Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(5): 1989-1994
Received: 10-07-2019
Accepted: 12-08-2019

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Effect of calcium chloride & sodium chloride on storage life of vegetables

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Abstract
Post harvest losses of horticultural produce are a serious problem in the post-harvest chain, because of the rapid deterioration during handling, transport and storage. Tomatoes and Cucumbers were treated with Calcium Chloride and Sodium Chloride with different steeping time. The effects of these pre-treatments were evaluated, by analyzing the pH, TSS, Weight loss and Shelf life of the treated vegetables. The results indicated that, due to pre-treatment increase in pH, TSS and Weight loss was lower in tomatoes and cucumbers treated with Calcium Chloride and Sodium Chloride as compared to Control. Shelf life of the Calcium chloride treated vegetables with a steeping time of 5 minutes, 10 minutes and Sodium chloride treated vegetables with a steeping time of 10 minutes is more compared to control.

Keywords: Post-harvest chain, pH, TSS, calcium chloride, sodium chloride

1. Introduction

Extending post–harvest life of horticultural products requires knowledge of all factors that can cause loss of quality so that affordable technologies can be developed to reduce the rate of deterioration (Babalola *et al*., 2010) [1]. Reduction in post harvest losses would increase the amount of food available for human consumption and enhance global food security (Trostle 2010) [12]. Fruits and vegetables are a major source of essential dietary nutrients such as vitamins and minerals (Sagar and Suresh kumar, 2010) [10]. Moreover, polyphenols, such as anthocyanins, flavonols and phenolic acids, constitute one of the most numerous and ubiquitous groups of plant metabolites. Postharvest losses of fruits and vegetables are due to physiological disorders, physical injury and fungal infections. To prolong the shelf-life of fruits and vegetables different Physical and Chemical methods have been so far used. Dipping treatments favour the dispersion of the solution on the surface of the vegetable (Soliva-Fortuny *et al*., 2003) [11]. Pre and post-harvest Calcium applications have been used to delay aging or ripening, to reduce post-harvest decay and to control the development of many physiological disorders in fruits and vegetables (Conway *et al*., 1994) [3].

In the form of edible or table salt Sodium Chloride is commonly used as a condiment and food preservative. Major application of sodium chloride is de-icing of roadways in sub-freezing weather. Many microorganisms cannot live in an overly salty environment. It is used to preserve some foods, such as smoked bacon, fish, or cabbage. Calcium (Ca) is a major element of fruit, and also functions as a intracellular signal transduction molecule in many physiological processes. Calcium is necessary for plant stress tolerance and proper photosynthetic function through membrane stability and cell signalling (Qu C *et al*., 2012) [8]. Calcium has an important influence on fruit quality and storability, and is used to maintain the quality of fruit during postharvest, reduce decay and extend shelf life for apple, peach, apricot, strawberry and pear. From the study of the effects of Calcium Chloride dip on the weight loss and texture of the pineapples, it is noted that the treatment substantially retarded their decay rate (Goncalves *et al*., 2000) [5]. Softening was delayed and storage life was increased by 10-12 weeks in kiwi fruits by application of 1% Calcium Chloride (Dimitrios & Pavlina, 2005). Calcium in the cell wall serves as a binding agent in the form of Calcium pectate. This helps to maintain the quality and extend the storage life by reducing respiration rate and physiological disorder.

Keeping in view of the usefulness of Calcium Chloride and Sodium Chloride, they were selected in this study to treat Tomato and Cucumber. The aim of present work was to determine the effects of these agents on physico-chemical properties and to increase the shelf life of treated fruits and vegetables.

2. Materials and Methods

2.1 Selection of Vegetables
Fresh Bananas and Tomatoes were purchased from a local wholesaler in Allahabad. All the fruits were cleaned and sorted. The good ones were washed thoroughly with water.

2.2 Pre-treatment of vegetables
3% solutions of Calcium chloride and Sodium chloride were made from distilled water. The Selected fruits and vegetables were dipped in both the solutions for 5 minutes and 10 minutes as per the experimental plan. After that they were air dried under fan and kept in baskets at room temperature.

