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Research article

EFFECTS OF ESSENTIAL OIL AND CALCIUM CHLORIDE ON QUANTITATIVE AND QUALITATIVE FEATURES *ZIZIPHUS MAURITIANA* DURING STORAGE

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ABSTRACT: In this paper the effect of calcium chloride and some essential oils, on preservation quality of jujube (*Ziziphus mauritiana*) was investigated. The treatments included control (distilled water) and concentrations 250 and 500 ppm of Shirazi Thyme, *Artemisia sieberi* and *Salvia* essential oils. After the treatments, fruits were stored at 4 ° C and relative humidity of 70%.Evaluation of quantitative and qualitative features done at four periods of 10, 15, 20 and 25 days storage. Characteristics such as Percentage of decay, weight loss and fruit juice pH, titratable acidity, soluble solids and vitamin C were measured. The results of this study showed that, decay rate, vitamin C loss and weight loss were increased by increasing storage period, whereas the application of treatments declined these traits. Calcium chloride and thyme essential oil were the best treatment however no significant differences were observed in treated fruits with *Artemisia sieberi* and Salvia compared to controls at most determination times. Our results suggest that calcium chloride and thyme essences have potential effect on maintaining the quality and extending postharvest life of jujube fruit.
Keyword: *Ziziphus mauritiana*, Shirazi Thyme, *Artemisia sieberi*, *Salvia*, Calcium chloride, storage life.

INTRODUCTION

Ber is a tropical and subtropical fruit native to the northern hemisphere. It belongs to the genus *Ziziphus* of the family Rhamnaceae and order Rhamnales. It is favored for its high nutritional value, good taste. However, the fruit is very perishable and susceptible to browning, decay and water loss after harvest, which greatly affects its edible and commercial value [21]. The storage life of ber fruits is extremely short and the rapid perish-ability of the fruits is a problem. Fresh fruits of *Z. mauritiana* deteriorate fast and cannot be kept for more than 10 days under ambient conditions without serious deterioration [28], even though some improved cultivars in India are known to store for up to 15 days without loss of organoleptic quality [20]. Several studies have examined the effect of treatment on postharvest changes in the chemical constituents of ber fruits and on their storage behavior. According to Monthira [17] fruits could be stored in perforated polythene bags for 8, 16 and 24 days at 15°C, 10°C and 5°C, respectively. Fruits stored at 5°C lost only 48% of their weight during the entire 12-week storage duration, while fruits stored at 22 and 15°C lost 70 and 75% of their weight, respectively. At 3 weeks of storage more than 40% of fruits had shriveled under the 22°C and 15°C storage temperatures compared with only 3% under the 5°C storage temperature. The difference in storage life seems due to variation in year of production, regions, orchard management practices, irrigation geometry, maturity stages, locations of the fruits and the time of harvesting fruits from tree, and the storage environment, etc. Sankhla *et al*. [24] introduced the Methyl cyclo-propane 1- (1-MCP) to prevent softening of the jujube fruit and loss of vitamin C amount. Kudachikar *et al.* [14] report that Plant growth regulators can use to increase life after harvesting fruit of *Ziziphus mauritiana*. In this respect, ethephon effective growth regulator presents to expedite the process and improve the quality of fruit. Siddiqui and Gupa [27] used from 500 to 100 ppm Cycocel for 15 minutes dipping method to reduce the decay and delay fruit ripening *Ziziphus mauritiana* at 25°C.

