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Impact of Salinity on Quality and Post-Harvest Conservation of Gherkin (*Cucumis anguria* L.)

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Abstract

Gherkin presents short shelf life. Its quality is influenced by cultivation's conditions which has scarce information in the literature. The objective of this study was to evaluate the impact of salinity on quality and post-harvest conservation of gherkin. For this, an experiment was carried out in a randomized block design, with treatments arranged in a 2 × 4 factorial scheme (two cultivars, 'Do Norte' and 'Liso Gibão' and four salinity levels; 2.0, 3.5 and 5.0 dSm^{-1}), with three replicates, with the experimental unit being represented by six plastic vessels with capacity of 10 liters, each one with one plant. Harvest was carried out 60 days after planting of seedlings and the following analyzes were proceeded: length, fruit diameter; soluble solids content (SS); titratable acidity (TA); SS/TA ratio; total sugar content; chlorophyll and total phenolic content. The highest yield ('Liso Gibão') allowed the storage of fruits, stored in trays covered with PVC, at 15±2 °C and 85±2% RH for 0, 3, and 6 days. Increase in saline solution reduced fruit length and diameter and increased pH, soluble solids and SS/TA ratio. The cultivar 'Liso Gibão' was superior to 'Do Norte' cultivar for the variables length, diameter, pH, total sugars and SS/TA ratio. The fruits of the 'Liso Gibão' mixer can be stored for six days without loss of quality. Fruits cultivated with saline solution of 2.0 dS m^{-1} presented higher acidity and chlorophyll content during storage, but reduced total sugars and pH in fruits of gherkin.

Keywords: chlorophyll, phenolics, gherkin do Norte, Liso Gibão

1. Introduction

Gherkin (*Cucumis anguria* L.) is an horticultural species, non-conventional, in Cucurbitaceae botanic Family, appreciated for costumers in many places in Brazil, used in isolated forms, associated with other foods or processed as pickles (Lima et al., 2006). The agricultural census of 2006 revealed a national production of 33,722 tons, with the Northest region responsible for 21,124 tons (IBGE, 2006).

A great part of gherkin production is limited due to the lack of specific farming practices for this crop, as its production is derivative from weed species which grow in areas cultivated with other crops, such as beans and corn (Oliveira et al., 2006). However, quality characteristics of fruits are strongly influenced by genotype, environmental conditions, and in-field crop management (Yativ et al., 2010; Cao et al., 2015), and also for its handling in post-harvest (M. I. F. Chitarra & A. B. Chitarra, 2005).

On the other side, in the Brazilian semi-arid region, one of the major limiting factors of agricultural production is rain shortage and the accumulation of salts in soils and water (Dias et al., 2010). In the conventional method of production, or hydroponic system, the effect of salinity has been studied in many species from Cucurbitaceae family (Oliveira et al., 2014; Dias et al., 2010; Santana et al., 2010). Most of the studies report negative effect on root's water absorption, affecting plant growth, production, and fruit's quality (Alves et al., 2011; Oliveira et al., 2014; Dias et al., 2010; Santana et al., 2010).

Despite the lack of information on salinity effects on gherkin fruit's quality, however, there are many reports to other cultures. Overall, salinity increase in crops promotes increase in soluble solids concentrations in the titratable acidity of cucumber (Medeiros et al., 2010) and strawberry (Andriolo et al., 2009).

The greenish color is an indicative of gherkin's quality, being greater with chlorophyll level around 0.156 mg g^{-1}. Change in green color to yellow in gherkin fruits determines its senescence (Silva, 2016), however there is little information on the shelf life of gherkin's fruit, being it an important information to ensure a good commercialization of fruits. In general, the most used technology in supermarket shelves for its commercialization is refrigeration, which reduces metabolism activity and, as a consequence, retards its senescence (M. I. F. Chitarra & A. B. Chitarra, 2005).

However, there is a deficit of studies that address the pre harvest factors for Gherkin crop, as well as relating the impact of salinity on quality characteristics of the fruit at harvest and/or post-harvest conservation.

