

## A study on the Effects of using the Essential Oil of Medicinal Plants (Cinnamon, Fennel, Clove) and Storage Temperature on Physicochemical Characteristics and Marketability of Date Fruit of *Halilehei* Cultivar

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**ABSTRACT:** *Halilehei* date is considered as a cultivar of fresh date fruit. There is no study conducted on this cultivar and any countable resource available on the chemical characteristics of this cultivar so far. Therefore, to investigate the *Halilehei* cultivar and the effect of using the essential oil of medical plants (cinnamon, fennel, and clove) on physiochemical characteristics of this type of date fruit, a factorial experiment was conducted based on a completely randomized block design with three replications, and different mean of essential oils and their effects on *Halilehei* cultivar were investigated and compared using Duncan's test. The treatments consisted of different concentrations of *Halilehei* cultivar. After washing and draying the dates, they were sprayed with the essential oils of cinnamon, fennel, and clove in concentrations of 200, 400, 600, and 800  $\mu\text{l.l}^{-1}$ , and packaged into cardboard cartons with plastic film in the weight 300±500 g. After two months, the levels of humidity, pH, acidity, soluble solids, and total sugar were measured from all samples. The experienced appraisers and the data obtained from the questionnaire were used to compare the effects of herbal essential oils on the shelf life, quality, and marketability of *Halilehei* cultivar. The results showed that this cultivar has higher moisture content, and treatments reduced the level of sugar content in this cultivar. Moreover, sugar content of *Halilehei* cultivar treated with the essential oils of cinnamon, fennel, and clove increased with an increase in the level of acidity. The control had the lowest level of acidity compared to the treatments indicating that the essential oils of cinnamon, fennel, and clove prevented the transformation of organic acids in date fruit to other materials including sugars. The research results showed that there is an inverse relationship between the level of humidity and pH. Among the studied essential oils, the fennel essential oil increased the index of flavor. The study of the effect of essential oils on tissue freshness showed that applying treatments in all study concentrations had positive effect on this cultivar of date fruit, and the best acceptability among different concentrations from the viewpoint of appraisers belongs to the *Halilehei* cultivar treated with cinnamon essential oil.

**Key words:** *Halilehei* date, Cinnamon essential oil, Fennel essential oil, Clove essential oil

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### INTRODUCTION

Farmers use traditional methods to store the date fruit and protect it against the attack of pests. Soft dates are stored into crockeries with loose mouth or baskets made from palm leaves or compressed tanned leather, which causes the air to flow out of the packing containers and prevents the onset of pests to the product. The shelf life of the date increases with this method, but this type of products are not appropriate in terms of appearance to be marketed in international markets. Therefore, other techniques are applied to increase the storage life of

date fruit. These techniques, on one hand, better preserve the appearance and tissue of the products, and prevent their weight loss, on the other hand (Falade and Abbo, 2007). In cultivars of fresh date with high moisture content, microorganisms like bacteria, molds, and yeasts cause the spoilage of the date (King and Bolin, 1972). There is a close relationship between the level of the moisture content of the date and the susceptibility to spoilage resulted from fermentation, rancidity and mildew.

