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# The Effect of Oregano Essential Oil in Post-Harvest Quality of Minimally Processed Radish

**D.A.V Montero[1], J.R. Jambassi[1], R.M. Evangelista[1], M.A. Tecchio[1], F.P.G. Bonfim & L.C. Ming[1]**

## Abstract

The objective of this study was to evaluate the postharvest quality of minimally processed radish treated with a solution made with essential oil of *Origanum vulgare* (oregano) and ascorbic acid. Sliced radishes were immersed in different concentrations of essential oil and ascorbic acid for 1 minute and then centrifuged in domestic spin for 3 minutes to remove water excess. The control was obtained by immersing the slices of radish in distilled water. The slices of radish were placed in polystyrene trays covered with polyvinyl chloride (PVC) film and stored in a cold room at 5 ± 1ºC. The pH values ranged from 5.1 to 6.6. The levels of titratable acidity were not significantly different. The content of reducing sugars tended to decrease with storage time, being higher in radishes that were subjected to treatment with the essential oil solution. The minimum and maximum values of ascorbic acid were 83.9 and 276.7 mg/100 ml at concentration of 0.2% essential oil solution. The mass loss increased in average 1.5 to 2%. The concentration 0.2% could be recommended to maintain the quality of radish from a chemical point of view.

**Keywords:** *Oreganum vulgare*, ascorbic acid, postharvest, quality, *Raphanus sativus*

## 1. Introduction

The radish (*Raphanus sativus* L.) is a plant easy to grow and can be found in most home gardens, has intense flavor and aroma (SWIADER et al., 2002). Belongs to the Brassicaceae family and is an important vegetable cultivated worldwide, especially in China, Japan, Korea, and Southeast Asia, having a broad adaptation, high productivity and abundant nutritional content (ZHAO-LIANG, et al., 2008). Despite being a minor crop in relation to acreage, the radish is considered important for many smallholders who grow a variety of vegetables. It can be used as a cash crop between other crops of longer cycle due to the relative roughness and short cycle of about 30 days. Moreover, it is an excellent source of phosphorus, calcium and manganese, contains vitamins B1 and B2, and niacin and vitamin C work as diuretic and anti-scurvy, and stimulates digestive glands and liver by promoting the increase in bile production and better digestion (del Aguila, et al., 2008). Its nutritional composition in 100 g of root in nature is: 15.9 calories; 96.20% of water; 30 mg of vitamin B1 (thiamine); 30 mg of vitamin B2 (riboflavin); 0.30 mg vitamin B3 (niacin); 18,3 mg vitamin C (ascorbic acid); 0.50 mg copper; 10 mg magnesium; 3.70 mg of zinc; Potassium 382.9 mg; 86.50 mg sodium; 138 mg calcium; 1.71 mg iron and 64 mg of phosphorus (Cortez, 2009).

The radish is gaining huge market share at minimally processed products, although their physiological behavior after packaging is still little known. Postharvest physiology in vegetables is less studied than in fruits, possibly due to the diversity of organs used, the variability of species and the great influence of factors over post-harvest plant products. In a generic definition, we can say that vegetables are parts of plants that do not belong to the group of fruits and cereals and are eaten fresh, raw or processed (CHITARRA, CHITARRA, 2005).

[1] Department of Horticulture, Faculty of Agronomical Science, State University of Sao Paulo, (UNESP, Botucatu), Rua José Barbosa de Barros, 1780 - CEP 18610-307, Botucatu / SP (Brazil), + 55 14 3880-7203, E-Mail: dvillamontero@gmail.com

Some of the problems of minimal processing are the physical and physiological changes that compromise the quality and viability of the product, since physiologically behave differently from intact fruits and vegetables showing greater perishability, which results in several processes that must be controlled in order to enhance the durability of the product. The stresses suffered by the plant tissues as they passed by cleaning, peeling and cutting operations generate physiological responses as transient increases in ethylene evolution, increase in respiratory activity, degradation of lipids in cell membranes caused by mechanical damage at various stages of processing, browning from oxidation of phenolic compounds, yellowing due to the loss of chlorophyll, and so on. Furthermore, the internal tissues are exposed to endogenous enzymes and microorganisms (Moretti, 2007).