2.3 pH determination
To determine the pH, distilled water was taken in a beaker and the electrode of the pH meter was dipped in the distilled water and reading of pH meter was set manually by knob to 7 i.e. the neutral value. Then samples were taken in beaker and pH was measured by dipping electrodes of digital pH meter.

2.4 Total soluble solids
TSS was determined using Hand Refractometer. A drop of juice sample was dropped on the face of the Refractometer. TSS was noted through the eye piece and is expressed as °Brix.

2.5 Determination of Weight Loss
Before storage three vegetables in each replication were separately marked and weighed on digital balance at the start of the experiment and thereafter the same vegetabls were consistently weighed during the storage period. Weight was calculated by using the following formula: Weight Loss % = (Vegetable initial weight-vegetable weight at each sampling date/vegetable initial weight) ×100

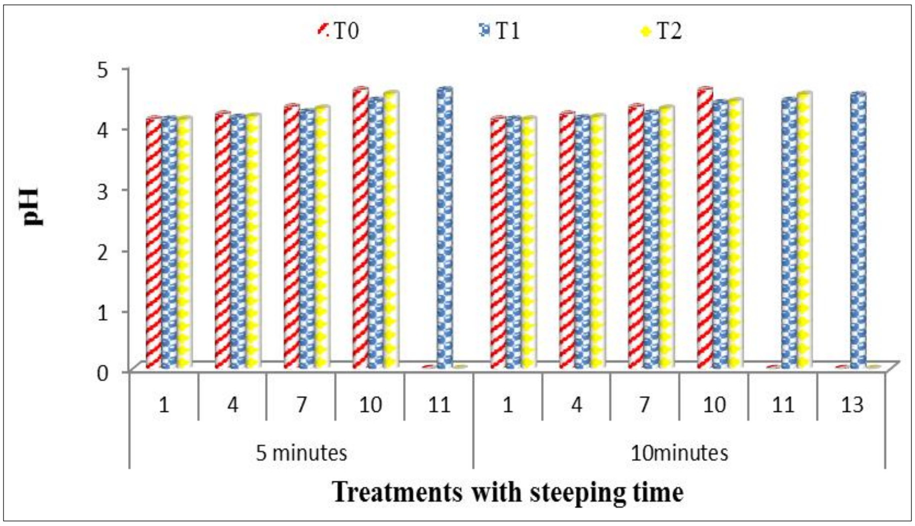
2.6 Determination of Shelf life
The recorded data was statistically analyzed by the 'Analysis of variance- one way classification'. The significant effect of treatment was judged with the help of 'F' (variance ratio). If calculated value exceeded the table value, the effect was considered to the significant. The significance of the study was tested 5% level to study the differences in the processing parameter and premix in composition.

2.7 Statistical Analysis
After pre-treatment, the vegetables were drained, then the treated and control vegetables were stored at room temperature. Shelf life was calculated by counting number of days the vegetables were acceptable for usage by visual observation.