Ramkrishan and Godara [23] maintain using potassium permanganate 1000-ppm *Ziziphus mauritiana* for 14 days in Ordinary storage. Shamili and Hajiani [26] used nitrate and calcium chloride on fruit of *Ziziphus mauritiana*, Concentration of zero, 1, 2, and 4% and they found Calcium compounds can reduce the appearance of brown spots and also increase calcium levels in flesh of the fruit. The 4% calcium nitrate introduced as a superior treatment. Studies in India showed that the life storage of *Ziziphus mauritiana* increase significantly using wax, Packed in polyethylene bags and stored at temperatures up to 3.3 °C or less than 4 °C, 40 and 21 days, respectively. However, the Non-treated fruit stored at room temperature maintain Maximum 7 days [21]. Recent experiments show that plant essential oils are effective for quality maintenance and improvement of post-harvest longevity in fruits and vegetables [1, 3, 16, 18, 25]. Because of possible application of essential oils as natural antimicrobial and antioxidant agents in fresh horticultural crops, they may be considered as valuable alternatives for preserving physical and chemical properties of food plants. However, little information exists on postharvest physiological responses of Indian jujube fruit to essential oils. Therefore, the purpose of this experiment was to prolong the postharvest life and maintaining the quality parameters in Ber (*Ziziphus mauritiana*) with application of Shirazi Thyme, *Artemisia sieberi* and *Salvia* essential oils during cold storage.

MATERIALS AND METHODS

The Indian jujube fruits were picked at mature-green stages from agricultural research station in Minab places at 100 km East of Bandar Abbas to the longitude 57 degrees 13 minutes latitude and 27 degrees 10 minutes with a height of 27 meters above sea level. The average rainfall is 150 mm and the minimum and maximum temperature of 4 °C in summer and 49 degrees east to west wind in winter and the air moisture in January. Then they were transported in open boxes to laboratory. Fruits were selected for their uniformity of shape, size and color and the physical damaged or diseased ones were removed. The treatments were: Control (non-treated fruit), $CaCl_2$ treatments at 2 and 4% for 5 min, Thyme essential oil with concentrations of 250 and 500 ml for 5 min, Artemisia essential oil with concentrations of 250 and 500 ml for 5 min, Salvia essential oil with concentrations of 250 and 500 ml for 5 min. After treatment, the fruits of each repetition are weight to measure the percentage of weight loss at the end of each sampling time and it placed at 4 °C. Sampling on the tenth, fifteenth, twentieth and twenty-fifth consider after conducting quantitative and qualitative characteristics of their storage. At each sampling time, the total number of fruits and the number of decayed fruits were counted, respectively, and the decayed fruits were removed after each examination. The decay rate and percentage of weight loss calculated by using the following formula respectively:

Fruit decay percent=the number of decayed fruits×100/total number of fruits, percentage of weight loss=initial weight-secondary weight/initial weight×100, titratable acidity was determined by titration with 0.1 M NaOH to pH 8.2 and expressed as citric acid (mg) on the basis of fresh weight (FW). The juice pH value using a pH meter, percentage of total soluble solids (TSS) is calculated by using a handheld refract-meter. The ascorbic acid was measured by 2,6-dichloro phenolindo-phenol titration**.** Briefly, tissue (50 g) from six fruits was immediately homogenized in 50 ml of a 0.02 g/ml oxalic acid solution and then centrifuged at 15000 g and 4˚C for 15 min. Afterwards, 10 ml of supernatant were titrated to a permanent pink color by 0.1% 2,6-dichloro phenolindo-phenol titration. Ascorbic acid concentration was calculated according to the titration volume of 2,6-dichlorophenolindophenol and expressed as mg/100 g fresh weight. Based on the measured traits before starting storage and in four different times, Data as a percentage and the rate of change of each attribute consider at different times. The experiment was established in a factorial lay out based on completely randomized design with four replications. Data were analyzed using SAS software (2001) and the mean values were compared using the Duncan test at $P \leq 0.05$

Table 1- Data analysis of variance in relation to the evaluated traits in storing of Indian Ber fruits

S.V	D.F	Mean Square (MS)					
		Decay %	Weight loss %	Vitamin C loss %	Total acid loss %	TSS increase %	pH increase %
Replication	2	4.0^{ns}	0.4^{ns}	4.7^{ns}	3.53^{**}	0.2^{ns}	0.296^{**}
Treatment (A)	8	694.8^{**}	896.2^{**}	219.8^{**}	209.71^{**}	1184.9^{**}	17.780^{**}
Error (a)	16	1.1	0.6	5.5	0.02	0.8	0.002
Sampling time (B)	3	7874.8^{**}	855.4^{**}	2259.4^{**}	2281.58^{**}	2123.8^{**}	212.499^{**}
AB	24	233.6^{**}	34.0^{**}	20.2^{**}	25.03^{**}	78.8^{**}	2.212^{**}
RB	6	0.8^{ns}	1.0^{ns}	4.3^{ns}	0.25^{*}	0.6^{ns}	0.024^{*}
Error (b)	48	0.8	0.6	2.2	0.11	0.8	0.010
C.V %		6.2	5.9	9.4	2.1	4.9	2.07

^{ns} not significant, * and ** significant at 5% and 1% level, respectively.