The dimming control of the minimally processed products by chemical methods can be accomplished by the use of antioxidants such as ascorbic acid, citric acid, calcium chloride and ethylene diamine tetra-acetic acid (FAGUNDES; AYUB, 2005). L-ascorbic acid and its neutral salts, alone or in combination with citric acid, are known as antioxidants used in fruits, vegetables and juices for prevention of browning and other oxidative reactions. Ascorbic acid acts on the reduction of o-benzoquinone to the irreversible inactivation of polyphenol oxidase (PPO). Additionally, it removes oxygen from the environment, going to de-hydro-ascorbic acid, promotes regeneration of antioxidants, as well as acting synergistically with complexing agents (PINELLI, 2004). González-Aguilar et al. (2005), for example, found that pineapple slices reduced the degradation of sugars, vitamin C and phenolic compounds when treatment with ascorbic acid and iso-ascorbic acid. The efficiency of ascorbic acid to reduce enzymatic browning is the best when incorporated into an emulsion (Moretti, 2007).

The essential oils of plants have been proposed to treat various types of products, including minimally processed. It has been suggested that the addition of citrus essential oils into a mixture of fresh cut fruit (apple, pear, peach, grapefruit and kiwi) inhibited the proliferation of naturally occurring microorganisms. Also, has been reported that the addition of citrus essential oils 0.02 (v / v) to a mix of fresh cut fruits inhibiting the proliferation of micro-flora naturally occurring and reduced the rate of growth of inoculated *S. cerevisiae*, thereby increasing the shelf-life without affecting sensory properties (WHO -Oliu, et al. 2010).

Oregano essential oil is extracted from the species *Origanum vulgare*. This essential oil has reddish-brown coloration. The taste provokes a burning sensation, being acceptable only after extensive dilution. The essential oil of oregano is widely used in perfumery, especially for medicinal note. The main component, carvacrol, is also a powerful antioxidant, helping to preserve food and assisting in the formulation of cosmetic products with purpose to prevent premature aging of the skin (Grossman, 2005). In one study, carvacrol in conjunction with the cinnamic acid (0.015%, v / v) were effective in reducing and inhibiting microbial growth on kiwi and melon, respectively, without causing harmful effects to sensory aspects. In the kiwi fruit, the concentration of carvacrol (0.075 = 0.225%, v / v) were also effective in reducing microbial population; however changes in odor and color of the fruit (WHO Oliu, et al. 2010) were observed. Therefore, this study aimed to evaluate the postharvest quality of minimally processed radish treated with oregano essential oil associated with ascorbic acid.

## 1. Materials and Methods

The experiment was conducted at the Laboratory of Postharvest, Faculty of Agricultural Sciences, UNESP, Botucatu-SP. The radishes used in the experiment were produced on the Faculty´s experimental farm “São Manuel”, located at 22 º 38,372 'S, 48 º 43,163' and 580 m altitude. The climate, according Tubelis and Salibe (1989), is classified as Cfa (mesothermal temperate climate) and soil, according to Embrapa (2006), is characterized as dystrophic Oxisol. Immediately after harvest the radishes were transported to the laboratory in plastic boxes, washed in running water to remove adhering soil, air dried and sliced in a domestic processor to the application of treatments.

The experimental design used was a randomized block design with split plots of five blocks, where the plots corresponded to four concentrations of oregano essential oil associated with ascorbic acid (T1: Control, T2: 0.1 ml L-1 essential oil oregano and ascorbic acid solution 2%, T3: 0.2 ml L-1 oregano essential oil and ascorbic acid solution 2%, T4: 0.3 ml L-1 oregano essential oil and ascorbic acid solution 2%) and the subplots were established by the five assessment times (0, 2, 4, 6 and 8 days).

Fresh aerial parts of *O. vulgare* were collected in the morning at the medicinal garden of the Department of Horticulture, FCA / UNESP-Botucatu. 100g were used for the extraction of essential oil by the method of hydrodistillation using the Clevenger apparatus for 2 hours. The oil was separated from hidrolact and transferred to amber glass bottles.

