed in percentage (%). Based on Table 2, the weight loss increased (P≤0.05) with the storage time (day one to three = 0.77%; day three to six = 1.40%). By the end of the storage, the size 1 and 3 of prickly pear cactus stems lost (P≤0.05) the most weight (3.24 and 1.93%, respectively) with respect to size 2 (1.34%). Luo et al. (2012) reported weight loss on *Zizania latifolia* whole and cut storaged at 1°C. Yahia and Guevara-Arauza (2010) mentioned weight loss increases in the whole prickly pear cactus stems *O. ficus indica* 'Milpa Alta' packed in modified and refrigerated atmospheres (5°C). The high weight loss in prickly pear cactus stems size 1 could be because of a higher breathing rate than the other sizes; it could also be mentioned that the younger tissue has a higher breathing than the older ones (Del Valle et al., 2004) Another reason can be a high transpiration because the damaged areas is facilitated due to the elimination of the epidermis and the cuticle. López et al. (2009) indicated that the drying time of prickly pear cactus stems (*O. ficus indica*) was reduced when the 30% of cuticle was removed. The size 1 prickly pear cactus stems had the bigger area of injuries during the thorn removal. This fact causes more serious injuries in a reduced surface compared to size 2 of prickly pear cactus stems.

Color

Brightness

The brightness fluctuated between 38.49 to 43.99 and increased (P≤0.05) on day three (43.090), while it decreased (P≤0.05) on day six (40.821) with respect to the three days. In the evaluation of day one, the brightness was statistically equal for the three sizes (41.90, 39.76 and 38.595, respectively). On day three, the values increased (size 1=43.99; size 2=42.93; size 3=42.36) without significant differences and same situation occurred for day six (size 1=41.18; size 2=40.18; size 3=41.10). Increments in the brightness during storage was reported by Yahia and Guevara-Arauza (2010) in prickly pear cactus stems *O. ficus indica* 'Milpa Alta' without packaging in an atmosphere of 40 and 80 KPa of CO_2. In general, the values of brightness were similar to the values as reported by Aguilar-Sánchez et al. (2007). They reported a 40 to 46 range for 19 varieties of *O. ficus indica* L., including the variety of this study (43.08).

Tone angle or hue angle

All measurements turned out between 178 y 180°, in the green tone (Figure 1) and it decreased (P≤0.05) after day one (179.42, 179.03, 178.96, days one, two and three, respectively). Size 1 was (P≤0.05) less green (179.38) than other sizes, sizes 2 and 3 did not show significant differences (179.41 and 179.46). By day six storage, the size 3 showed (P≤0.05) a lower value in hue angle (178.87). The values of the tone angle did not agree with the report of Aguilar-Sánchez et al. (2007), in which the angle tone of 'Atlixco' was 114.80°. The tone angles on size prickly pear cactus stem 1 on day one might imply that it has less developed chloroplasts. Tone angle decreasing on day six (on size 3) could be due to color change from green to yellow, probably because of chlorophyll degradation (Toivonen and Brummell, 2010). Similar results have been reported in purslane (*Portulaca oleracea* L.) (Rinaldi et al., 2010), and rocket leaves (*Eruca sativa* Mill) (Koukounaras et al., 2007), as a result of high storage temperatures where the metabolism of vegetables increased and caused changes in color and a decrease in the hue angle values.

Color intensity or chroma

It shows whether the tone is pale, or intense. On the overage, chroma reached the highest values on day

