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Effect of edible tragacanth coating on fruit quality of tomato cv. Falkato

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ABSTRACT

Purpose: Considering the high perishability of agricultural products, especially vegetables, it is very important to use edible coating materials that increase their postharvest life and are edible and non-chemical. **Research method**: In this study, the effect of tragacanth gum coatings (0, 5, 7.5, and 10 $g.L^{-1}$) on the edible quality of tomato fruits cv. Falkato was investigated during 35 days of storage (15 °C and 85-95% relative humidity). The fruits were immersed in tragacanth gum solutions for three minutes and carefully weighed and labeled and packed after drying. During storage time, every one week (7 days) fruits were removed and the fruit weight loss, pH, soluble solids concentration (SSC), titratable acidity (TA), fruit firmness, shrinkage, and decay index were measured and compared with the uncoated sample (distilled water treatment). **Findings**: According to the results the tragacanth gum coating significantly reduced the percentage of fruit weight loss and improved the quality of tomato fruits such as firmness, SSC and TA compared to the control sample. So, coated fruits showed better edible quality than uncoated fruits. Then tragacanth gum is recommended for use after harvesting the tomato fruit**. Research limitations**: No limitations were founded. **Originality/Value**: In this research, for the first time, the effect of tragacanth gum coatings on the storage life of tomatoes was investigated.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) fruits have nutritional value such as micronutrients, carotenoids, and natural antioxidants (Oshima et al., 1996; Yahia et al., 2007; Peralta et al., 2008), so it is among the top vegetables in the world. It has allocated for more than 15% of world vegetable production (FAO, 2007). Tomato is a climacteric fruit and has a shorter shelf life after harvest due to some factors such as high respiration rate, then its quality such as flavor, firmness, color, and shelf life changes continuously after harvesting (Zapata et al., 2008; Ju et al. 2000). Tomato fruits are susceptible to frost damage, so they should be stored at temperatures over 11 °C (Cheng and Shewfelt, 1988). Therefore, maintaining the quality of fresh tomatoes is still a major challenge in the post-harvest period.

Edible coatings and films are made from natural polymers and edible films form a thin layer of food and prevent the transfer of moisture, gases, soluble and aromatic substances. These films must have favorable mechanical properties and be chemically stable (Zapata et al., 2008). Edible films and coatings are used as carriers of antimicrobial agents to control microbial contamination of food (Flores et al., 2007). Film or edible coatings reduce the transfer of moisture, oxidation, and respiration of the fruit, thereby preserving their quality and prolonging their shelf life. The coverage of tomato fruits with gum arabic has delayed the process of ripening and maintaining the antioxidant capacity (Ali et al., 2013). Also, the effect of hydroxypropyl coating on tomato shelf life was investigated. The edible coating delayed the tomato color from pink to red during storage, texture, and color changes (Zhuang and Huang, 2003). The rate of respiration and production of ethylene in tomatoes coated with alginate-based edible films was lower than in uncoated samples (Zapata et al., 2008). In one research it was concluded that coatings prevented significant changes in firmness, weight loss, soluble solids concentration, titratable acidity, and the percentage of decay compared to uncoated control tomato fruits (Mahfoudhi et al., 2014). Tragacanth gum also has appropriate coating properties. Its use as an edible coating has been reported on certain fruits such as sweet cherry (Esmaeili et al., 2022) and mango (Ali et al., 2022). Results exhibited that mango fruits coated with 1.5% TG showed substantially lower disease incidence and weight loss (Ali et al., 2022). In a recent study, effect of guar, Persian and tragacanth gums on the surface characteristics of biopolymer-coated tomato and cucumber epicarps was investigated (Mostafavi, 2019). Therefore, based on the investigations that have been done, no research has been done regarding the effect of tragacanth gum on fruit characteristics of tomato. Then, in this study the effect of tragacanth gel coating on storage life and quantitative and qualitative properties of tomato fruit cv. Falkato was investigated.