The oregano essential oil at concentrations of 0.1, 0.2 and 0.3 ml L-1, was emulsified (Tween 40-2 ml) and incorporated with ascorbic acid 2% solution. The sliced radishes were immersed in these solutions for 1 minute and then centrifuged for 3 minutes to remove water excess. The control was obtained by immersing the slices of radish in distilled water. After treatments, the slices of radish were placed in polystyrene trays covered with polyvinyl chloride (PVC) film and stored in a cold room at 5 ± 1 º C. The loss of weight, pH, titratable acidity, soluble solids, reducing sugars and ascorbic acid content evaluations were performed during the experiment.

The loss of weight was determined as a percentage, considering the difference between the initial mass and that obtained at each sampling time interval, according to the formula

$$PM\,(\%) = \frac{\left(P_i - P_j\right)}{P_i}.100$$

Where: PM= Mass loss; $P_i$ is the initial mass and $P_j$ is the mass in the evaluated period.

The pH was determined directly in the radish pulp after being crushed, using a Tecnal Model Tec - 3MP potentiometer following the Adolfo Lutz Instituted technique (Brazil, 2005). Soluble solids (SS) were determined and expressed in ° Brix by readings of ATAGO PR - 32 Palette (0-32%) digital refractometer, as recommended by AOAC (2005). The titratable acidity (TA) was determined by titration with 0.1 N NaOH and expressed as percentage of malic acid (g Malic acid 100g-1 fresh tissue), according to the technique of the Institute Adolfo Lutz (Brazil, 2005). Reducing sugars were determined from 1g sample and assayed by the method described by Somogyi and adapted by Nelson (1944) and expressed in percentage (%). The levels of ascorbic acid (AA) were determined by the Ministry of Agriculture, Livestock and Supply (2012) method and expressed in $mg^{-1}$ AA $100ml^{-1}$ pulp. The results were subjected to analysis of variance and the means were compared by polynomial regression analysis, using the SISVAR program.

## 2. Results and Discussion

There were statistically significant differences between the pH values on different days. The average pH was 5.1 on day 0; 6.2 on day 2; 6.5 on day 4; 6.4 on day 6 and 5.9 on day 8. The doses increased the pH until approximately 0.2% concentration, and thereafter, certain stability was observed. The highest value (pH 6.6) was observed on day 6 at a concentration of 0.19% and the lowest value was observed on day 0 with 0.7% in the control ( Figure 1).

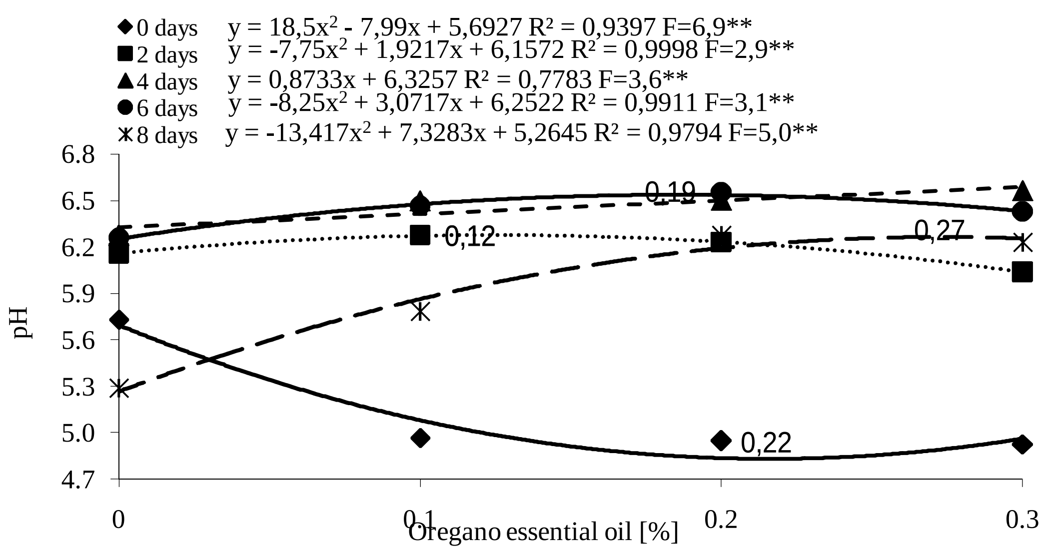

**Figure 1:** PH of minimally processed radish treated with essential oil of oregano and ascorbic acid and stored at 5 ± 1 ° C for 8 days. [** Significant at 1% by F test].