2. Material and Methods

The research was developed in the experimental area of the Universidade Federal Rural do Semi-Árido (UFERSA), located in the city of Mossoró-RN (5°12′02″S, 37°19′37″O, and 18 m of altitude), between March 2016 and July 2016. According to Koeppen classification, the region climate is classified as BSwwh', hot and dry; with rainfall average of 673.9 mm per year (Carmo Filho & Oliveira, 1995).

The experiment was carried out in a randomized block design, with treatments arranged in a 2 × 4 factorial scheme, with three replicates, with the experimental unit being represented by six plastic vessels with a capacity for 10 liters of substrate (coconut fiber), each one with one plant, using spacing of 1.5 m × 1.0 m.

Two Gherkin cultivars (C1-Do Norte and C2-Liso Gibão) were studied, undergone to different levels of water salinity used in nutrient solution preparation (0.5; 2.0; 3.5; and 5.0 dS m^{-1}).

For 0.5 dS m^{-1} salinity concentration it was used water from UFERSA's water system (Campus Mossoró), which physicochemical analysis determined the following characteristics: pH = 8.3; CE = 0.5 dS m^{-1}; Ca^{2+} = 3.1; Mg^{2+} = 1.1; K^+ = 0.3; Na^+ = 2.3; Cl^- = 1.8; HCO_3^- = 3.0 and CO_3^{2-} = 0.2 (mmolc.L^{-1}). Other salinity concentrations (2.0; 3.5, and 5.0 dS m^{-1}) were prepared by dissolution of sodium chloride (NaCl) in water collected from deep water well located on campus (UFERSA Mossoró).

Drip irrigation was used, with four sets (one for each salinity concentration) consisting of a water reservoir (500 L), consisting in an electric pump, 12 mm-diamiter flexible polyethylene tubes, microtube-like emitters, and a timer to regulate irrigation.

All irrigations were done using nutrient solution, in order to provide fertigation in every irrigation event. It was used the nutritive solution recommended by Castellane and Araújo (1995) for melon crop in hydroponic system, in mg L^{-1}: 200 (N); 40 (P); 165 (K); 150 (Ca); 133 (Mg); 100 (S); 0.3 (B); 2.2 (Fe); 0.6 (Mn); 0.3 (Zn); 0.05 (Cu), and 0.05 (Mo). Nutrient solution contained the following concentration of micronutrients: 36 g of Fe^-DTPA, 1.8 g of boric acid; 2.54 g of manganese sulfate; 1.15 g of zinc sulfate; 0.12 of copper sulfate, and 0.12 g of sodium molybdate.

Plants were grown in no-protected area using 1.5 × 0.75 m of spacing, resulting in a population of 8,889 plants. Plants were staked vertically with ribbons tied up to vertical espaliers alongside the planting line. Fruits were harvested 60 days after planting of seedlings, when reached the point of physiological maturity (20 days after anthesis), showing an external coloration between green and yellow until full yellow (Medeiros et al., 2010).

After harvest, fruits were transported to the Laboratório de Tecnologia de Alimentos lab, UFERSA, where they were washed, divided in two batches: one for analysis just after harvest and the rest were put in a tray (5 fruits per tray), covered with a polysterene film and stored at temperature of 15º and 85% of Relative Humidify for posterior analysis in intervals of 0, 3, and 6 days after harvest.

However, only one of the two cultivars had enough fruits to be stored ('Liso Gibão' cultivar). Fruits from 'Do Norte' cultivar did not adapt to the environment, in a way that fruits harvested at the same time were enough only for quality evaluation. For this reason, the study was made in two parts: quality and storage, with quality analysis for both cultivars ('Do Norte' and 'Liso Gibão'), and for storage only fruits from 'Liso Gibão' cultivar were analyzed, and only for two levels of salinity, using completely randomized design because fruits harvested in each treatment were mixed up and then separated in batches, annulling the effects of blocks.

In each batch were analyzed the following variables: fruits' length and diameter, using a pachymeter, with results expressed in mm; external color, determined by refractometry, using a colorimeter CR-10 (konicaMinolta®, Japan), and readings expressed in L, c* and ºh modules. Total chlorophyll content was evaluated by method suggested by Linder (1974) and results expressed in mg/g; Soluble solids content was determined directly from the homogenized juice, with a digital refractometer (PR-100 model, Pallette, AtagoCo., LTD., Japan) and results expressed in percentage. Total sugar content, evaluated by the Antrona method, as in Yemn and Willis (1954) and results expressed in percentage. Potential of Hydrogen (pH) analyzed in the juice using a digital pHmeter. The titratable acidity was determined according to IAL methodology (1985) and results expressed in percentage of citric acid. The SS/TA ratio was determined by the quotient between both characteristics. And Total phenolic content was measured according to method described by Meda et al. (2005), and results expressed in mg of gallic acid (AG)/100 g of sample.