RESULT AND DISCUSSION

The results of data analysis showed significant differences at 1% in all attributes. So that the effect of individual factors (sampling time and treatment) is on traits were significant at 1%. Furthermore, a significant interaction at 1% represents between the two factors (Table 1).

Percentage of decay

The results revealed that calcium chloride and essential oils decreased the decay and increased life storage of *Ziziphus mauritiana* effectively. In all treatments, fruit stored in the tenth day remain healthy and they were no decade. On the fifteenth, Fruits treated with calcium chloride didn't show any decade which twentieth day and had low severity of decay. Fruits treated with calcium chloride and thyme essential had percentage of decay. Treated fruits with essential oil of Artemisia and Salvia had significantly higher Percentage of decay (60 and 58 respectively). In general, the use of calcium chloride treatments and thyme essential oil is able to keep the quantity and quality of the *Ziziphus mauritiana* fruit at refrigeration temperature to increase its storage time.

Generally, essences prevents decay duo to antibacterial and antifungal properties of coatings. In fact, given the role of calcium in the cell wall structure and strengthen it, treatments containing calcium are able to remove the decay of the weak cell wall. Some researcher reported that mango fruit treated with microencapsulated essential oils showed the lowest incidences [3]. In addition, Pila *et al.* [22] reported study the effect of calcium chloride on postharvest tomato, which the treatment result in Significant delay in ripening fruit and decreased the rate of decay. Jalili-Marandi *et al.* [11] reported that thyme extract had favorable effect on table grapes storage. Jawandha *et al.* [12] reported the lowest percentage of decay and quality of fruit *Ziziphus mauritiana* treated with 2% calcium chloride. Papaya fruit dipped in thyme and Mexican lime essential oils experienced reduced decay caused by *C. gloeosporioides* and *R. stolonifer* by up to 50% and 40%, respectively, compared with the 100% infection observed in non-treated papayas [7]. Marjanlo *et al.* [15] reported that storage life of the strawberry fruits was increased by the use of Cumin (*Cuminum cyminum* L.) Essential Oil significantly, by inhibition of fungal infection compared to controls.

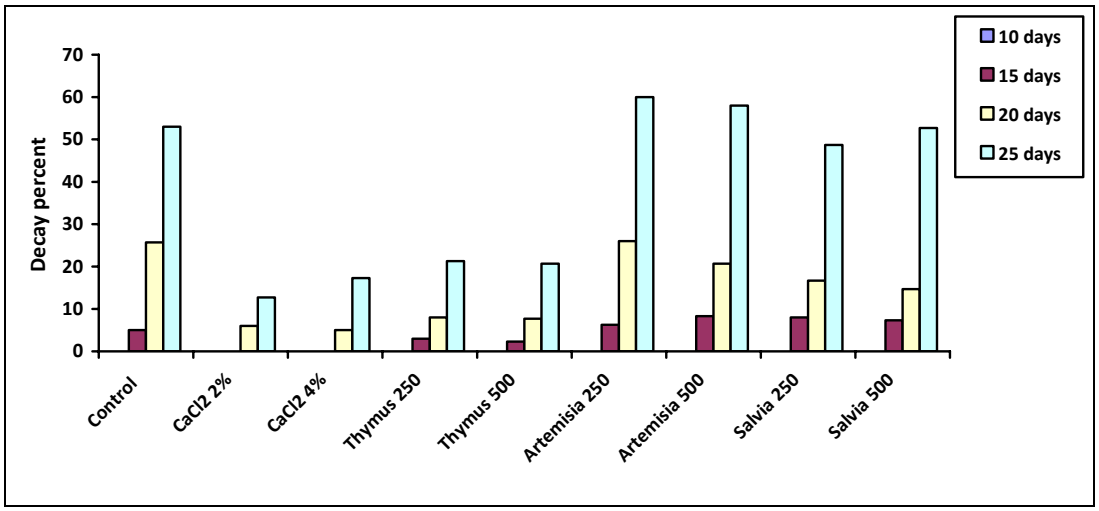

Figure 1- Interaction between treatments and sampling time on fruit decay percent