Oms-Oliu et al. (2010) argue that the antimicrobial effect with the addition of organic acids in food increases the concentration of protons, causing drop in external pH values. Thus, growth of microorganisms is inhibited when the pH is below values which provide their development. A study by Russo et al. (2012), with minimally processed melon, reported that the pH values showed some stability and that this could be associated with low temperatures and therefore the stability of pH values is indicative that the product does not have any type of fermentation because of possible microbial contamination. Still, in the work mentioned above, Oms-Oliu et al. (2010) reported that carvacrol and cinnamic acid 0.0015% v/v was effective in reducing and inhibiting microbial growth in minimally processed kiwi and a variety of melons, respectively, without affecting their sensory properties. In minimally processed kiwi, carvacrol concentrations between 0.075 and 0.225% v/v were effective in reducing the natural microflora of the product, however caused changes in color and odor. Microbial reduction due to the concentrations of oregano essential oil may explain the stability of the pH to avoid degradation reactions.

Regarding acidity, no statistically significant values were obtained. It can be seen that the acidity was increased up to ± 0.2% concentration of oregano essential oil and then decreasing as the dose was increased from the same (figure 2).

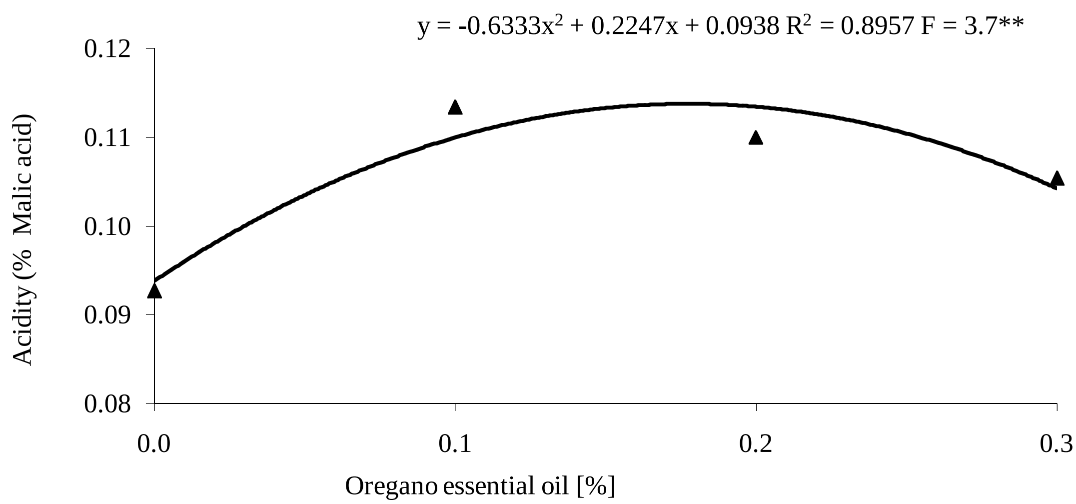


**Figure 2:** Acidity of minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1° C for 8 days. [** Significant at 1% by F test].

According to a study by Del Aguila et al. (2008), this is due to the effect of acids in general. The radishes treated with ascorbic acid increased acidity only until the second day, probably due to the rapid consumption of acids by oxidative reactions that have occurred over the days.

Another study done by Del Aguila et al. (2006), in which the radishes were cut and stored in different ways at different temperatures showed that there was no difference in acidity between the different types of cutting and storage temperatures, so the% values were between 0.05 to 0.06% Malic Acid. The consumption of soluble solids was statistically significant only on days 0, 2 and 8. Lower value of soluble solids can be observed on the last day of storage with 2.5 ° Brix and the highest value on day 0 and 2 with 4.2 ° Brix, as shown by the curves of Figure 3.