MATERIALS AND METHODS

Materials

Tomato fruits were provided from a traditional greenhouse located in Dehaghan (Isfahan, Iran) and transferred to cold storage immediately. The 180 identical and healthy fruits were harvested at the mature red stage having no visible stain. Tragacanth gum was supplied from the local market in Isfahan (Iran). They were grinded and sieved for producing powder and this powder was used for the preparation of different concentrations of coating solutions.

Preparation of coating treatments

The powdered tragacanth gum at different concentrations (0, 5, 7.5, and 10 $g.L^{-1}$) was added gently to the distilled water, and then stirring the solution was done to obtain a complete dissolving of the gum (Jahanshahi et al., 2018).

Coating and storage

The fruits were immersed in the treatment solution for three minutes at room temperature. Sterile distilled water was used as the control solution. After that, the fruits were air-dried and packed in boxes after weighing them with digital scales (China Note Book Model) and labeling the weight of the fruit. The fruits were stored in cold storage (15 ±1 °C and 85-95% relative humidity) for 35 days and during storage time the fruits were removed from storage at 7-day intervals and the desired traits were measured.

Physicochemical properties

Weight loss and Firmness

To evaluate weight loss, all fruits were weighed at the beginning of storage (day 0) and all sampling days. Water losses were calculated as a percentage of weight loss using the following formula (1):

$$\text{Weight loss (\%)} = \frac{Wi - Wf}{Wi} \times 100 \qquad (1)$$

W_i: Fruit weight before storage, W_f: Fruit weight at each sampling day

A manual fruit penetrometer (model GY3, China) was used to measure the firmness of the fruit tissue. At first, a fruit was randomly selected from each replicate and the probe was used on the fruit tissue and pressed to determine the amount of tissue firmness.

Titratable acidity (TA), Soluble solids content (SSC), and pH

To measure the TA, 10 ml of fruit juice was used and diluted to 100 ml with distilled water. The diluted extract was titrated with 0.1 N NaOH. The following formula (2) was used to calculate the amount of titratable acidity, and it was expressed as a percentage of citric acid per 100 ml of fruit juice (AOAC, 2002). The SSC was analyzed by a refractometer (Model N1, Atago, Japan) at room temperature (25 °C) and expressed as a degree of Brix. The pH of the fruit juice was measured by the pH meter (AOAC, 2002).

$$\text{\% Acid (wt/vol)} = N \times V1 \times \text{Eq wt} / y \times 10 \qquad (2)$$

V: Volume of consumption for titrant (ml), N: Normality of titrant (0.1 normal), Eq.Wt: Equivalent weight of citric acid (70 mg/mEq) and y: volume of Sample (ml).

Fruit shrinkage and decay evaluation

The shrinkage area of the fruit was calculated and expressed in terms of the percentage of shrinkage. Shrinkage of fruits is not homogeneous, so the direct evaluation method requires several measurements at different parts of a fruit, to obtain representative results (Sahin & Sumnu, 2006). Also, the fruit decay was evaluated visually. The degree of surface decay was measured through the same scale of browning judgment. For this purpose, each time the samples were taken out of the cold storage, the fruits were carefully evaluated and graded for fungal contamination (Cao et al., 2010).

Statistical analysis

The experiment was factorial in a split-plot design with three replications. The main factor was tragacanth gum concentrations and the storage time was submitted as a sub-factor. The data analysis was performed using SAS version 9.3. Data normality was tested by the Kolmogorov-Smirnov test and data normality was confirmed. The mean comparison was analyzed by LSD test.

RESULTS AND DISCUSSION

Weight loss

The highest percentage of weight loss occurred in the control treatment (distilled water). The tragacanth coating caused less weight loss in fruits and the results of this research showed that at 7.5 g.L^{-1} tragacanth gum, less weight loss occurred during storage time (Fig. 1). The tomato juice is 90-95% at harvest time. But after fruit harvesting, a significant amount of fruit juice is lost by evapotranspiration (Meidani, 2003; Mazaheri et al., 2007). Fruits coated with 10 and 15% gum had less weight loss compared to the control, and weight loss gradually increased during storage time (Ali et al., 2010).