3. Results

3.1 Effect of Calcium chloride & Sodium chloride on Tomato

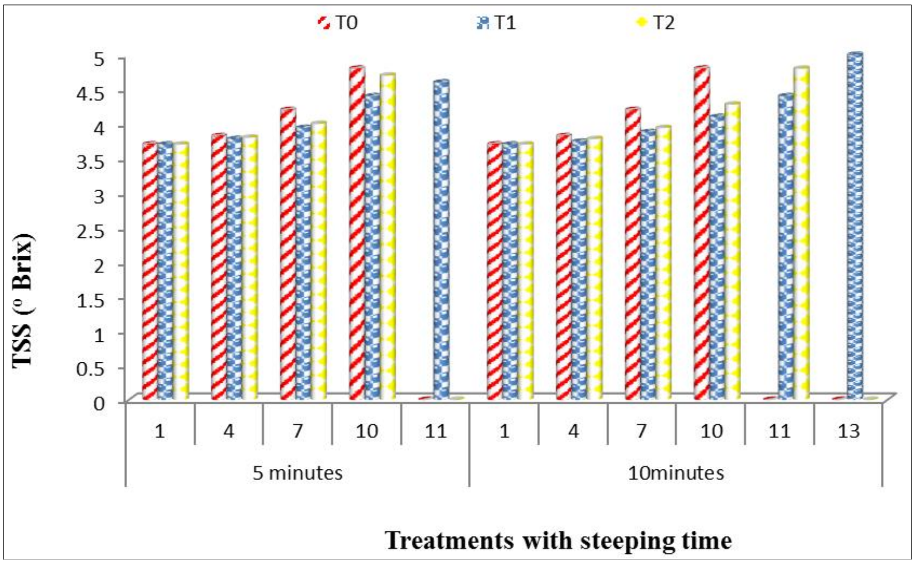
3.1.1 pH of Tomato
The results regarding to the pH of Tomatoes is shown in Fig 1. Before treatment pH of Tomatoes was observed as 4.02. On 10th day, the pH of Calcium Chloride treated Tomatoes with steeping time of 5 min (4.41) and 10 min (4.34) was less followed by Sodium Chloride treated Tomatoes with steeping time of 5 min (4.52) and 10 min (4.46) compared to Control (4.58). On 11th day Control and Sodium Chloride treated Tomatoes with steeping time of 5 min were spoiled. On 13th day, Sodium Chloride treated Tomatoes with steeping time of 10 min were spoiled, the pH of Calcium Chloride treated Tomatoes with steeping time of 10 min was recorded as 4.59, after 13th day these tomatoes were spoiled.



T_0 = Control, T_1 = $CaCl_2$ treated Tomatoes, T_2 = NaCl treated Tomatoes

Fig 1: Effect of Calcium chloride and Sodium chloride on pH of Tomatoes

3.1.2 TSS of Tomato
The results regarding to the TSS of Tomatoes is shown in Fig 2. Before treatment TSS of Tomatoes was observed as (3.7 ºBrix). On 10th day the TSS of Calcium Chloride treated Tomatoes with steeping time of 5 min (4.4 ºBrix) and 10 min (4.3 ºBrix) was less followed by Sodium Chloride treated Tomatoes with steeping time of 5 min (4.7 ºBrix) and 10 min (4.5 ºBrix) compared to Control (4.8 ºBrix). On 11th day Control and Sodium Chloride treated Tomatoes with steeping time of 5 min were observed to be degraded. On 13th day Sodium Chloride treated Tomatoes with steeping time of 10 min were degraded, TSS of Calcium Chloride treated Tomatoes with steeping time of 10 min was recorded as 5.0 (ºBrix), after 13th day they were observed to be degraded.

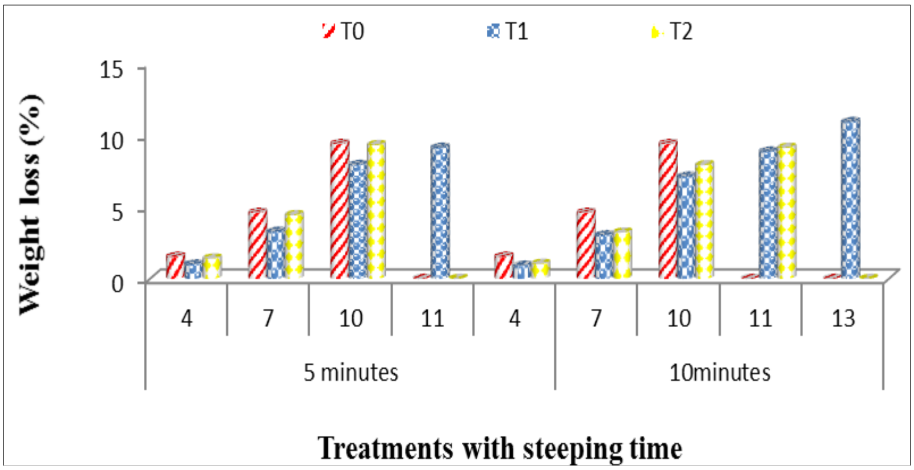


T_0 = Control, T_1 = $CaCl_2$ treated Tomatoes, T_2 = NaCl treated Tomatoes

Fig 2: Effect of Calcium chloride and Sodium chloride on TSS of Tomatoes

3.1.3. Weight loss of Tomato

The results regarding to the Weight loss of Tomatoes is shown in Fig 3. On 10th day, the weight loss of Tomatoes treated with Calcium chloride with steeping time of 5 min (7.93%) and 10 min (7.12%) was less followed by Sodium chloride treated Tomatoes with steeping time of 5 min (9.31%) and 10 min (7.91%) compared to Control (9.39%). On 11th day, Control and Sodium chloride treated Tomatoes with steeping time of 5 min were degraded. On 13th day, Sodium chloride treated Tomatoes with steeping time of 10 min were degraded and Calcium chloride treated Tomatoes with steeping time of 10 min were recorded with a weight loss of 10.92%, after 13th day they were spoiled.