Data collected after harvest and after storage were analyzed separately. For post-harvest data a variance analysis was performed and means referred to salinity's effect were subjected to regression analysis, while means of cultivars were subjected to Tukey test at 5% of probability. Data referring to storage, for 'Liso Gabão' cultivar, and storage period were analyzed by Tukey test at 5% of probability. Statistics analyses were made with Sisvar software (Ferreira, 2011).

3. Results and Discussion

3.1 Quality at Harvest

Significant effect was verified within the interaction between cultivar and salinity factors for: fruit length, fruit diameter, pH, and SS/TA ratio. Isolated effect of cultivars for acidity, soluble solids content, phenolic compounds, and total sugar content. Isolate effect of salinity for soluble solids content and chlorophyll.

'Liso Gibão' cultivar presented higher values for length, diameter, pH, and SS/TA ratio variables (Figures 1A, 1B, 1C and 1D), with fruit's length and diameter higher values observed in 'Liso Gabão' cultivar for most of salinity levels, except fruit's length at 0.5 and 2.0 dS m^{-1}, in which both cultivars did not differ.

This confirms Oliveira et al. (2005) results, which also verified that 'Liso Gibão' fruits showed greater length and diameters than 'Do Norte'.

There was no significant effect of salinity on fruit's length for 'Liso Gibão', with average value of 48.5 mm. Notwithstanding, there was significant response to salinity in fruit's length of 'Do Norte' cultivar, which presented linear and decreasing behavior with the increase of salinity, reducing 1.58 mm for each unitary value of salinity, in which for the highest salinity level (5.0 dS m^{-1}) occurred reduction of 15.6% on fruit's length (Figure 1A).