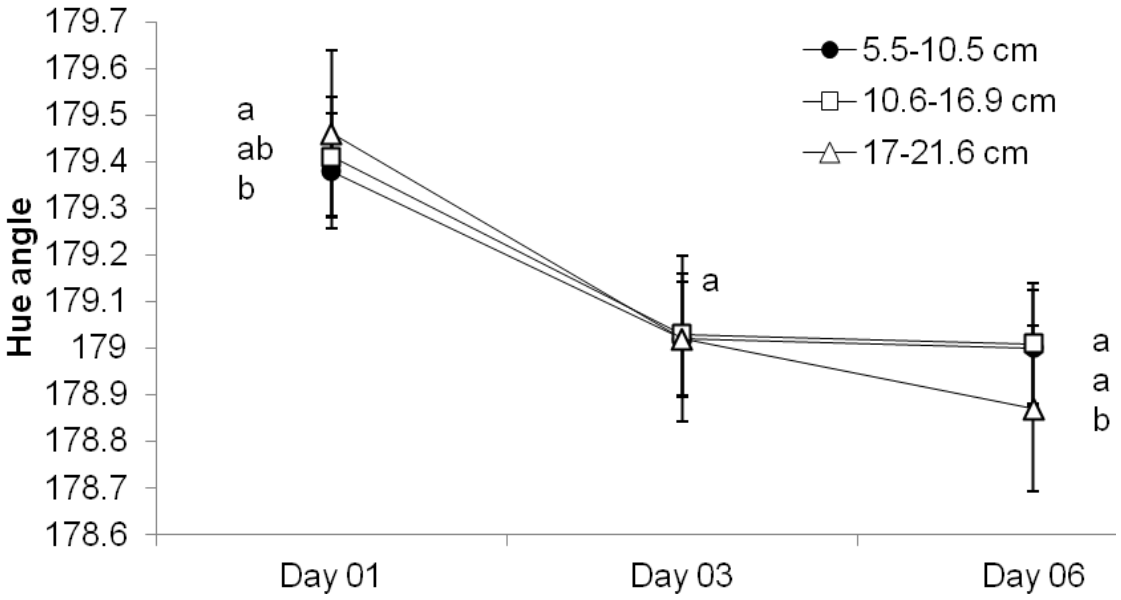

Figure 1. Hue angle in days one, three and six of three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

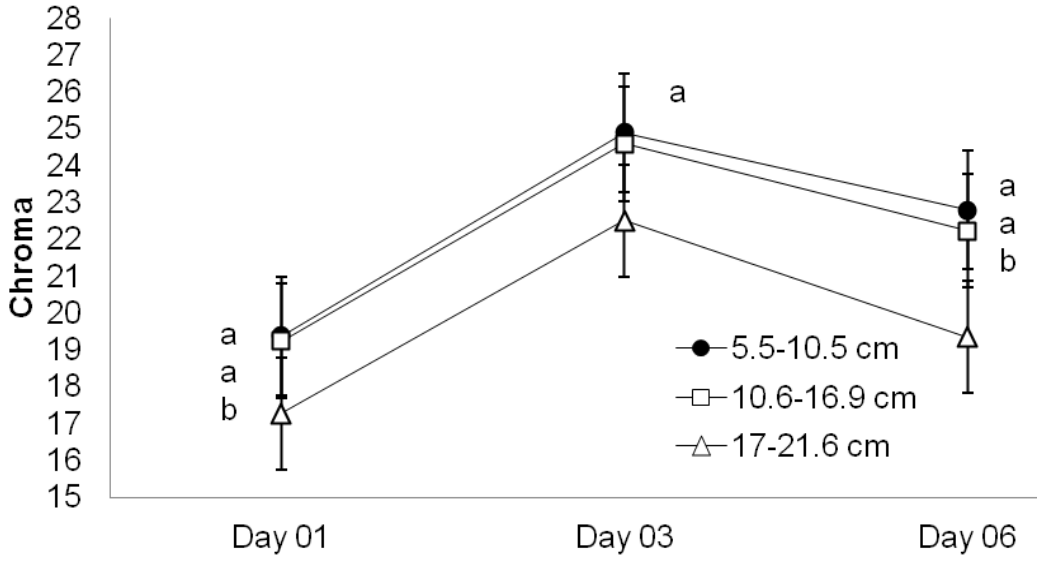

Figure 2. Chroma in days one, three and six of the three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

three (P≤0.05) of storage (24.00) in comparison with days one and six, which were statistically different from them (18.64 and 21.46, respectively). Analysis indicated a range of values between 17.29 and 24.91 (Figure 2). Values of size 3 were (P≤0.05*)* smaller in days one and six (17.29 and 19.35, respectively). Chroma was associated to brightness (r=0.499**; r=0.774**; r=0.599**) and size of prickly pears cactus stems (day three: r=-0.527**; day six: r=-0.538**) and size 3 showed a green color less intense that the other sizes. Values on day one and size 3 of day six was smaller than the results reported in 19 *O*. *ficus indica* L. varieties by Aguilar et al*.* (2007). They reported a range between 20.93 and 29.452, and specifically, a value of 23.47 for the 'Atlixco'