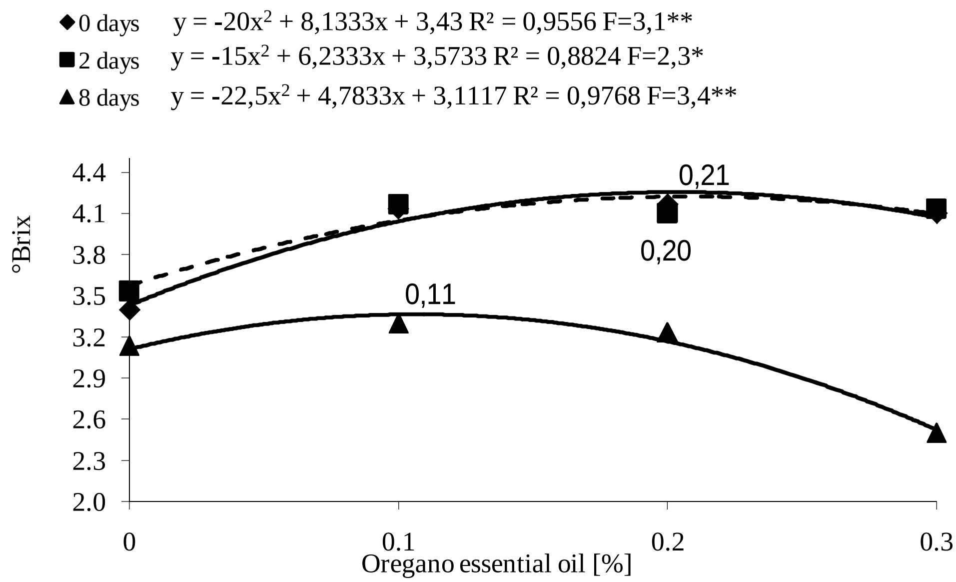


**Figure 3:** Soluble solids of minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1 ° C for 8 days. [*and**significant at 1% and 5% respectively by F test].

According to Del Aguila et al. (2008), the minimal processes of radish affects the loss of soluble solids and thus with higher level of processing more reactions are activated for the loss of these parameters. Grated radishes lost about 2.2% soluble solids during 10 days in cold storage while the loss observed in sliced and whole radish were 0.43 and 1.1% respectively. This decrease in soluble solids can be attributed, in part, to the consumption of carbohydrates during the respiration process associated with tissue injury, therefore the larger the surface area, the greater the loss. Another study done by Del Aguila et al. (2006) showed that the soluble solids content was always lower in the control compared to the other treatments, suggesting a higher intake of carbohydrates during respiration. However, analysis with 42 cultivars of radish by Zhao-liang et al. (2008), observed variation between 2,233 and 15,457, where even then, the values obtained from our study were within the normal range.

Reducing sugars were statistically significant only for days 0 and 2 with a maximum value of 1.9% and minimum 1.3%, respectively. The maximum value was obtained at a concentration of 0.16% essential oil and thereafter tended to fall with increasing concentration (Fig. 4).

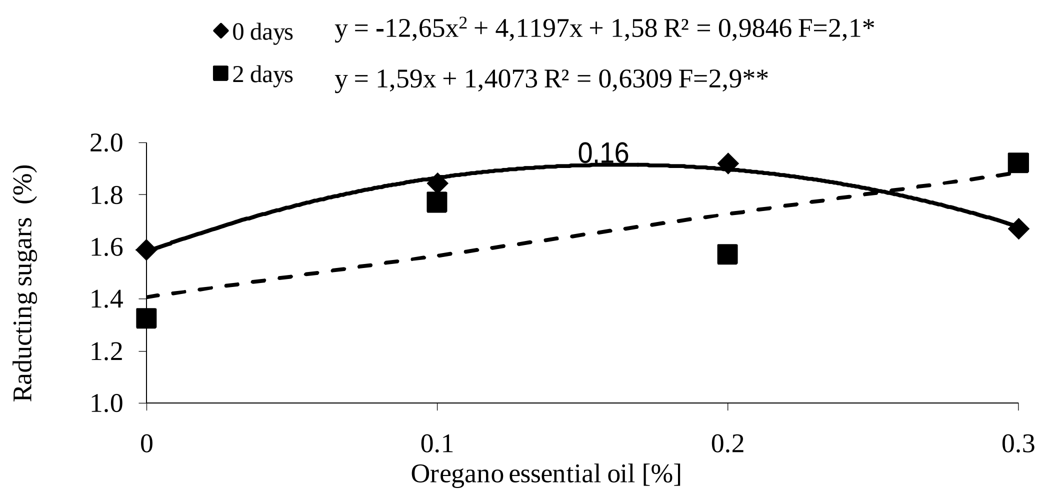


**Figure 4:** Reducing Sugars of minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1 ° C for 8 days. [*and** significant at 1% and 5% respectively by F test].