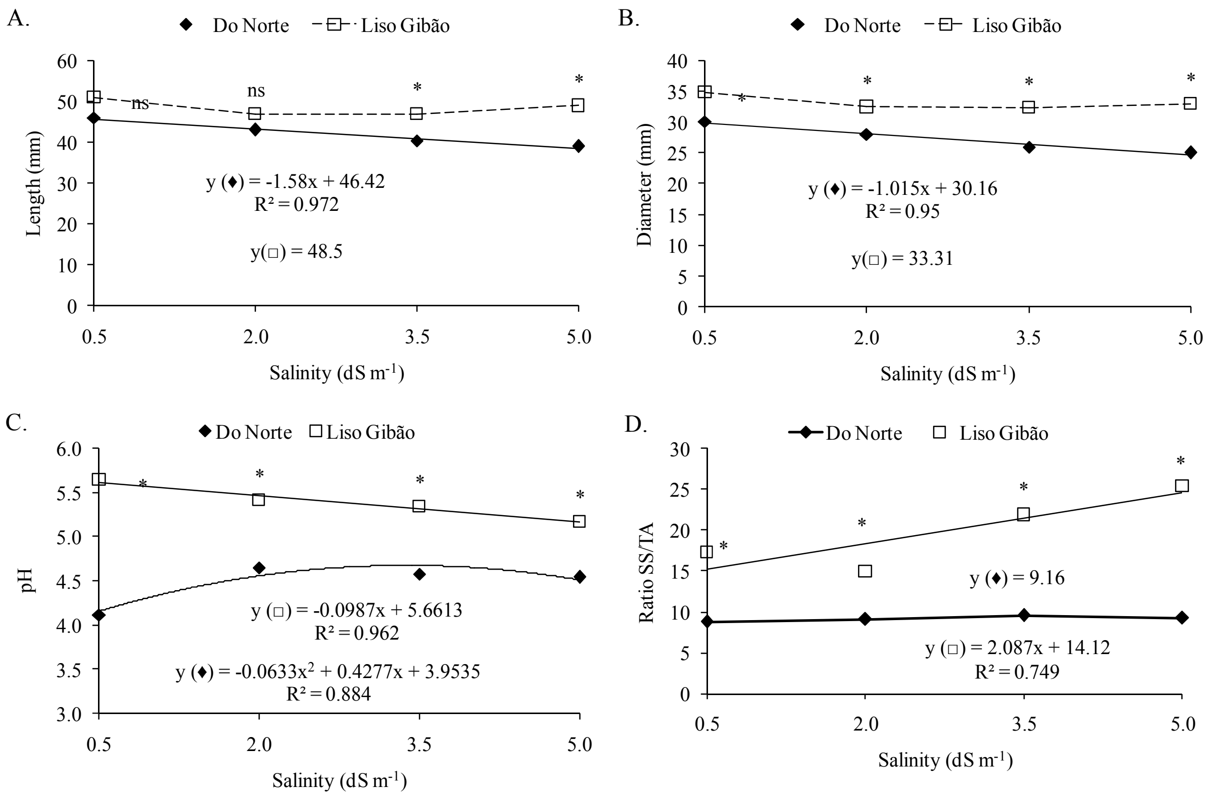

Figure 1. Length (A), diameter (B), pH (C), and SS/TA ratio (D) of Gherkin fruits, 'Do Norte' and 'Liso Gibão' cultivars, related to salinity level of nutrient solution

There are few studies in the literature about the effect of salinity on maxixie's fruit length, however, in a study by Oliveira et al. (2015) evaluating nitrogen fertigation effects over three gherkin cultivars ('Do Norte', 'Liso de Calcutá' and 'Liso Gibão'), the authors verified that higher doses of nitrogen caused a reduction in this variable in 'Do Norte' cultivar. Referred authors argued that this reduction occurred in probable consequence of increasing salinity of nutrient solution.

Just as observed for length, there was no effect of salinity on fruit's diameter in 'Liso Gibão' cultivar, with average of 33.31 mm of diameter. On the other side, there was significant and linear response for 'Do Norte' cultivar, where highest values for diameter were obtained with salinity concentration of 0.5 dS m^{-1}, reducing 1.015 mm for each unitary increase in salinity, in a way that at a level of 5.0 dS m^{-1} occurred the lowest values (25.08 mm), resulting in a total reduction of 15.40% (Figure 1B).

Effect of salinity on fruit's diameter was also reported by Oliveira et al. (2014) studying eggplants, observing quadratic response to the salinity increase. This way, it is seen that gherkin plant is probably more sensible to salinity stress.

This result may be explained as salinity affects negatively water absorption by roots, affecting plant growth (Alves et al., 2011). Growth inhibition caused by salinity is due to osmotic effect, since it promotes physiological drought, as well as the toxic effect, caused by ions concentration in the protoplasm (Taiz & Zeiger, 2013).

Increase of salinity caused a decrease in pH of fruits from 'Liso Gibão' cultivar, and increase in pH of fruits from 'Do Norte' cultivar up to a saline concentration of 3.5 dS m^{-1} (4.68%). However, pH of fruits decreased for both cultivars from 3.5 dS m^{-1} saline concentration (Figure 1C).

pH of fruits decreased with increase in pulp's acid concentrations. According to Feltre (1992), pH (-log $[H^+]$) is the real or actual acidity of solution, indicates the concentration of ions H^+ that are ionized in equilibrium or dissociated in solution.

pH values of fruits obtained in this study are pretty close to the ones found by Nascimento et al. (2011) in a study made with *in natura* gherkin fruits, with pH of 5.3.

Studies on salinity over fruits pH may be observed by Sousa et al. (2016). Cultivating watermelon with saline water they verified that the increase in irrigation water's salinity saw a decrease in fruits pH. But Gurgel et al. (2010) working with melon cultivars observed that salinity effect on fruits pH may vary depending on the cultivar studied.

Cultivar and salinity affected SS/TA ratio of fruits, with effect of salinity over SS/TA ratio only for 'Liso Gibão' cultivar. Data obtained were adjusted to an increasing linear equation, in a way that SS/TA ratio increased with the increase of salinity, occurring an increase of 2.087 units of SS/TA ratio by each unitary increase of salinity, resulting in a total increase of 61.9% (Figure 1D).