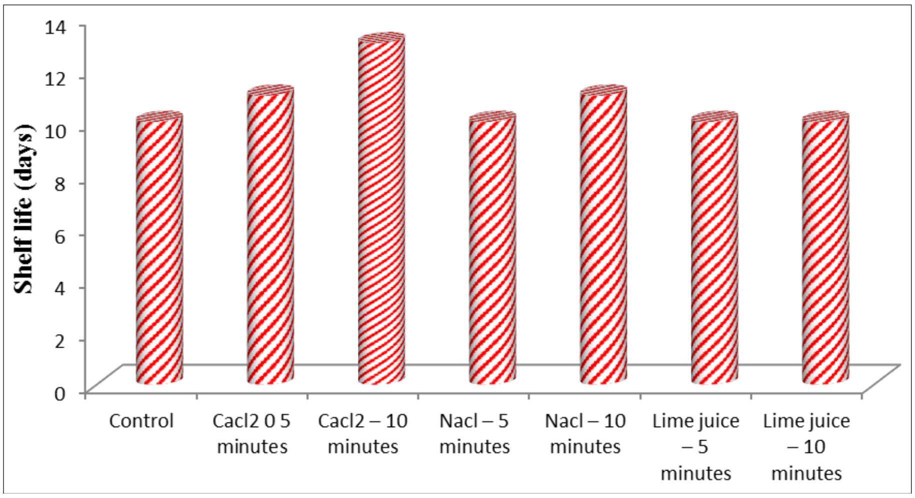


T_0 = Control, T_1 = $CaCl_2$ treated Tomatoes, T_2 = NaCl treated Tomatoes

Fig 3: Effect of Calcium chloride, Sodium chloride on Weight loss of Tomato

3.1.4 Shelf life

The results regarding to the shelf life of Tomatoes is shown in Fig 3.1.4. The Shelf life of Calcium Chloride treated Tomatoes with steeping time of 5 min (11 days) and 10 min (13 days), Sodium Chloride treated Tomatoes with steeping time of 10 min (11 days) was more compared to Control (10 days). Fruit and vegetable tissues are still alive after harvest, and continue their physiological activity. Physiological disorders occur as a result of mineral deficiency, low or high temperature injury, or undesirable environmental conditions, such as temperature, light, aeration and high humidity. Physiological deterioration can also occur spontaneously owing to enzymatic activity, leading to over ripeness and senescence, a simple aging phenomenon.