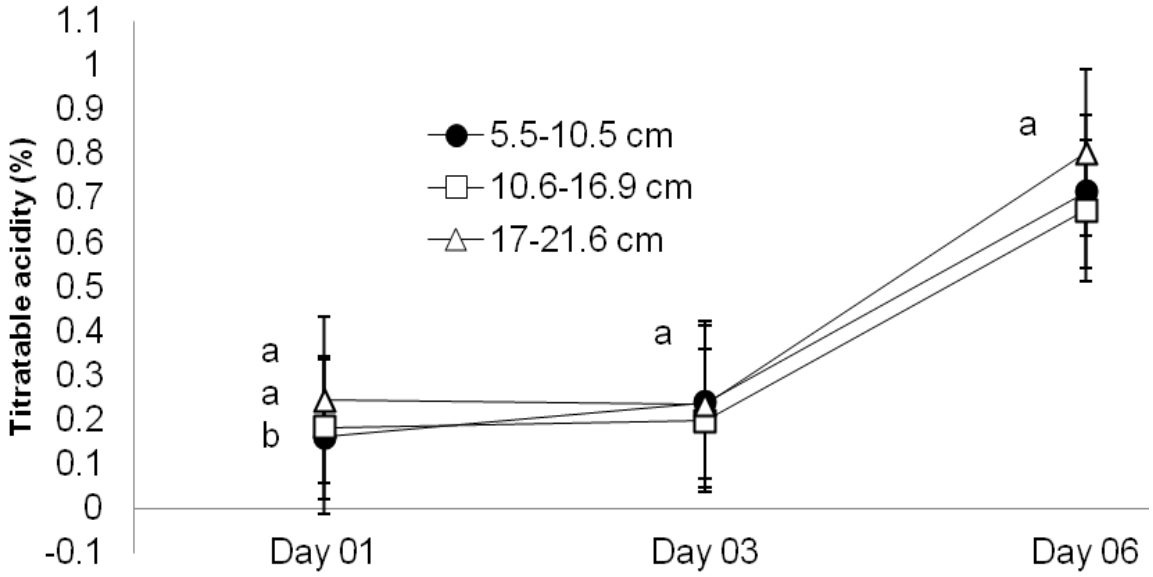

Figure 3. Titratable acidity (%) in days one, three and six of the three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

variety of 20 cm size.

Titratable acidity

In general, prickly pear cactus stem constituted of several acids such as: oxalic, malic, citric, malonic, succinic, tartaric and pscidic (Jianqin et al., 2002). Titratable acidity ranged from 0.162 to 0.803% during storage and increased significantly (P≤0.05) on day six (0.74% of overage). Size 3 of prickly pear cactus stems were significantly (P≤0.05) more acidic on day one (0.25%) and size 1 was the least acidic (0.162%) (Figure 3). Days one and three showed titratable acidity lower than the values of 0.28 to 0.95%, 0.4 to 0.6%, 0.30 to 0.85% as reported by Cantwell et al. (1992), Corrales-García et al., (2004), and Betancourt-Domínguez et al. (2006), respectively. The low acidity could be linked to climate conditions, soil conditions, and crop management.

Titratable acidity increased during storage time which is in line with results reported by Cantwell et al. (1992) on whole prickly pear cactus stems of *O. ficus indica* L. 'Inermis' of 10 cm long, refrigerated at 10°C, and harvested in the morning. Titratable acidity is modified by the storage temperature (Cantwell et al., 1992), and according to Vickery (1954) in conditions of low temperature and darkness, there is a continuous accumulation of malic acid. Such event might be able to explain the increments in titratable acidity in all sizes of tested prickly pear cactus stems during day six.

On the other hand, the acid composition of prickly pear cactus stems can change with the development stage (Stintzing and Reinhold, 2005). For example, pscidic acid can increase up to four times as age progresses, and the forbic acid can decrease up to a 50% (Teles et al., 1994). This explains the differences *(*P<0.05) between the sizes 1 and 3 in day one of the assessment. The acidity values in day one increased with the size of the prickly pear cactus stem (r=0.560**).