SS/TA ratio gives a good evaluation of fruit's flavor, representing it better than the measurement of sugars and acidity, isolated (Lima Neto et al, 2010), however high SS/TA ratio indicates a greater concentration of SS and lower acidity, influencing in product's flavor (M. I. F. Chitarra & A. B. Chitarra, 2005).

In this study, the increase in salinity did not affect titratable acidity (TA), but increased soluble solids content (SS). And even with the high SS content (6%) and TA (0.65%), 'Do Norte' cultivar did not show difference in SS/TA ratio in any level of salinity, since ratio held an average of 9.16. Moreover, 'Liso Gibão' cultivar with low SS (4.6%) and acidity (0.24%) showed increment in SS/TA ratio with increase in salinity.

These results demonstrate that SS/TA ratio is a quality characteristic strongly related to the genetic material. Behavior already reported in other crops, such as melon (Dalastra et al., 2016), and watermelon (Carmo et al., 2015).

'Do Norte' cultivar showed higher values for soluble solids content, titratable acidity, and total phenolic content in comparison to 'Lison Gibão', being 29.6%, 170.8%, and 42.7% greater, respectively. On the other side, 'Liso Gibão' cultivar was 187.7% superior for total sugars concentration. Both cultivars did not differ for total chlorophyll content, with an average concentration of 0.20 mg g^{-1} (Table 1).

Table 1. Mean values of soluble solids (SS), titratable acidity (TA), total phenolic content (TP), total sugar content (TS%), and total chlorophyll content in cultivars of gherkin, UFERSA, Mossoró, RN, 2017

Cultivars	Chemical characteristics				
	Soluble solids content (%)	Titratable acidity (%)	Total phenolic content (mg/100 g)	Total sugar content (%)	Total chlorophyll content (mg/g)
Do Norte	6.00 a	0.65 a	55.58 a	0.49 b	0.20 a
Liso Gibão	4.63 b	0.24 b	38.95 b	1.41 a	0.20 a
Means	0.45	0.45	47.26	0.95	0.20
LSD	0.05	0.05	3.90	0.07	0.02

Note. * Means followed by same letters within columns do not differ with each other, by Tukey test, at 5% of probability; LSD: least significant difference.

Soluble solids content was significantly affected by salinity in identical way for both cultivars. Linear increase of soluble solids happened between cultivars in a rate of 0.38 ºBrix/dS m^{-1}, with increase of 38.3% at 5.0 dS m^{-1} of salinity (6.17 ºBrix), in comparison to value obtained for 0.5 dS m^{-1} of salinity (4.46 ºBrix) (Figure 2A).

Costa et al. (2013) explained that increase in soluble solids concentration is due to reduction on plant's water absorption because of high levels of salinity in irrigation water.

There are few studies in the literature about the effect of salinity on gherkin fruit's quality, however, there are studies that show significant response to salinity for fruit's quality from other cucurbit plants, such as melon and watermelon. This way, results of this study are similar, in part, to the ones found with melon fruits (Gurgel et al., 2010; Terceiro Neto et al., 2013), which the increase of salinity levels promoted an increase in level of soluble solids of fruits. Similar behavior was evidenced in watermelon, where value of SS increased due to increase of salinity (Costa et al., 2013).

Silva (2016) also verified higher titratable acidity (0.29%) in 'Do Norte' cultivar fruits, but for 'Liso de Calcutá' cultivar results were similar to this present study.

There was no effect of salinity on titratable acidity of fruits. The same way, Dias et al. (2010) did not observe effect of salinity on titratable acidity of melon. On the other hand, increase in salinity provided an increase in titratable acidity of cucumber (Medeiros et al., 2010) and strawberry (Andriolo et al., 2009).

Even though Velloso et al. (2009), and Croteau et al. (2000) reported that biotic and abiotic factors, such as hormones, light, lack of nutrient, and water stress may promote an increase in total phenolic levels, this study did not show effect on total phenolic levels of gherkin with increasing levels of salinity up to 5.0 dS m^{-1}, considering that they are compounds intimately linked to defense strategies of the plant (Nass, 2007).