The spoilage in date fruit is associated with the growth and activity of yeasts and lactic acid, and activity of these microorganisms causes the rancidity and bad taste of the date fruit (Rygg, 1953). Moreover, activity of yeasts and bacteria of lactic acid causes the rancidity and bad taste of the date fruit (Ahmed *et al.*, 1997). Using herbal essences is one of the healthy and safe techniques to control the postharvest diseases (Chouitah *et al.*, 2017). Essences are complex compounds in which there are different types of chemicals including hydrocarbons, alcohols, ketones, aldehyde, etc. (Plotto *et al.*, 2002). Like other films, essences are directly used on the surface of food stuffs through the suspending, spraying, and rubbing methods in order to improve the physical properties, facilitate shipping, and better maintain the volatile flavoring compounds. In the recent years, a large number of essences and their components have been studied on many microbes, bacteria and fungi causing food spoilage in terms of antibacterial properties (Pradhan and Vishwakarma, 2018; Rawat *et al.*, 2018; Devkota and Das, 2016; Abdalla and Abdelghadir, 2016; Nabavi *et al.*, 2015 & Bakkali *et al.*, 2008), and using herbal essences such as ginger and cloves on three study cultivars has showed a significant decrease of the microbial spoilage (Atia, 2011). Essential oils have wide range of bioactivities and play an important role as supreme natural sources of antimicrobial and antioxidant (Morsy, 2017 & Arive *et al.*, 2017). The date with high moisture content has softer tissue and better flavor compared to the dates with low moisture content, and its storage life is short and quickly gets rancid and spoiled (King and Bolin, 1972). The *Halilehei* cultivar is a kind of serotinous and high quality cultivars. The fruit of this cultivar is yellow in color at Kharak and Rotab stages, and thin-skinned with a soft and perishable tissue. There is little information available on this cultivar of date fruit. However, Karamat and Khorvash (2002) were only people who mentioned this cultivar as Shahdadi cultivar and attributed the highest moisture content to it in comparison of Iranian date cultivars (Karamat and Khorvash, 2002). Different stages are passed from the pollination stage to the full ripening of the date fruit of *Halilehei* cultivar including Hababouk, Kimeri, Khalal, Rotab and Tamar stages. The Kimeri is the longest stage in ripening of the date fruit, in which the fruit is green in color and its core is white. The weight, size and the level of the reducing sugars of this fruit increase at Kimeri stage. At the Khalal stage, the color of the fruit changes into light yellow and the increase of the fruit weight proceeds slowly. At Rotab stage, the tissue of the fruit gets soft and its color changes into brownish yellow. In addition to color change, the tissue of the fruit also undergoes some changes during the ripening stages. At Kimeri stage, the fruit of *Halilehei* cultivar has fragile tissue and it gradually changes into a soft and juicy tissue at Rotab stage (Abazarpour and Basirian, 1994). Like chemical properties of this cultivar, there is not reliable information in terms of the

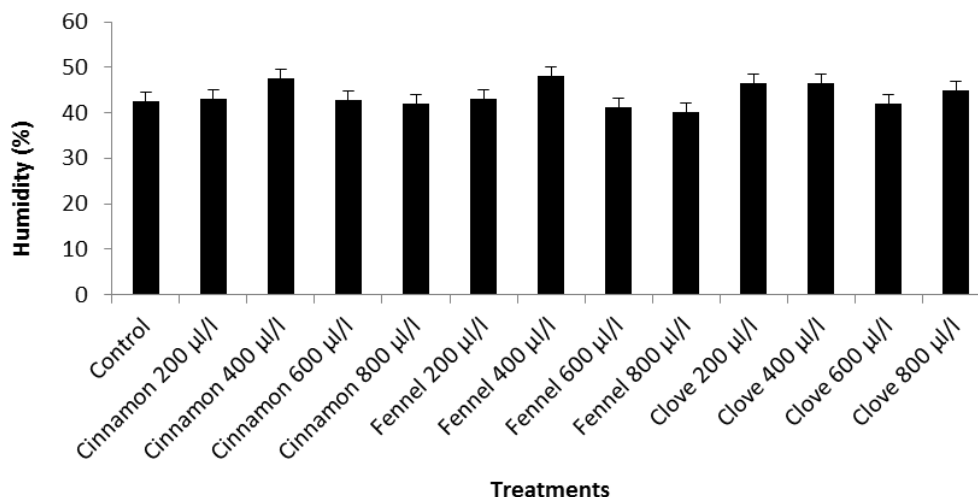
storage temperature of this cultivar. Therefore, application of herbal essential oils (cinnamon, fennel, and clove) was examined in order to increase the storage life of this tasty cultivar of date fruit.

## MATERIALS AND METHODS

In this research, the effect of cinnamon, fennel, and clove essential oils on physicochemical properties, marketability and storage life of the *Halilehei* cultivar of the date fruit was studied. This study was conducted in a completely randomized design at three experimental levels with concentrations of 0, 200, 400, 600, and 800  $\mu\text{l.l}^{-1}$  of cinnamon, fennel, and clove essential oils with emulsion. After the initial washing and drying, the predetermined concentrations of these essential oils were sprayed on the samples of the *Halilehei* cultivar. Then, they were packaged into the cardboard cartons with plastic film at weight of  $300\pm 500$  g and kept for two months. The humidity, pH, and acidity tests were performed based on the international methods (A.O.A.C., 1990). The level of soluble solids was measured at room temperature using refractometer and recorded in terms of Brix degree. The total sugar content was measured using optical absorbing method (glucose as a standard and anthran as a reagent) and reading the samples at wavelength of 620 nm (Maccready *et al.*, 1950). The experienced appraisers and the data obtained from the questionnaire were used to compare the effects of herbal essential oils and storage temperature on the shelf life, quality, and marketability of the date fruit. In this evaluation, the factors such as odor, color and appearance, flavor, and overall acceptability were investigated. To do so, some tables were already prepared and the scores were ranked from 0 to 100, and in each case, the score 100 was assigned to completely favorable and marketable fruits and the score 0 was assigned to unacceptable fruits. After collecting the data using SAS software, they were analyzed. The Duncan's method was used to compare the mean treatments, and the tables were drawn.