The pH of fruit juice

The results showed that 7.5 g.L^{-1} tragacanth coating was better-preserved pH during storage time (Fig. 2). The highest increase in pH occurred in the control treatment (distilled water). Thus, the tragacanth coating caused the pH to increase more slowly during the storage time. The pH of tomato fruit increases during ripening and storage (Flores et al., 2007). The significant effect of tragacanth gel on pH in this study was in agreement with the results of *Aloe vera* gel research on grapefruit (Asghari & Ahadi, 2013).

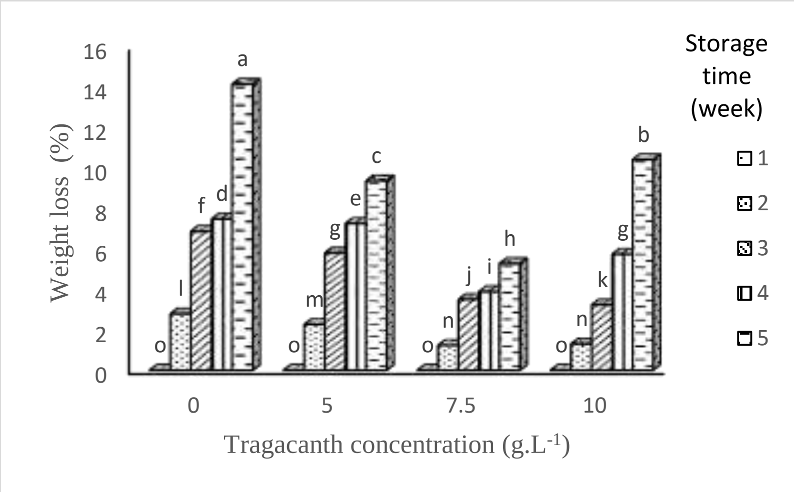

Fig. 1. Effect of tragacanth gum concentration on the weight loss of tomato fruits during storage time.

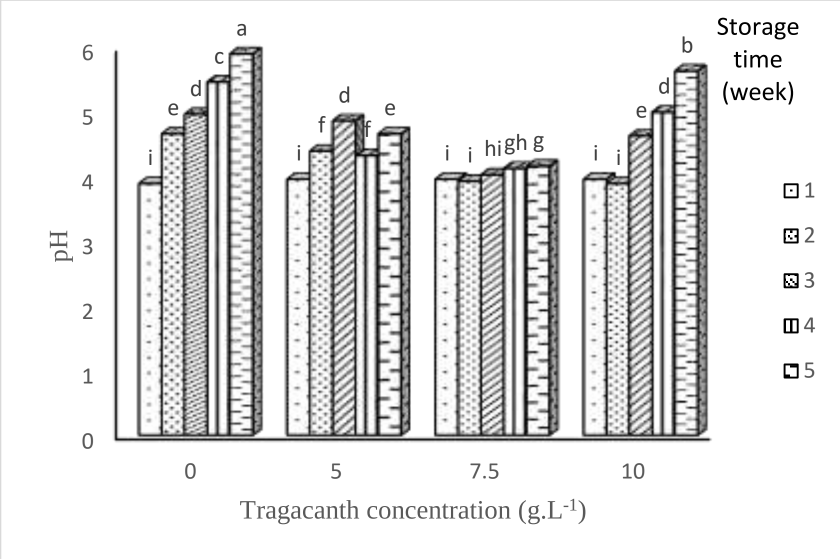

Fig. 2. Effect of tragacanth gum concentration on the pH of tomato fruits during storage time.