On the contrary of results found in this study for total sugar content, Silva (2016) did not verify difference between cultivars for this variable, with average of 1.75 and 1.71% in fruits from 'Do Norte' and 'Liso de Calcutá' cultivars, respectively. The same author reported that during growth and fruit's maturation, some chemical reactions change organoleptic characteristics, such as total sugars. Theses transformations involve a complex and accelerated metabolism, which may promote appearance of a typical flavor, due to, sometimes, transformation of starch in soluble sugars, decrease and/or increase of acidity, and astringency disappearance (Lucena, 2006).

Level of chlorophyll was affected in quadratic form by the increasing salinity, showing increase with increment of salinity up to the level of 2.7 dS m^{-1}, reaching maximum of 0.256 mg/g (Figure 2B), followed by decline until salinity of 5.0 d Sm^{-1}.

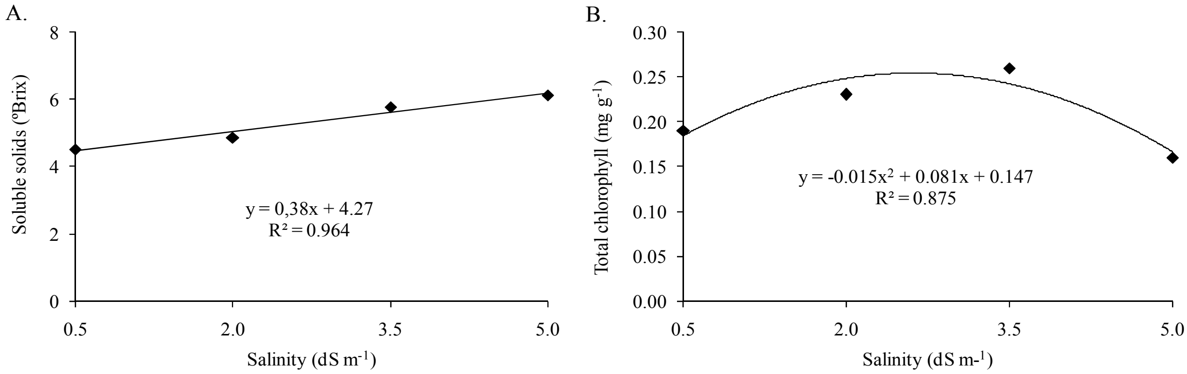

Figure 2. Soluble solids (A) e total chlorophyll (B) from gherkin fruits, 'Do Norte' and 'Liso Gibão' cultivars, related to salinity of nutriente solution

Loss of greenish color in gherkin, caused by chlorophyll degradation, is associated with decrease in its quality (Silva, 2016). Color is a parameter of quality for fruits and vegetables where presence of pigments, such as chlorophyll, carotenoids, anthocyanins, turn fruits more acceptable for consumers (M. I. F. Chitarra & A. B. Chitarra, 2005).

Taiz and Zeiger (2013) reported that magnesium has an important function on activation of enzymes involved in respiration, photosynthesis, and DNA and RNA synthesis processes, besides that it makes part of chlorophyll molecule.

This way, effect of saline stress on chlorophyll level in fruits is, possibly, due to a reduction on magnesium absorption by plants, according to what Maia et al. (2005), and Silva et al. (2008) observed, both studying melon crop.

3.2 Post-Harvest Conservation

The storage process was done only for fruits of 'Liso Gibão' cultivar and it was verified significant effect of interaction between storage period and salinity level only on soluble solids content, as well as isolated effect of storage period for SS/TA ratio, total sugar content, and total chlorophyll content. Isolated effect of salinity for titratable acidity, pH, total sugar content and total chlorophyll content.

During storage, were detected higher levels of chlorophyll at 6 days (0.25 mg/g) of storage compared to time zero (0.19 mg/g), however these results did not differ from values found at 3 days of storage (0.22 mg/g). It is noted an increase in chlorophyll's level of fruits at 3 (15.70%) and 6 (31.57%) days of storage, respectively. Opposite to the present study, Silva (2016) observed decrease in levels of chlorophyll throughout the storage period. In fruits from 'Do Norte' cultivar (0.13 mg/g of Fresh Mass) and 'Liso de Calcutá' cultivar (0.28 mg/g of FM), at the beginning of storage, levels was near what was found in this study.