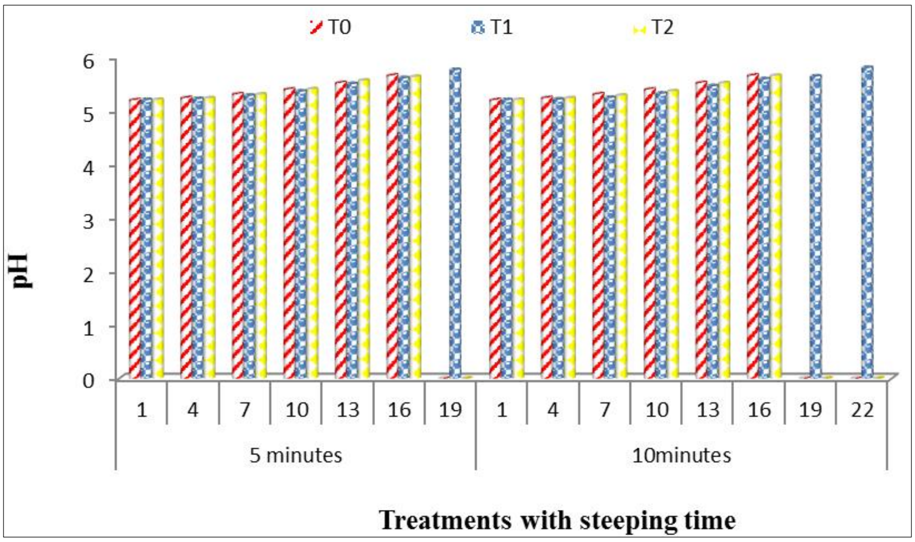
Treatments with steeping time

Fig 4: Effect of Calcium chloride, Sodium chloride on Shelf life of Tomato

3.2 Effect of Calcium chloride & Sodium chloride on Cucumber

3.2.1 PH of Cucumber

The results regarding the pH of Cucumber are shown in Figure 5. Before treatment, pH of Cucumber was observed as 5.2. On the 16th day, the pH of Calcium Chloride treated fruits, with steeping time of 5 min (5.61), 10 min (5.49) was less followed, by Sodium Chloride treated fruits with steeping time of 5 min (5.72), 10 min (5.62), compared to the Control (5.74). On the 19th day, Control and Sodium Chloride treated Cucumbers with steeping time of 5 min were degraded. On the 22nd day, Cucumbers treated with Sodium Chloride with steeping time of 10 min were spoiled, pH reading of 5.76 was observed in Calcium Chloride treated Cucumbers with steeping time of 10 min, after 22nd day they were spoiled.

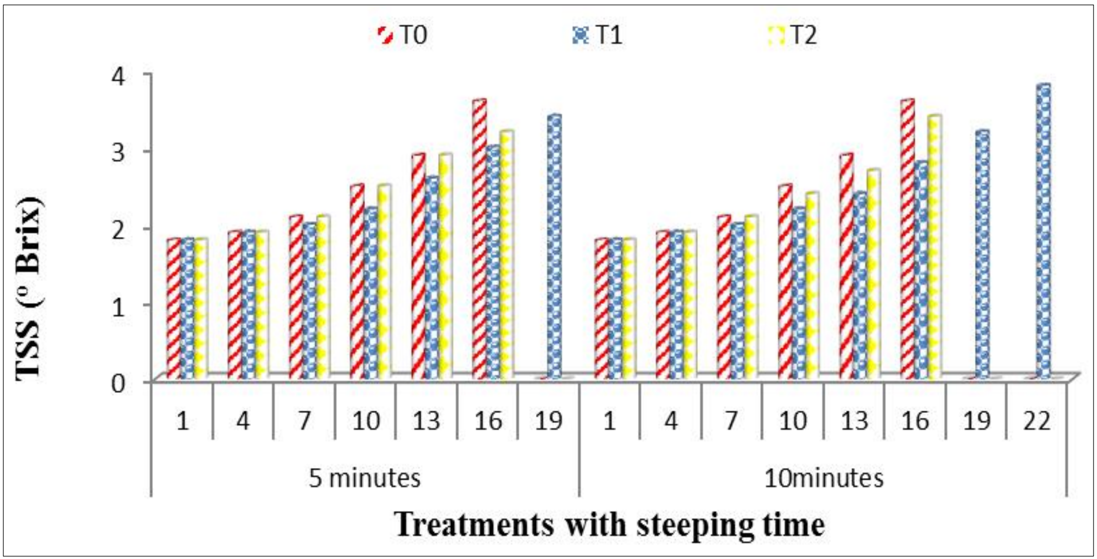


T0 = Control, T1 = $CaCl_2$ Treated Cucumbers, T2 = NaCl Treated Cucumbers

Fig 5: Effect of Calcium Chloride, Sodium Chloride on pH of Cucumber

3.2.2 TSS of Cucumber

The results regarding to the TSS of Cucumber are shown in Figure 6. Before treatment, TSS of Cucumber was observed as 1.8. On 16th day, the increase in TSS of Calcium Chloride treated Cucumbers with steeping time of 5 min (3 ºBrix), 10 min (2.7 ºBrix) and Sodium Chloride treated Cucumbers, with steeping time of 5 min (3.2 ºBrix), 10 min (3.1 ºBrix) was less compared to Control (3.2 ºBrix). On 19th day, Control and Sodium Chloride treated Cucumbers with steeping time of 5 min were degraded, Calcium Chloride treated Cucumbers with steeping time of 5 min and 10 min, were recorded with a TSS of 3.4 (ºBrix), 3.1 (ºBrix). On 22nd day, Sodium Chloride treated Cucumbers with steeping time of 10 min were spoiled, TSS reading of 3.7 (ºBrix) was recorded in Calcium Chloride treated Cucumbers with steeping time of 10 min, after 22nd day they were spoiled.