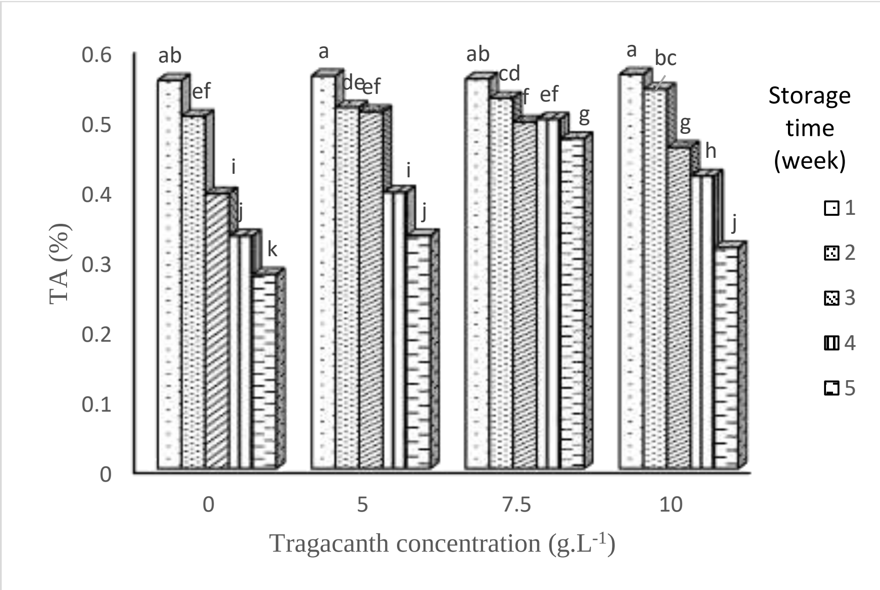

Fig. 3. Effect of tragacanth gum concentration on the TA of tomato fruits during storage time.

TA

The highest decrease in acidity occurred in the control treatment (distilled water). This result also showed that 7.5 g.l^{-1} tragacanth gum had the best effect in this fruit attribute and this level of concentration reduces fruit respiration and decomposition of organic acids by creating a coating on the surface of the fruit (Fig. 3). The TA is associated with the fruit ripening and causes a sour taste in the fruits. As the fruit matures, the organic acids decreases and the fruit harvesting period depends on the soluble solids, and the rate of acid decomposition. The breakdown of organic acids during fruit ripening is dependent on the rate of respiration, as these acids are used in respiratory enzymatic activity. In general, the titratable acidity of tomato fruits decreases during storage time (Mazaheri et al., 2007).

According to our results, the titrated acidity of covered and uncovered fruits decreases during storage time. Garousi (2010) achieved similar results by coating apricot fruit with whey and gellan gum.

SSC

The SSC was constant during 14 days of storage time in both coated and uncoated fruits. In the control treatment (distilled water), the SSC increased after 14 days of storage. However, the SSC increased more slowly in coated fruits. Thus, the tragacanth gel retained the soluble solids at an almost constant level. The SSC remained constant at 7.5 g.L^{-1} tragacanth concentration. However, at 5 and 10 g.L^{-1} of coating treatments, the SSC significantly increased during the last month of storage (Fig. 4).