Regarding the effect of salinity, plants irrigated with water of higher saline concentration (2.0 dS m^{-1}) had 20% more chlorophyll concentration than fruits of lower salinity (0.5 dS m^{-1}). According to Medeiros et al. (2010) growing plants with excess of salts affects vegetative development, what reflects in delay of harvest period. As fruits were harvested at the same time, fruits where was used higher saline concentration may be in an earlier stage of maturation.

When analyzed the storage period within each salinity level it is verified difference only in soluble solids content of fruits with high concentration (2.0 dS m^{-1}). At the third day of storage it was observed that values of soluble solids content of fruits were higher than the rest of the days of storage, with an increase of 51.13% on SS compared to the day of harvest. However, from the third day on level of soluble solids decreased 25.33% (Table 2).

Table 2. Means values of soluble solids content (ºBrix) of gherkin fruits related to salinity and storage period

Period (days)	Salinity		
	0.5 dS m^{-1}	2.0 dS m^{-1}	Means
0	3.60 Aa	3.97 Ab	3.78
3	4.40 Ba	6.00 Aa	5.20
6	4.77 Aa	4.48 Ab	4.63
Means	4.26	4.81	
LSD (days)	1.21		
LSD (salinity)	0.98		

Note. * Means followed by same letters within column did not differ with each other, by Tukey test, at 5% of probability; LSD: least significant difference.

Same way, Gurgel et al. (2010) verified that in fruits of melon (Orange Flesh cultivar), with increment of salinity, occurred increase in soluble solids content but after storage the levels of soluble solids decreased.

Reductions on soluble solids content during storage occur due to the use of organic substrates on metabolism related to respiration associated to growth and maturation of activities and cell structures (Taiz & Zeiger, 2013).

When analyzed salinity within the storage period, significant difference was verified only at third day, when the use of high saline concentration (2.0 d Sm^{-1}) increased level of soluble solids in 36.36% when compared to fruits irrigated with water of low salinity (0.5 dS m^{-1}). On the other side, there was decrease at day 6 of storage (Table 9).

According to Medeiros et al. (2010), soluble solids content may be formed from many substances, with sugars being the main substance for many fruits. Saline stress promotes increase in sugar concentration, organic acids, and percentage of fruit's dry mass. In contrast, it may reduce fruit's size and production (Cuartero & Feñandez-Muñoz, 1999).

Storing period affected only total chlorophyll content and SS/TA ratio variables, where higher values were seen at 3 and 6 days of storage (Table 3). The use of solution with salinity of 0.5 dS m^{-1} reflected higher values of total sugars and pH. On the other side, fruits from plants irrigated with solution of salinity of 2.0 dS m^{-1} were superior for titratable acidity and total chlorophyll content (Table 3).

SS/TA ratio values on this study are similar to what was reported by Silva (2016) which studying development of gherkin fruits detected soluble solids content of 3.2 and titratable acidity of 0.29% in fruits from 'Do Norte' cultivar at commercial maturity, equivalent to a SS/TA ratio of 11.03. And in fruits from 'Liso de Calcutá' cultivar found SS of 3.4 and TA of 0.17%, giving a SS/TA ratio of 20.

On the other side, SS/TA of fruits significantly increased from time zero to day three of storage, reflection an increase of 57.37%. Notwithstanding, these ratios did not differ from values detected at sixth day of storage. SS/TA ratio, even though may be influenced by SS and TA variables, it is observed that titratable acidity did not vary during storage, but soluble solids content did, and there was an increase in soluble solids content at the third day, with salinity (Table 3).

Table 3. Mean values for titratable acidity (TA), total phenolic content (TP), total sugar content (TS%), total chlorophyll content, pH e SS/TA ratio in fruits from cultivars of gherkin, UFERSA, Mossoró, RN, 2017