## DISCUSSION AND CONCLUSIONS

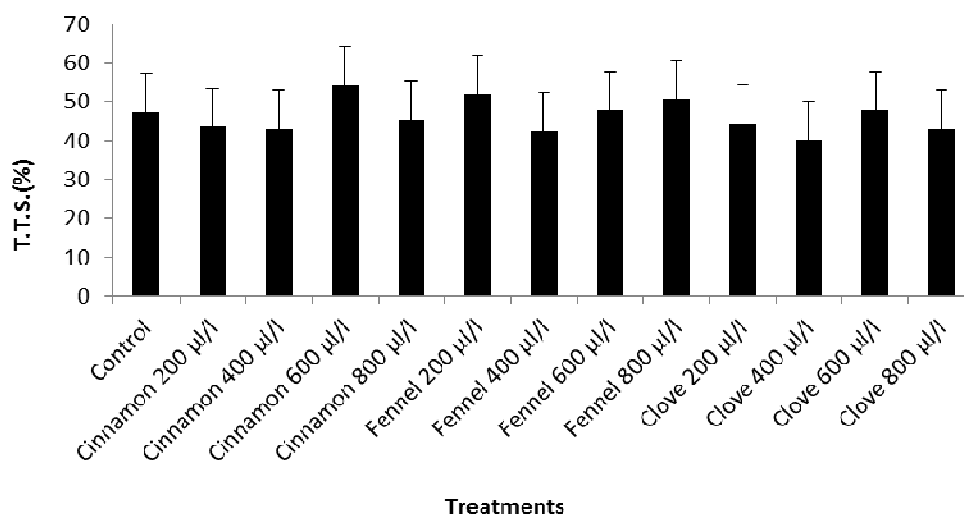
The study *Halilehei* cultivar of the date fruit with mean moisture content of 42.613% had the highest moisture level compared to other cultivars of Iranian fresh date fruits like Mazafati, Kabkab and Zahedi with moisture content of 37.50, 31, and 30.90%, respectively (Sahari *et al.*, 2008). In the study of the factor of humidity, *Halilehei* cultivar treated with 400  $\mu\text{l.l}^{-1}$  fennel essential oil had the highest moisture content with rate of 47.98%, which followed by *Halilehei* cultivar treated with 400  $\mu\text{l.l}^{-1}$  cinnamon essential oil and *Halilehei* cultivar treated 400  $\mu\text{l.l}^{-1}$  clove essential oil with moisture content of 47.65 and 46.60 %, respectively (Fig. 1). Fig. 1 also shows that using all essential oils at concentration of 400 $\mu\text{l.l}^{-1}$  increases the moisture content.



**Fig. 1.** Percentage of moisture content in *Halilehei* cultivar treated with the essential oil of medicinal plants.

Considering the role of moisture in sustainability and quality of the date fruit during storage time, it is recommended to use this concentration on dried cultivars in order to improve the quality of tissue and avoid its application on fresh cultivars due to their reduced storage time. Fig. 2 illustrates the comparison of the mean effect of essential oils on soluble solids in the fruit, and Fig. 3 presents the comparison of the

mean effect of the essential oils on the percentage of sugar in date fruit of *Halilehei* cultivar. Since the measurement of soluble solids might not properly predict the final soluble sugars after ripening the fruit, the soluble solids are compared with other factors. Considering the high moisture content of *Halilehei* cultivar, the low level of sugar content is justifiable in this cultivar.