Ascorbic acid

Ascorbic acid decreased significantly (P≤0.05) on days three and six (5.72 and 5.15 mg 100 g^{-1}). Day one showed the highest average (15 mg 100 g^{-1}) but did not show any significant differences due to the size (Figure 4). Reduction of ascorbic acid was reported by Nath et al. (2011) in stored broccoli florets under open ambient in 15 ± 1°C and in 4 ± 0.5°C which decreased from 130 to 35.3 mg 100 g^{-1} and from 130 to 92 mg 100 g^{-1} on day six, respectively. Similar results have been reported by Lu et al. (2010) in salicornia (*Salicornia bigelovii* Torr.) storage in several temperatures (0, 2, 8 and 25°C). Rinaldi et al. (2010) reported that the content of ascorbic acid decreased rapidly in purslane (*P. oleracea* L.) when it was stored at 10°C. Decrease in the loss of ascorbic acid may be linked to the oxidation caused by the enzyme Polyphenol Oxidase. Ascorbic acid content ranged from 0.5 to 15 mg per 100 g pulp, day one values were within the range as reported by Rodríguez-Félix and Cantwell (1988), who reported values from 0.7 to 18 mg per 100 g pulp in *O. amyclaea* Tenore*, O. ficus indica* L. and O.

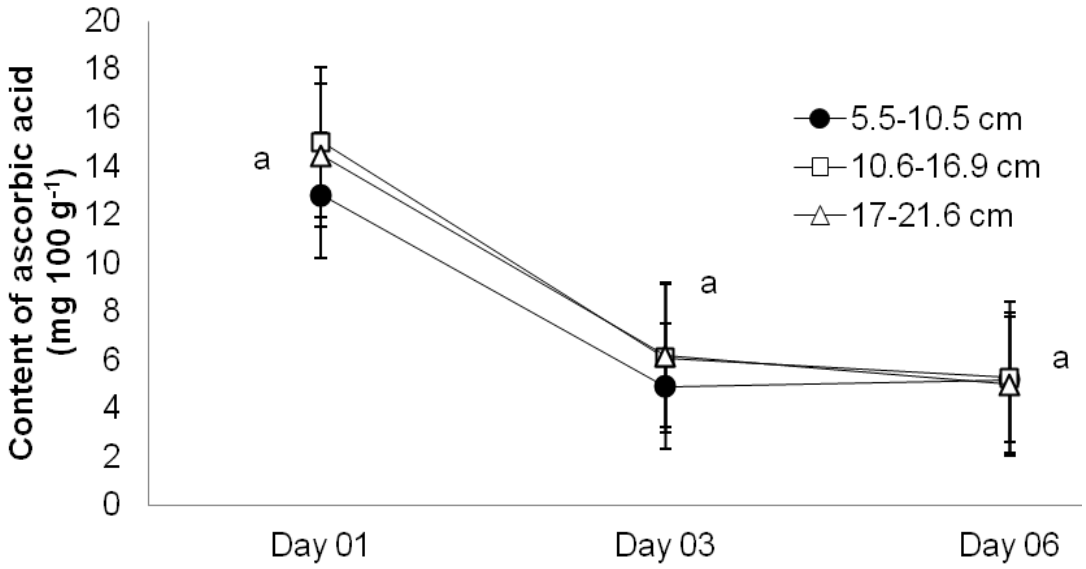

Figure 4. Content of ascorbic acid (mg per 100 g pulp) in days one, three and six of the three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

Table 3. Chlorophyll a, b, total (mg per 100 g pulp) in days one, three and six of the three sizes of 'Atlixco' prickly pear cactus stems, stored at 8 ± 2°C.