Percent weight loss

The results of variance analysis in our study demonstrated that the effect of different essential oils and storage time on fruit weight loss percentage was significant. Due to transpiration, weight loss during storage was observed for all treatments (Figure 2). Compared to the control, jujube treated with calcium chloride, 2 and 4% exhibited a significantly lower weight loss. The highest percentage of weight loss was recorded in control and fruit treated with oil of Salvia Artemisia 500 or 250, on the twenty-fifth (0.32, 0.31, 0.32 and 0.32 percent, respectively). In total, treatment using calcium chloride and thyme Essence is able to prevent weight loss *Ziziphus mauritiana* fruit at the refrigerator temperature. The moisture and subsequent weight loss in fruits increased linearly with increase in storage duration due to water loss and respiration [8]. Gholamiyan *et al.* [9] and also Hamzezad *et al.* [10] reported that the positive effects of 3% calcium chloride to prevent weight loss peach varieties of Alberta and the saffron, respectively which corresponded with the research. *Ziziphus mauritiana* of Fruit during warehousing found that weight loss and shrink fruit with yellow or golden yellow color change from green to red brown [21]. Marjanlo *et al.* [15] reported that no significant fruit total soluble solids were observed in treated strawberry fruits with essential oil compared to controls at all determination times.

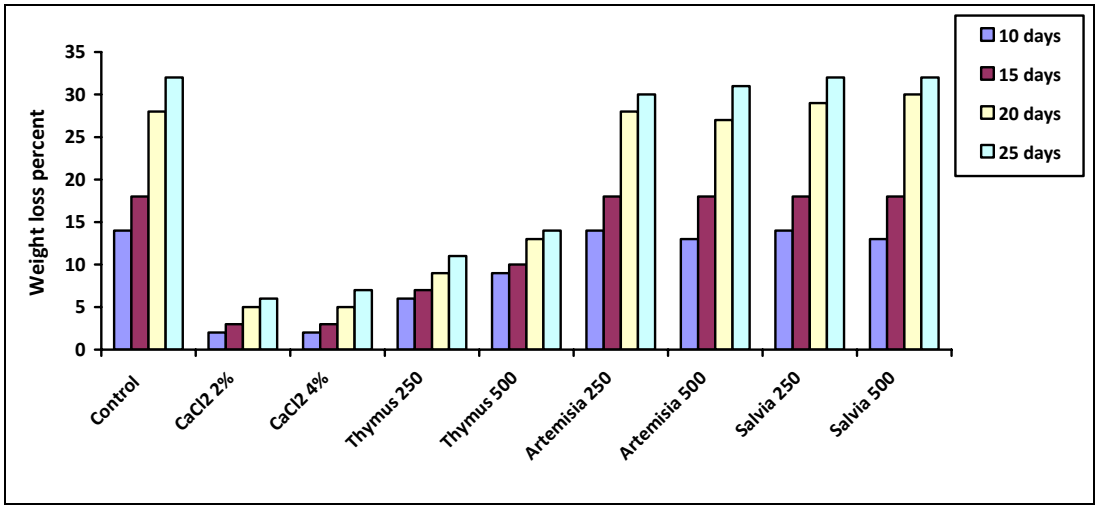

Figure 2- Interaction between treatments and sampling time on fruit weight loss percent