Storage period (days)	Chemical characteristcs					SS/TA ratio
	Titratable acidity (%)	Total phenolic content (mg/100 g)	Total sugar content (%)	Total chlorophyll content (mg/g)	pH	
0	0.24 a	38.14 a	1.39 a	0.19 b	5.40 a	11.33 b
3	0.25 a	38.46 a	1.20 a	0.22 ab	5.27 a	17.83 a
6	0.22 a	39.36 a	1.33 a	0.25 a	5.33 a	16.50 a
LSD	0.059	4.25	0.19	0.04	0.19	4.92
Salinity						
0.5 dS m^{-1}	0.21 b	38.80 a	1.39 a	0.20 b	5.52 a	16.00 a
2.0 dS m^{-1}	0.26 a	38.50 a	1.23 b	0.24 a	5.15 b	14.44 a
General mean	0.23	38.65	1.31	0.22	5.33	15.22
LSD	0.03	2.83	0.12	0.03	0.13	3.28

Note. * Means followed by same letter within column did not differ from each other, by Tukey test, at 5% of probability; LSD: least significant difference.

It is worth mentioning that even though there was no significant difference in SS/TA ratio between the third and sixth day of storage, it was possible to observe decrease of 8.06% from the third to the sixth day, and increase of 45.61% if compared to the value measured just after harvest (11.33). SS/TA ratio is used to indicate palatability, and its increase may imply an increase in flavor and indicate the ripening stage of fruits (Soares Júnior et al., 2008).

For M. I. F. Chitarra and A. B. Chitarra (2005) SS/TA ratio is a very important factor, because it reflects the balance between sugars and acids of fruit. It is one of the most utilized methods to evaluate flavor, being more significant than the isolated measurement of sugars or acidity.

There was a decrease in total sugar content of 11.51% on fruits irrigated with high salinity (2.0 dS m^{-1}). According to Medeiros et al. (2010), salt excess in soil causes plants to absorb less water and nutrients, consequently a greater period for vegetative growth and fruit's harvest point, remaining longer in plant, deliberating an excessive enzymatic activity, and may still indicate lower levels of some fruit's compounds, such as sugars.

Dias et al. (2005) reported in melon crop that fruits from more saline treatments showed maturation stages less developed than those irrigated with lower levels of salinity. On the other side, Navarro et al. (2006) verified that total concentration of sugars increased significantly with higher levels of salinity in pepper fruits.

Acidity average of fruits during storage period was 0.24%. These results are lower for 'Do Norte' cultivar (0.28%) and higher for 'Liso Gibão' cultivar (0.17%) in a study by Silva (2016) at 22 days after anthesis.

In a study developed by Del Amor et al. (1999) with melon crop cultivar 'Gália', authors reported that fruit's quality was significantly affected by salinity levels, with the AT increasing with salinity as pH decreased.

There was an interaction of pH and titratable acidity values, that is, growth in lower salinity level (0.5 dS m^{-1}) gave lower acidity and higher pH (Table 10). A decrease in pH of 6.7% with salinity of 2.0 dS m^{-1} was verified. Similar behavior was reported in melon crop (Gália) which increment in salinity levels, during growth period, reduced pH values of fruits (Del Amor et al., 1999).

pH measures acidity of fruits and food in a general way, indicating which is the best treatment necessary to preserve food. This parameter determines the hydrogen concentration of a solution and its increase is inversely related to acidity, what happens with the advance of maturation of fruits (M. I. F. Chitarra & A. B. Chitarra, 2005).

Navarro et al. (2006) verified increase in total phenolic compounds level with increment in salinity of mature fruits, but it was unchanged or slightly decreased in black peppers. This argument may be applied to results from this present study, in which gherkin fruits were harvested unripe, evidencing non-significant effect for salinity.

According to Ali and Ismail (2014) phenolic compounds are secondary metabolic that act protecting vegetal tissue against oxidative stress caused by salinity, and contribute to increase tolerance of plant to salinity, affirming that saline levels used in this study were not sufficient to activate the defense system of gherkin plants.

4. Conclusion

(1) Increment in saline solution levels reduced length and diameter of fruits, but increased pH, soluble solids content and SS/TA ratio.

(2) 'Liso Gibão' cultivar was superior than 'Do Norte' cultivar for length, diameter, pH, total sugar content, and SS/TA ratio.

(3) Fruits from 'Liso Gibão' gherkin plants may be stored for six days without loss of quality.

(4) Fruits cultivated with saline solution of 2.0 d Sm^{-1} showed greater acidity and chlorophyll content during storage, but decreased total sugar content and pH in fruits.

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