Size	Chlorophyll a		
	Day 01	**Day 03**	**Day 06**
1[z]	2.38 ± 1.16[c]*	2.93 ± 0.39[c]	3.26 ± 0.54[a]
2	3.62 ± 0.84[b]	3.64 ± 0.55[b]	4.05 ± 1.38[a]
3	4.58 ± 0.66[a]	4.65 ± 1.41[a]	4.19 ± 1.20[a]
Means	3.53 ± 1.40	3.74 ± 1.13	3.83 ± 0.97
		Chlorophyll b	
1	3.54 ± 1.82[b]	4.80 ± 1.82[c]	4.86 ± 0.72[b]
2	5.47 ± 0.98[a]	5.67 ± 1.33[b]	6.62 ± 2.16[ab]
3	6.08 ± 1.18[a]	6.58 ± 1.71[a]	6.97 ± 1.42[a]
Means	5.08 ± 1.86	5.68 ± 1.56	6.15 ± 1.59
		Total Chlorophyll	
1	5.92 ± 2.89[b]	7.73 ± 1.50[c]	8.12 ± 1.24[b]
2	9.09 ± 1.67[ab]	9.31 ± 1.81[b]	10.67 ± 3.53[a]
3	10.66 ± 1.81[a]	11.23 ± 3.07[a]	11.16 ± 2.47[a]
Means	8.56 ± 3.20	9.42 ± 2.59	9.98 ± 2.47
Total means	5.72 ± 1.17	6.28 ± 1.7	6.65 ± 2.79

* Means with the same letter in columns are statistically equal (Tukey P≤0.05). z1=5.5-10.5 cm; 2=10.6-16.9 cm; 3=17-21.6 cm.[y]Standar deviation.

ficus indica L. 'Inermis'. Gil-Izquierdo et al. (2001) also noted some decrease in the ascorbic acid content due to the storage temperature in artichoke (*Cynaras colymus* L. 'Blanca de Tudela').

Chlorophyll

Chlorophyll b content was higher than chlorophyll a content (Table 3). Content of chlorophyll b increased

significantly (P≤0.05) with storage time in day six (6.15 mg per 100 g pulp). Apparently, chlorophyll a, and b are proportionally related to the size of the prickly pear cactus stem, as well as the total chlorophyll. Size 3 proved to have the highest (P≤0.05) content of chlorophyll a on days one and three (4.58 and 4.65 mg per 100 g pulp, respectively) and size 1, the lowest values (2.38 and 2.93 mg per 100 g pulp, respectively). The chlorophyll b was statistically different (P≤0.05) on size 1, which exhibited the lowest values on all the evaluated days (one day=3.54; three day=4.80; six day 4.86 mg per 100 g pulp). Size 1 was also significantly lower during all the evaluated days in total chlorophyll (5.92, 7.73 and 8.12 mg per 100 g^{-1}, respectively)

Chlorophyll b content higher than the chlorophyll a content as found in this study were different to the findings reported from Yahia and Guevara-Arauza (2010), who mentioned results in the opposite order. Increases of chlorophyll are in line with the results reported by Guevara et al. (2001) on prickly pear cactus stem 'Milpa Alta' during the first five days of storage in modified atmospheres. Smaller total chlorophyll contents in size 1 could be due to chloroplast that was less developed. The maximum value of total chlorophyll in size 3 found on day three (11.23 mg per 100 g pulp) was close to the initial value 12.4 mg 100 g^{-1} as reported by Guevara et al. (2001) for 15 cm long prickly pear cactus stems of 'Milpa Alta', in whole prickly pear cactus stems, with thorns, and packed in modified atmosphere at 5°C.

The relation between size and chlorophyll content was supported by the results and the correlations found for each day and the three sizes (day one r = 0.569**; r = 0.652**; r = 0.615**; day two r = 0.473**; r= 0.634**; r = 0.558; day three r = 0.397*; r = 0.550** and r = 0.508, respectively).

Conclusion

The middle part of the cladode had more cut resistance in regards to its base and tip. The cut resistance increased with the size of the prickly pear cactus stem. The weight loss of the prickly pear cactus stem increased with the storage time. The smallest prickly pear cactus stem size showed the biggest weight lost. Prickly pear cactus stem brightness increased within the first three days and then decreased. The hue angle was around 179 and 180° in the green tone and there was a tendency in color change from green to yellow in all the sizes of the prickly pear cactus stem. Titratable acidity increased with the storage time in all the sizes of the prickly pear cactus stem.

Ascorbic acid content decreased with the storage time and did not vary significantly with the size of the prickly pear cactus stem. Contents of chlorophyll a, b, and total were directly proportional to the size of the prickly pear cactus stem. It increased with the storage time during the six days of storage.

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