Percent reduction in vitamin C

Ascorbic acid is usually considered as an index of nutrient quality in fruit. The lowest percentage reduction in vitamin C found in fruits treated with calcium chloride (2%). In total, the use of calcium chloride treatments and Shirazi thyme essential oil are able to prevent the loss of vitamin C in *Ziziphus mauritiana* fruits at the refrigerator temperature. Essences of Artemisia and Salvia didn't have significant positive effect compared to the control to prevent the loss of vitamin C in fruits (Figure 3).These results are in agreement with those obtained by Azam-Ali *et al.* [6] found preserved *Ziziphus mauritiana* fruit at room temperature for 9 days, reduced vitamin C from 177.13 to 93.72 mg. Asghari-Marjanlo *et al.* [5], reported that the application of basil essential oil in low concentration increased the vitamin C content in strawberry. Beside abiotic factors, the ascorbic acid can be irreversibly oxidized [19], which decreases the edible quality and increases susceptibility to different physiological disorders during storage [13].

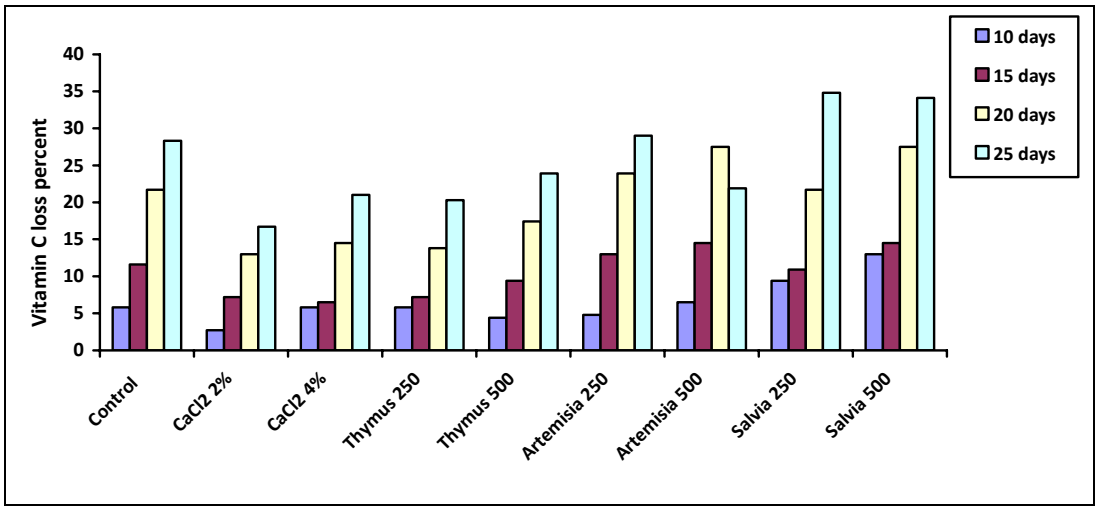

Figure 2- Interaction between treatments and sampling time on fruit vitamin C loss percent

Percent reduction of total acid

As showed in Figure 4 total acid decreased during storage in all treatment. The lowest percentage of total acid reduction found with 2% calcium chloride on the tenth day (1.3 percent) . In total, the use of calcium chloride treatments and thyme essential oil is able to prevent reduce the acid in the fruit. Salvia essence and Artemisia hadn't significant positive effect to prevent loss of acid in the fruit (Figure 4). Pareek *et al.* [21] found titratable acid increased in following the use of calcium chloride during storage, which in this study, the percentage of total acid reduction is consistent with Percentage of total acid reduction less in control. Within ripening *Ziziphus mauritiana*, since the formation of fruit until ripping fruit, the amount of acid decreased. The use of treatments that delay reduces the amount of acid in fruit can effect on increase the storage life of fruits [21] and it found Preserved *Ziziphus mauritiana* fruit Civil figure at room temperature for 9 days, reducing the total acid from 0.12 to 0.21.

During Preserved *Ziziphus mauritiana* fruit, the total acid is decreasing, which is consistent with the results of the present study. The changes in titratable acidity are significantly affected by the rate of metabolism especially respiration, which consumed organic acid and thus decline acidity during storage [8]. Fruit immersion in calcium chloride solution (1 to 2%) can increase storage life of *Ziziphus mauritiana* fruit by delay ripening. On the other hand, immersion in a solution of ascorbic acid (150 to 300 milligrams per liter), in addition to reducing the rate of ripening, increase TSS of fruit with no change in the total amount of acid or vitamin C [21].