Generally reducing sugars tended to decrease over the days of storage. This reduction is related to the cuts that were made in the radishes that accelerated the consumption of reserves in metabolism. The amounts of reducing sugars remained always higher in radishes which were subject to treatments compared to radishes that did not receive treatment.

The levels of ascorbic acid were significant until the 6th day of storage, where the highest value was observed at day 0 to 276.7 mg/100 ml dose of 0.2% essential oil (figure 5) and the lowest value on 4 to 83.9 mg/100 ml in the control (figure 5.1).

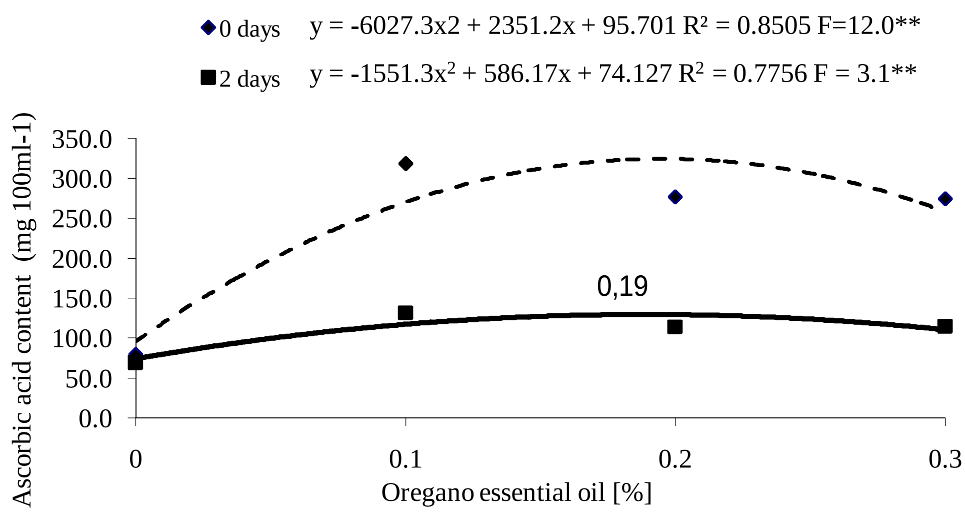


**Figure 5:** Ascorbic acid content of minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1 ° C for 8 days. [** Significant at 1% by F test].

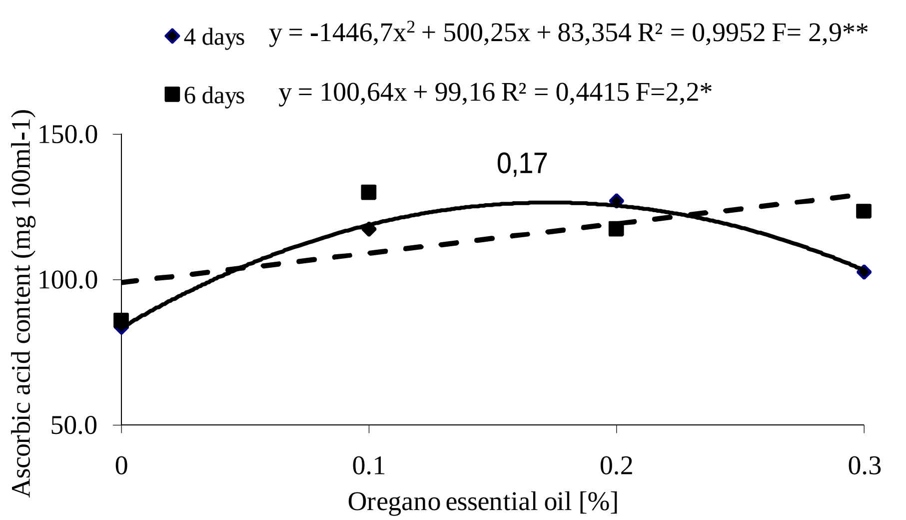


**Figure 5.1:** Ascorbic acid content of minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1 ° C for 8 days. [*and** significant at 1% and 5% respectively by F test].