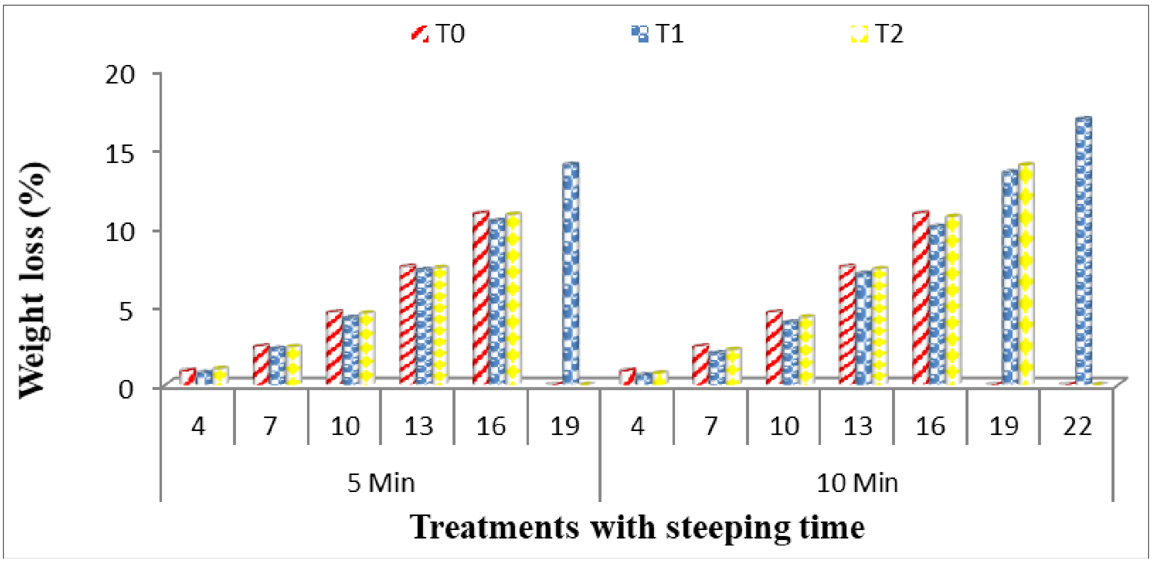


T_0 = Control, T_1 = $CaCl_2$ treated Cucumbers, T_2 = NaCl treated Cucumbers

Fig 6: Effect of Calcium Chloride, Sodium chloride on TSS of Cucumber

3.2.3 Weight loss of Cucumber

The results regarding to the weight loss of Cucumber is shown in Figure 7. As the storage period is increasing, the decrease in weight of Control was more compared to Sodium Chloride and Calcium Chloride treated Cucumbers. On 16thday, the weight loss of Calcium Chloride treated Cucumbers with steeping time of 5 min (10.37%) and 10 min (10.01%), was less compared to Sodium Chloride treated Cucumbers with steeping time of 5 min (10.77%) and 10 min (10.64%) and Control (10.85%). On 19th day Control, Sodium Chloride treated Cucumbers with steeping time of 5 min were degraded. On 22nd day, Sodium Chloride treated Cucumbers with steeping time of 10 min were spoiled, Calcium Chloride treated Cucumbers with steeping time of 10 min were recorded with a weight loss of 16.82%, after 22nd day, they were degraded.