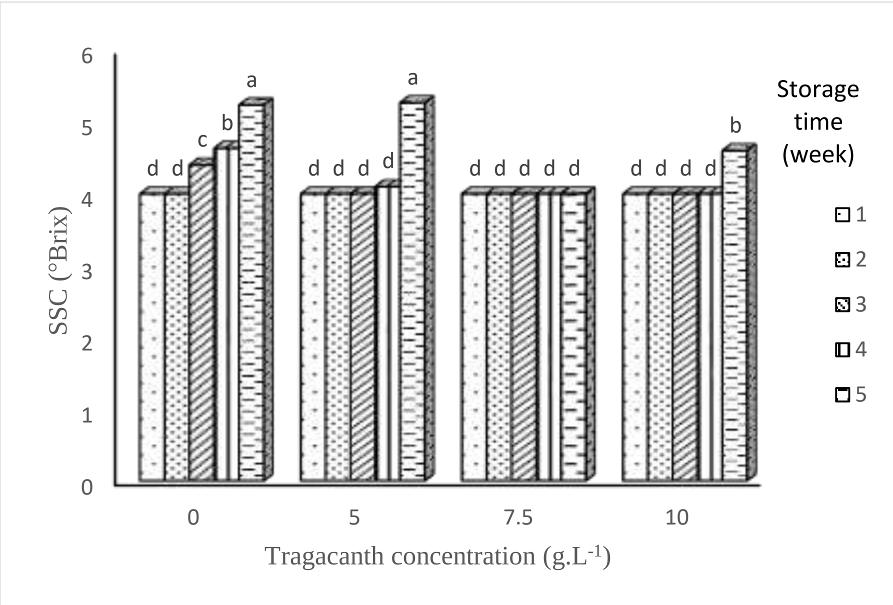

Fig. 4. Effect of tragacanth gum concentration on the SSC of tomato fruits during storage time.

Most soluble solids in fruits contain sugars and a small percentage of amino acids, organic acids, vitamins, and minerals. Fruit ripening and moisture loss in tomato fruits usually increase the SSC in them (Flores et al., 2007; Lee et al., 2003). The increase in SSC during storage time may be related to the weight loss of the fruit, which in turn increases the soluble solids concentration (Tanda-Palmu et al., 2005). However, because the lowest weight loss of the fruits was observed at 7.5 g.L^{-1} tragacanth concentration, so SSC was kept constant. Research on tomato (Chrysargyris et al., 2016) and grape (Asghari & Ahadi, 2013) fruits have also reported that fruits without Aloe vera gel coating had higher SSC after storage time. The SSC was significantly lower in 10% and 15% Aloe-coated fruits after 7 days of storage (Chrysargyris et al., 2016). The SSC in the control treatment was higher compared to coated fruit.

Fruit firmness

According to the results, the reduction in fruit firmness was observed with high speed over time in the control treatment (distilled water). However, in the fruits that were coated, the firmness of tomato fruits was maintained at a higher level. The results showed that at 7.5 g.L^{-1} tragacanth gum, the firmness decreased slower during storage time. Whereas, the firmness of fruit coated with both concentrations of 5 and 10 g.L^{-1}of tragacanth decreased more than 7.5 g.L^{-1} concentration of (Fig. 5).

Our results showed that the tragacanth can delay the softening and ripening process of tomato fruit. Fruit firmness is one of the important qualitative characteristics of many fruits, including tomatoes, which expresses the fruit's surface and internal properties. The tissue firmness of tomato fruits is reduced during the ripening process by the decomposition of insoluble protopectins into pectic acid and soluble pectins (Ali et al., 2010).

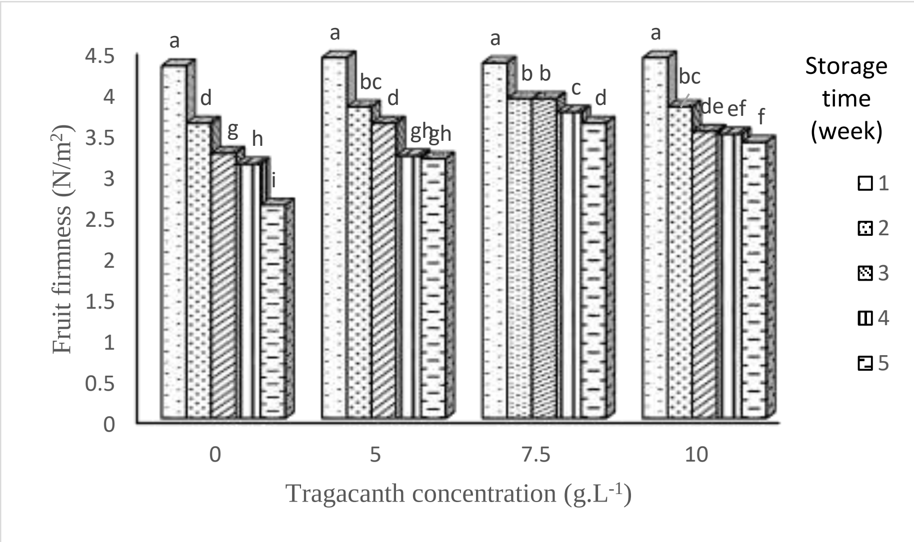

Fig. 5. Effect of tragacanth gum concentration on the fruit firmness of tomato fruits during storage time.