**Fig. 2.** Percentage of soluble solids of *Halilehei* cultivar treated with the essential oil of medicinal plants.

According to the results published by Mango (2000), although the total sugar content in cultivars of the fresh date fruits is between 65-81%, the low level of sugar content in *Halilehei* cultivar indicates the higher level of other nutrient factors like protein, fat, water-soluble vitamins and minerals. The highest level of sugar content was seen at the control and it seems that applying treatments decreases the sugar content in this cultivar of date fruit. Considering this issue that there is a direct relationship between the growth of

microorganisms and the level of sugar content, applying treatments with above-mentioned essential oils can increase the storage life of this cultivar. On the other hand, decreasing the sugar content in the treated samples will be effective in avoiding the quality loss of *Halilehei* cultivar through reducing the activity of malicious and perishing microbial activities. The effect of the concentration of the essential oils on acidity is shown in Table 4.

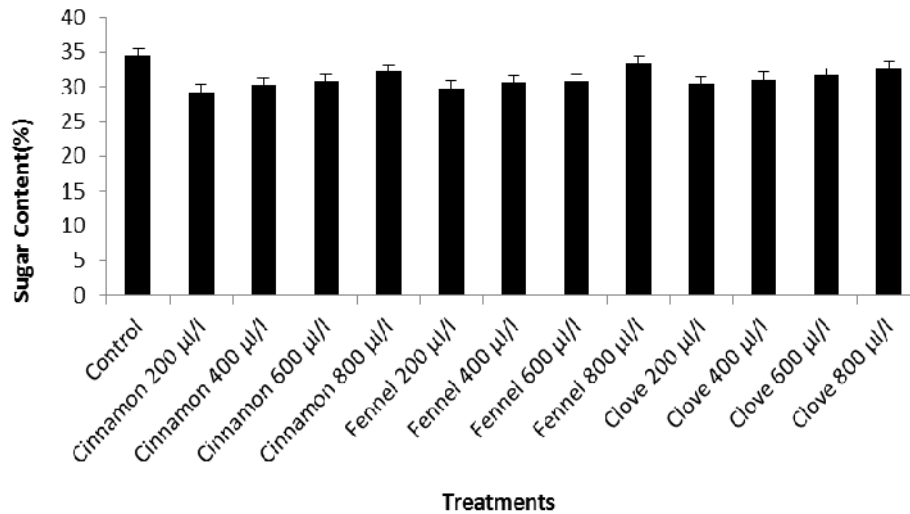


Fig. 3. Percentage of sugar content in *Halilehei* cultivar treated with the essential oil of medicinal plants.

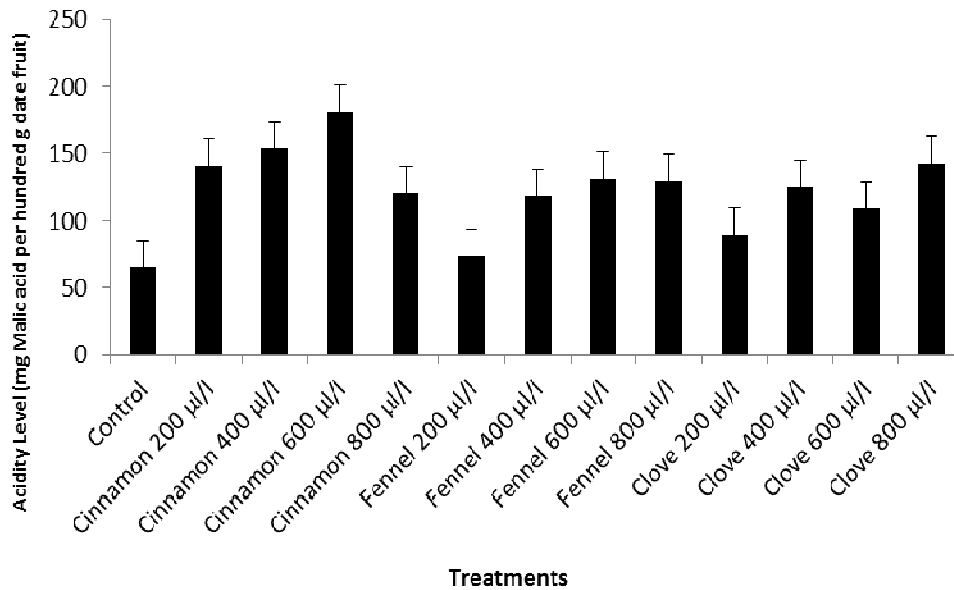


Fig. 4. Acidity level of *Halilehei* cultivar treated with the essential oil of medicinal plants.