In the cultivars evaluated by Zhao-liang et al. (2008), the levels of ascorbic acid ranged between 14.16 and 33.41 mg/100 ml. In the study conducted by Del Aguila et al. (2008), the radishes treated with ascorbic acid significantly increased the amounts of this compound and this pattern was maintained throughout storage.

On the 10th day of storage, 58.02 and 20.62 mg/100 ml of ascorbic acid were obtained in the radishes undergoing the treatment with ascorbic acid and the highest values obtained were 371.64 and 179.17 mg/100 ml.

Another study by Del Aguila et al. (2006) reported that a reduction in the levels of ascorbic acid was related to the different type of radish cut. This reduction was between 220.45 to 30.01 mg / kg. Minimal processing and other injuries done on roots, cause a reduction of ascorbic acid increasing the rate of browning reactions and degradation of the vegetable. The reduction of ascorbic acid was observed in this study and, in agreement with what has been reviewed, it can be assign to the effect of the minimum processing performed on radish. The values are above the average due to the treatment carried out with ascorbic acid, with similar values in radishes receiving the same treatment.

The mass loss was statistically significant demonstrating increased over the days of storage. In the control mass loss was between 0.7 to 2.3% on days 2 to 8 and 1.1 to 3.2% in treated radishes on days 2 to 8 respectively. Thus it can be seen that the weight loss was increased as increase the concentration of essential oil in the treatment solution and also days of storage. The increase in average was 1.5 to 2%, as can be seen in Figure 6.

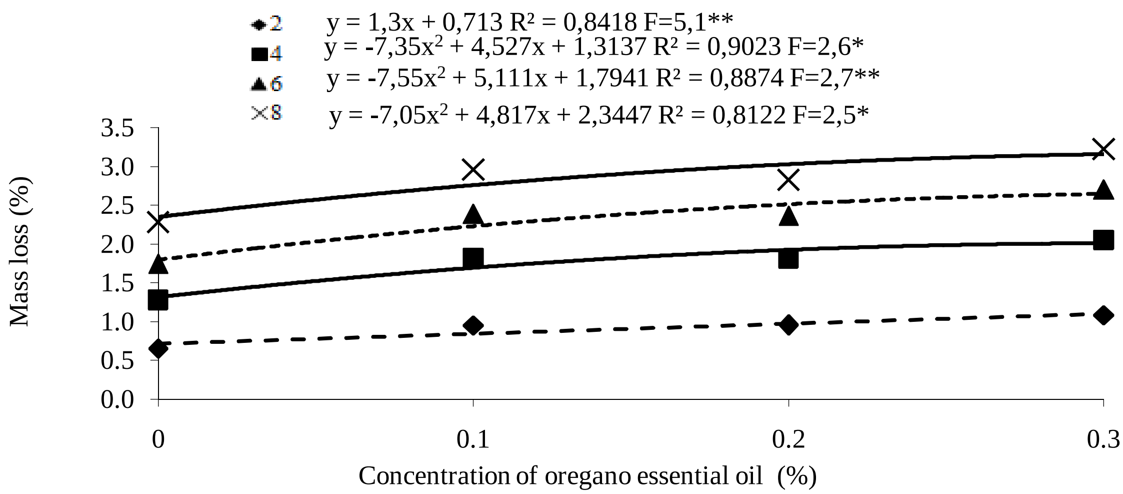


**Figure 6:** Mass loss in minimally processed radish treated with oregano essential oil and ascorbic acid. Stored at 5 ± 1 ° C for 8 days. [** And * Significant at 1% and 5% respectively by F test].

Del Aguila et al. (2006) found that the weight loss increases as a function of storage time and temperature, showing that with 1 to 5 ° C, the loss was 2 to 3% respectively. Regarding the types of cuts that have been made in the studies, no influence on mass loss was showed. Another study reported that weight loss had not significant increase and with 1% at the end of the trial period, a loss that was expected since the treatments offered no protection against water loss.

## 3. Conclusion

Compared with the control the treatment of oregano essential oil and ascorbic acid was associated with a favorable post-harvest conservation of minimal process radish. The concentration of 0.2% essential oil of oregano is recommended to maintain the quality of chemical standpoint radish stored at 5 º C.

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