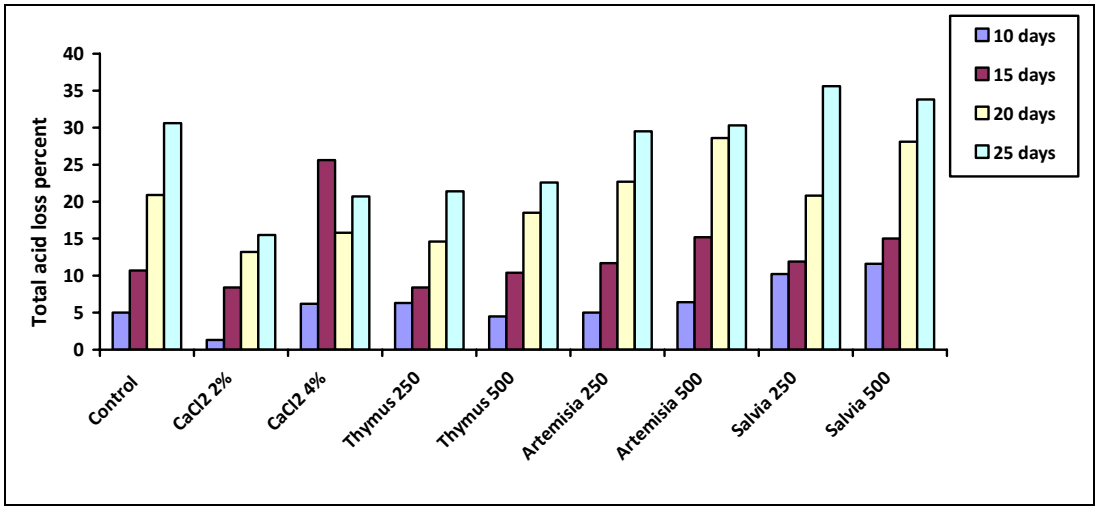

Figure 4. Interaction between treatments and sampling time on total acid loss percent

Percent increase in TSS

Total soluble solid of fruit is a major quality parameter which is correlated with the texture and composition. As shown in Figure 5, the total soluble sugars of ber with different treatments increased gradually with increasing the storage duration throughout the 25-day storage at 4 temperature. Calcium chloride could significantly inhibit the increase of total soluble sugar content compared with the control. On day 25, the total soluble sugars of the calcium chloride treatment reached 8.4%, which was significantly lower than the control of 44.8% ($P < 0.05$). Fruit treated with the essence of salvia 250 and 500 on the twenty-fifth (44.8 percent) did not show any significant with control. Azam-Ali *et al.* [6] reported that despite the decline in fruit quality characteristics such as vitamin C and total acid, increase the percentage of total dissolved solids cause the fruit sweeter so that preserved *Ziziphus mauritiana* fruits increase cultivar development at room temperature for 9 days, the TSS from 17.5 to 19.5 percent. The use of treatments such as calcium chloride and thyme essential oil which put off the conversion speed of the sugars in fruits can impact on increase the storage life of fruits. In different results; Basil essential oil spray emulsion (0.16% v/v) treatment on banana to control crown rot disease did not have any significant effect on TSS after induced ripening [4].