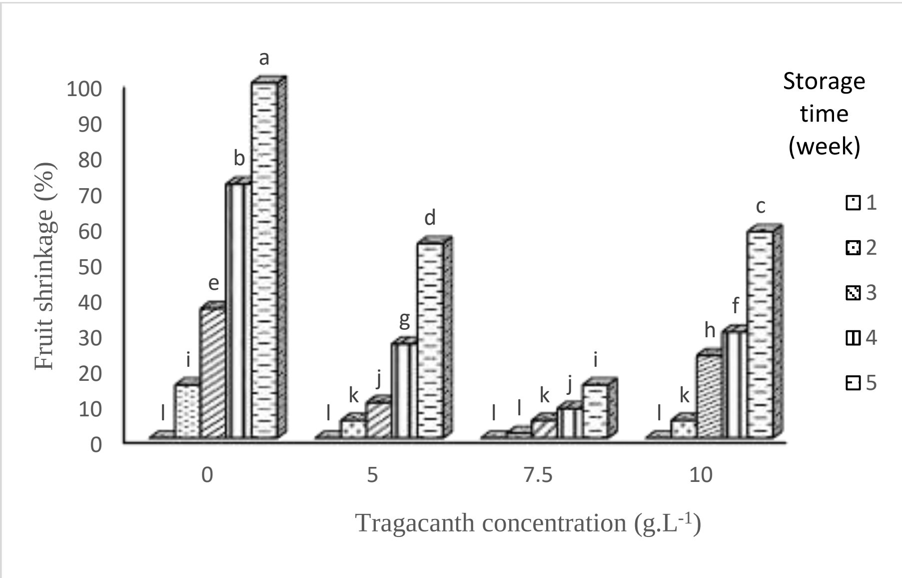

Fig. 6. Effect of tragacanth gum concentration on the fruit shrinkage of tomato fruits during storage time.

The use of edible coatings in many cases controls the softening of fruit tissue during storage time (Zhuang & Huang, 2003). In one research, fruit firmness was reduced during storage time for both coated and uncoated fruits. At the end of storage time, the control fruits showed the lowest firmness. The maximum firmness was maintained with 20% gum arabic until the 12th day (Ali et al., 2010). Martınez-Romero et al. (2005) reported that Aloe vera gel coating reduces weight loss of cherry fruit and thus preserves tissue firmness. Also, Hernandz-Munoz et al. (2006) reported similar results regarding the effect of chitosan and calcium coating on fruit firmness of strawberries, which is in agreement with this result. Aloe vera gel-treated grapes retained their firmness 50% higher than control grapes after 21 days of cold storage (Valverde et al., 2005).

The fruit shrinkage

Based on the results of the correlation between fruit shrinkage and weight loss percentage, these two traits were positively correlated with a 99% probability level (data not shown). This means that with increasing weight loss, shrinkage increases. So it can be concluded that the shrinkage of the fruit surface is directly caused by the loss of water and moisture.

The fruit shrinkage increased more rapidly compared to the coated fruits, so all fruit surface was shrinkage during the last week of storage. However, in the coated fruits, the shrinkage occurred less slowly and at a smaller surface area. The fruits coated with 7.5 $g.L^{-1}$ tragacanth have the least shrinkage area (about 15%) compared to other treatments in the last week of storage (Fig. 6).