T_0 = Control, T_1 = $CaCl2$ treated Cucumbers, T_2 = NaCl treated Cucumbers

Fig 7: Effect of Calcium chloride, Sodium chloride on Weight loss of Cucumber

3.2.4 Shelf Life

The results, regarding the shelf life of Cucumbers is shown in Figure 8. The shelf life of Calcium Chloride treated Cucumbers, with steeping time of 5 min (19 days), 10 min (22 days) was more followed by Sodium Chloride treated Cucumbers, with steeping time of 10 min (19 days) compared to Control (16 days). There was increase in shelf life of vegetables treated with Calcium chloride, as calcium in the cell wall serves as a binding agent, which helps to maintain the quality and extend the storage life, particularly by delaying ripening and senescence, as well as reducing respiration rate and physiological disorder. The above results were comparative with Bhattara *et al.*, (2006) [2].

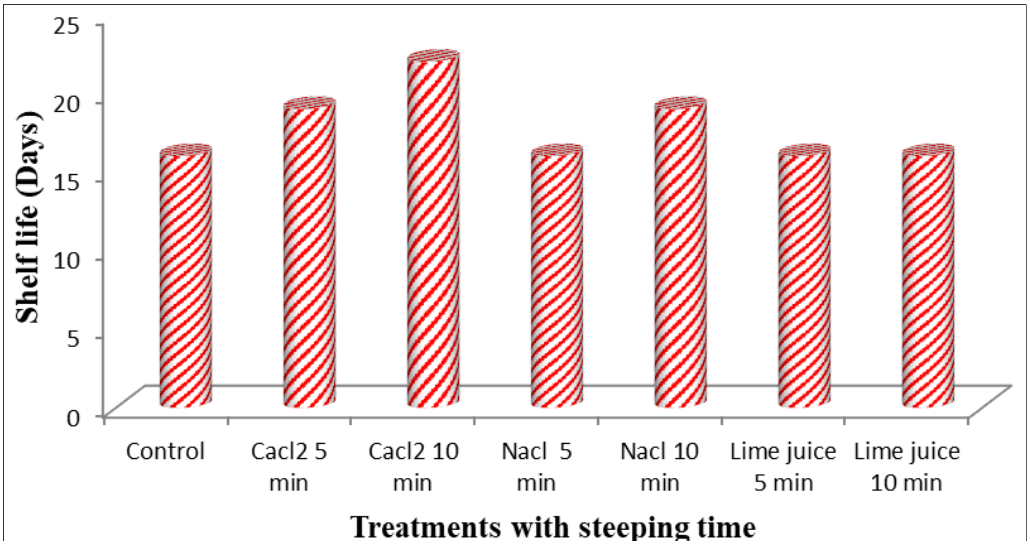


Fig 8: Effect of Calcium chloride, Sodium chloride on Shelf life of Cucumber

4. Discussions

Fruit and vegetable tissues are still alive after harvest, and continue their physiological activity. Physiological disorders occur as a result of mineral deficiency, low or high temperature injury, or undesirable environmental conditions, such as temperature, light, aeration and high humidity. That increase in the concentration of calcium chloride increases the firmness of the fruit (Hong and Lee 1999) [6].

In our study it was observed that increase in pH of Calcium Chloride treated vegetables was less compared to Sodium Chloride treated vegetables and Control. The increase in pH might be due to the breakup of acids with respiration during storage. The results were comparative with (Sabir *et al*., 2004) [9]. Increase in TSS of vegetables treated with Calcium chloride was less, as the presence of Ca2+ ions delay fruit ripening, Calcium Chloride delayed fruit ripening, improved resistance to fungal attack and maintained structural integrity of cell walls (Lara *et al*., 2004). The reduction in weight of vegetables treated with Calcium chloride was less. There was increase in shelf life of vegetables treated with Calcium chloride, as calcium reduced the rate of respiration and transpiration thus increased the shelf life. The results were comparative with (Mahajan & Dhatt 2004) [7].

5. Conclusion

Calcium chloride has positive effects in delaying vegetable ripening process, which results in improved storability of tomatoes and cucumbers. In terms of pH, TSS and Shelf life, this work shows that pre-treatment with Calcium chloride is quite beneficial compared to Sodium chloride. The data also suggest that the decrease in weight was less in vegetables treated with Calcium Chloride than Sodium Chloride. Overall, the results presented in this study show that Calcium Chloride with steeping time of 5 min, 10 min and Sodium Chloride with steeping time of 10 min was effective in increasing shelf life of vegetables.

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