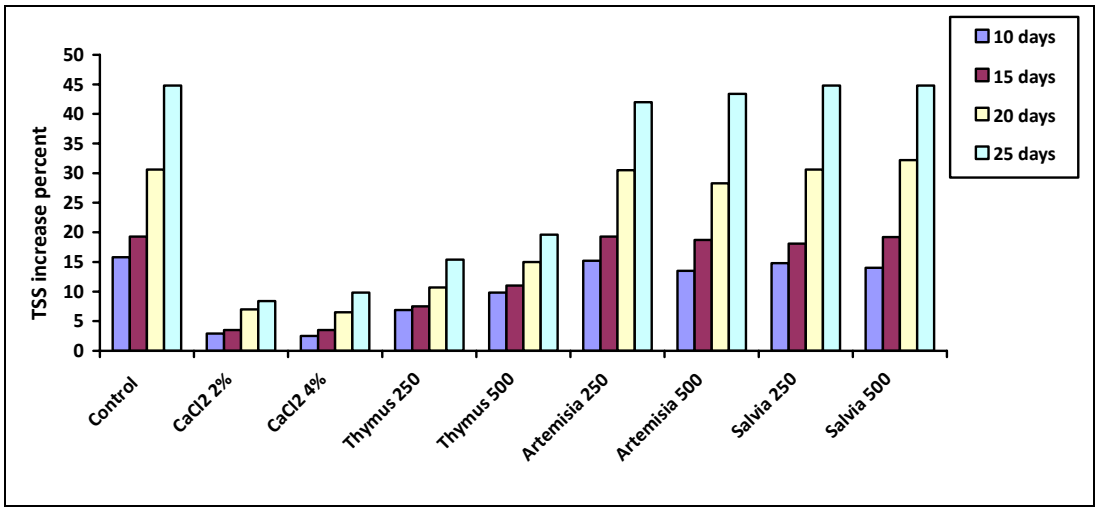

Figure 5. Interaction between treatments and sampling time on TSS increase percent

Percent increase in pH

The lowest percentage increase in pH at fruits treated with calcium chloride to 2% on the tenth day (0.3 percent) found that there was significant difference at 1% level (Figure 6).

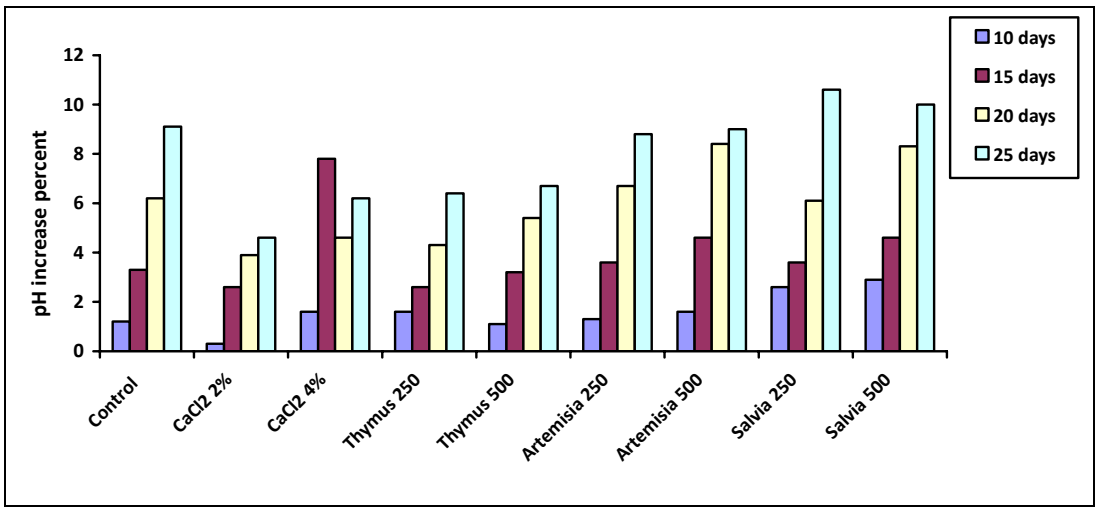

Figure 6. Interaction between treatments and sampling time on pH increase percent

By reducing the amount of acid in the fruit, pH value increased. In addition, during storage happen in this process and finally with the shrinking amount of acid in the fruit, pH value reach to the highest value [6]. The use of treatments such as calcium chloride and essential oil which put off reduce speed acid and increasing pH, can impact on increase the storage life of fruits. Based on reports Aboutalebi and Johnparvar [2], different treatments had no significant effect on the pH of citrus fruit juice. Our results confirmed other study results by others [15].

CONCLUSIONS

The use of calcium chloride treatments and the classification of essential oil are able to keep the quantity and quality of *Ziziphus mauritiana* fruit at refrigerator temperature and increase its period maintains.

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