The investigation of the effect of the essential oils concentration on the level of acidity showed that the control had the lowest level of acidity. Except *Halilehei* cultivar with concentration of 800 µl.l<sup>-1</sup>, in all *Halilehei* concentrations, the acidity level increased with increasing the concentration of the essential oils from 200 to 600 µl.l<sup>-1</sup> (Fig. 4). In justification of this event it can be said that there is a direct relationship between increases of acidity with increase of sugar content due to the increased invertase enzyme activity.

The pH level of the date fruit was reported in the range 5-6. From the comparison of the moisture content (Fig. 1) and pH level (Fig. 5) it can be concluded that there is an inverse relationship between the level of moisture and pH, so that the *Halilehei* cultivar with higher

moisture content had lower pH level. In sensory evaluation of foodstuffs, the consumer used his five senses instead of the measuring devices and tools in order to reject or accept the foodstuffs. According to the results from this evaluation, applying treatments improved the color of the samples, so that the control had the lowest level of color and appearance (33.53%) (Fig. 6). The study of the effect of concentration on the color, appearance, and flavor of the treated samples showed that the cultivars treated with the concentration of 400 µl.l<sup>-1</sup> from all three essential oils (cinnamon, fennel, and clove) had the highest level of color and taste compared to other study concentrations in their groups.

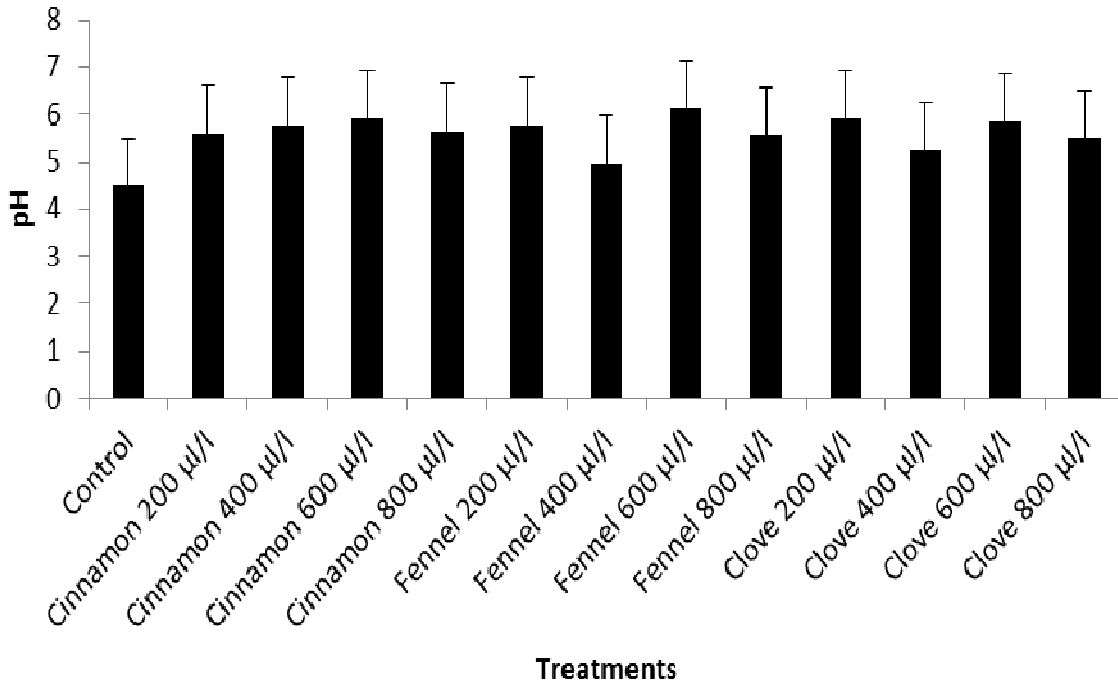


Fig. 5. The level of pH in *Halilehei* cultivar treated with the essential oil of medicinal plants.