Decay evaluation

Until day 14 of the storage, no decay was observed in uncoated or coated fruits. In the control treatment, the decay index of fruit increased faster during storage time, so that in the last week of storage many of the fruits in this treatment were completely crushed. However, in coated fruits, less contamination was observed. The results showed less contamination at 7.5 $g.L^{-1}$. However, at both concentrations of 5 and 10 $g.L^{-1}$, the rate of fruit decay increased during storage time (Fig. 7). Edible coatings can affect the growth of microorganisms due to the control of respiratory gases and fruit atmosphere. Some of them such as *Aloe vera* gel and chitosan have antimicrobial effects. Also, the addition of different antimicrobial agents to these coatings can prevent the growth of fungi and other microorganisms on the fruit surface (Hernandz-Munoz et al., 2006). It has also been reported that carvacrol in tragacanth has a wide range of antimicrobial effects. It inhibits ATPase activity and increases the nonspecific permeability of the bacterial membrane and not only inhibits the bacterial population but also increases the membrane permeability of the bacterium, making them susceptible to other antibacterial substances (Gill et al., 2006).

Similar results were observed by reducing the fruit surface microorganisms by using edible coatings such as carrageenan (0.5 g/100 ml) and whey protein concentrate (Lee et al., 2003). Chrysargyris et al. (2016) reported the same results by using Aloe vera coating on tomato fruits. Also until the fourth day of storage, no significant decay was observed in the coated or control fruits. After that, the coatings significantly reduced decay compared to control and fruits with 10% gum arabic coating, and remained unaffected even after 20 days of storage (Ali et al., 2013).

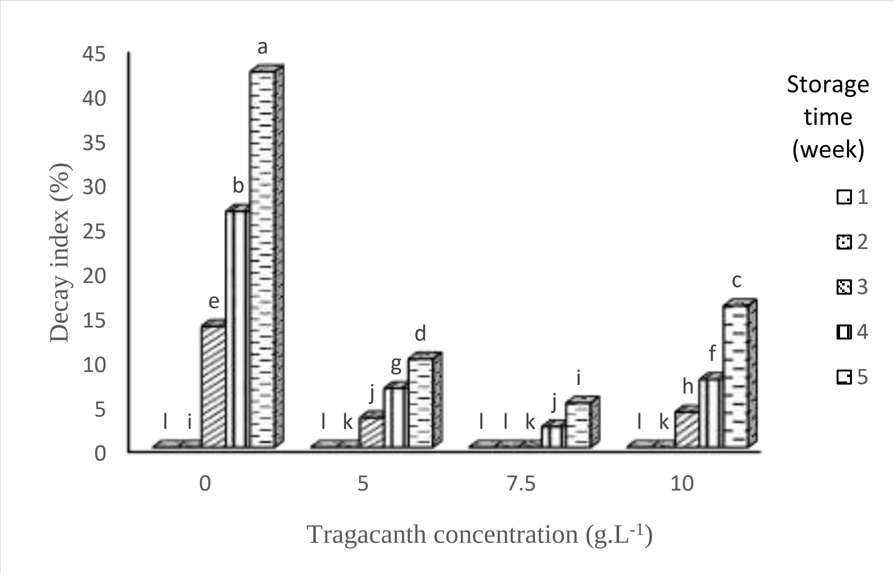

Fig. 7. Effect of tragacanth gum concentration on the decay index of tomato fruits during storage time.

CONCLUSION

According to our results, the fruits coated with tragacanth gum showed less weight loss, and shrinkage compared to the control treatment. The percentage of weight loss of the non-coated sample was about three times higher than coated fruit with 7.5 g.L^{-1} tragacanth gum. Fungal contamination in uncoated fruits was high in the third and fourth weeks of storage so some samples were eliminated. In addition, fruits coated with tragacanth gum were higher fruit firmness. So, the tragacanth coating improved the appearance of the fruit, which can influence the marketability and product sales, and then it could be used for increasing the postharvest life of tomato fruits.

Conflict of interest

The authors declare that they have no conflict of interest.

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