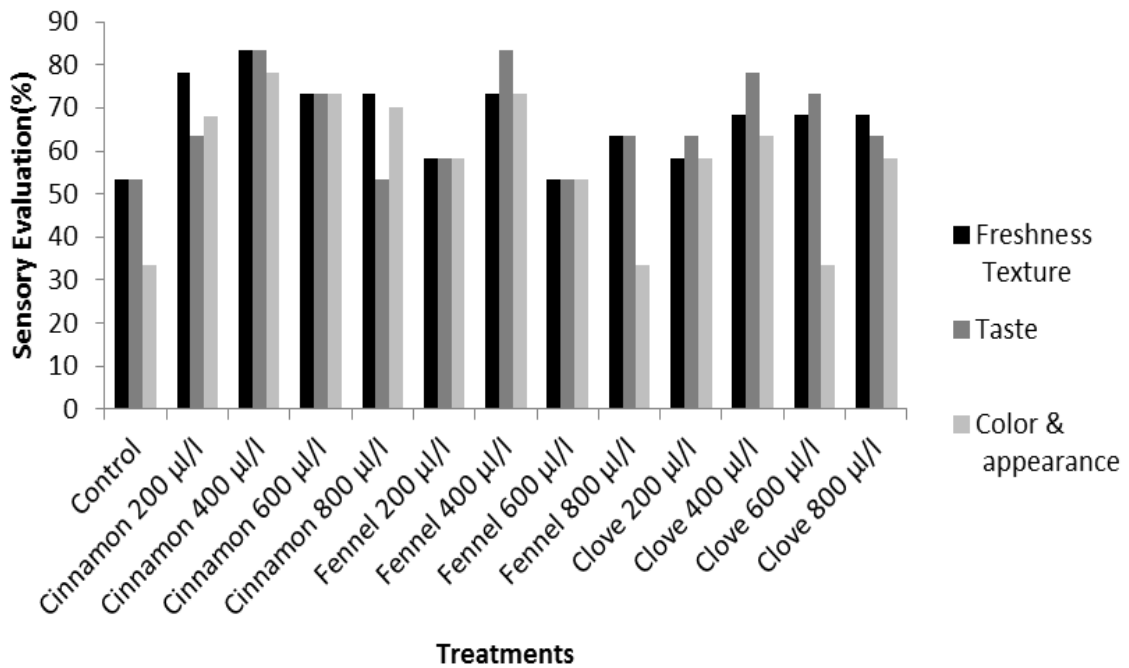
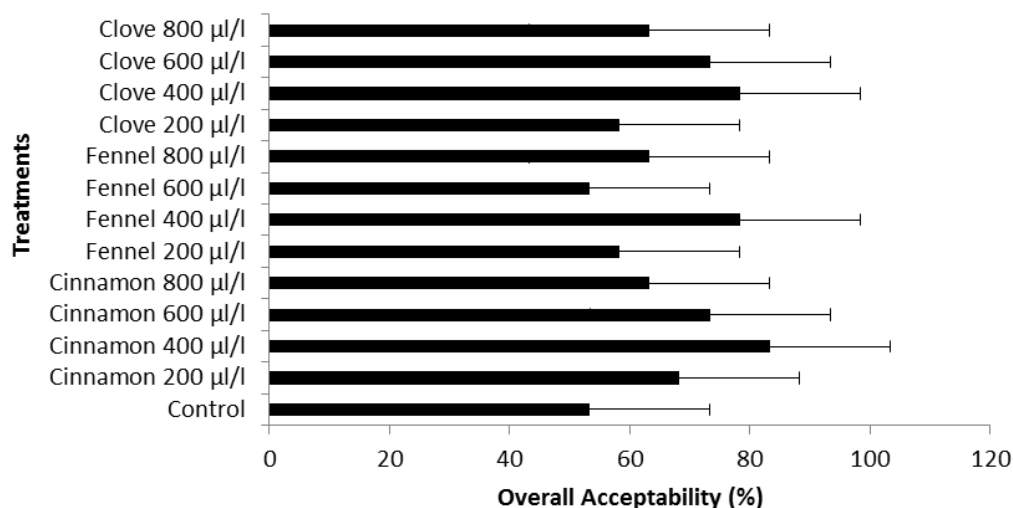


Fig. 6. The results of sensory evaluation of *Halilehei* cultivar treated with the essential oil of medicinal plants.

Application of this concentration caused the freshness of the tissue of *Halilehei* cultivar, and increased the flavor compared to other concentrations. So that the *Halilehei* cultivar treated with 400 µl.l<sup>-1</sup> cinnamon essential oil statistically had the highest level of tissue

freshness and flavor with 83.33% among all treated cultivars. The lowest rate of overall acceptability belonged to the control with 53.33 %, and finally, all consumers tended to consume *Halilehei* cultivar treated with 400 µl.l<sup>-1</sup> cinnamon essential oil (Fig. 7).



**Fig. 7.** The results of overall acceptability of *Halilehei* cultivar treated with the essential oil of medicinal plants by consumers.

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