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Original Article

Effect of Aqueous Extract of Tea Seed Powder on Quality of *Citrus sinensis* L. Osbeck in Cold Storage Conditions

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Abstract

Maintaining the nutritional value and increasing the shelf life of citrus, fruit coating is important. Currently, small gardeners in the north of Iran to rising storage time and maintain fruit quality, use unconventional methods or materials. The use of natural and organic material to produce a healthy product free of contaminants is rising. Tea seed powder is the by-product of tea seeds after oiling, which has no negative or harmful effects on the environment and use on farms as an organic insecticide. Therefore, the present study aims to investigate the effect of different concentrations of aqueous extract of tea seed powder on quantitative and qualitative characteristics of *Citrus sinensis* L. Osbeck. This research was done in the type of completely randomized design with five coating treatments as control (distilled water), commercial wax (XEDASOL- MX20), and three concentrations of aqueous extract of tea seed powder as 5, 10, and 15% w/v with three replications. After coating, the fruits were stored for 60 days in a cold house at 8 ^{o}C and 85% humidity. The weight of the shell, the juice content, the total soluble solids, the total acidity, and the anthocyanins concentration of the fruit were measured. The results showed that fruits coated with commercial wax had the lowest fruit weight loss. The treatments for tea seed powder extract are also significantly different from the control, and the treatment of 15% tea seed extract had the least weight loss. Fruits impregnated with commercial wax had the highest percentage of total soluble solids that did not significantly different from the tea seed powder extract but had 15% more total soluble solids than the control treatment. The fruits impregnated with commercial wax have the highest content of anthocyanins. The use of 5 and 10% tea seed extract has also had a positive and significant effect on the concentration of anthocyanins compared to control. As a result, it can state that the aqueous extracts of tea seed powder, compared to the control, improve and preserve the properties of the blood orange of the Moro cultivar during the post-harvest period. Therefore, tea seeds products can be promoted as an alternative to chemical pesticides currently used in ordinary warehouses.

Keywords: Citrus, Quality, Tea seed

Introduction

The highest citrus production in Iran, 47.6% belongs to the Northern provinces. It is observed every year in the north of Iran that only a small amount of citrus fruit enters the market directly, and others are stored for 3 to 4 months in ordinary warehouses or cold storage. However, due to the limited capacity of cold storage, the high cost, and the fact that the kiwi fruit-filled cold storage, the fruits are practically stored in ordinary warehouses. However, due to the lack of favorable conditions in these warehouses and because of decrease in aerobic respiration occurs inside the fruit it increases anaerobic respiration (fermentation), acetaldehyde production, and alcoholic taste of the fruit. It is possible to improve the postharvest quality and shelf life of the fruit by using healthy coatings while maintaining the quality of the fruit. Due to the expansion of cultivation and production of organic products, especially in the developed country, the use of non-chemical and organic substances in all stages of production and postharvest of horticultural products to reduce waste, maintain quality and prevent fruit spoilage is considered.

The most common coatings or waxes used for packing citrus are mainly a mixture of lacquer and wood resin. This coating primarily is designed to show high gloss at the time of purchase. When the fruits coated with wax, it acts as a barrier to the passage of gases. Wax is commonly used to reduce weight loss and improve the

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appearance of citrus fruits during postharvest storage. Shen *et al*. (2012) reported that wax is effective in reducing weight loss, microbial contamination, delaying softening, and maintaining freshness in citrus fruits during storage [1]. Today, to address the concerns about the effects of pesticides on the environment and consumers, efforts to replace natural and non-toxic substances with pesticides instead of pesticides to control agricultural waste have increased [2].

Okey (2015) reported the effect of leaf extracts of *Azadirachta Indica* A.Juss. and *Chromolaena Odorata* (L.) R.M.King & H.Rob. on the biological control of fungal diseases after the orange harvest and stated that *A. Indica* leaf aqueous extract is a better environmental friendly agent for controlling orange fungal contamination [3]. Aboutalebi *et al*. (2010) determined the fungicidal properties of peppermint and eucalyptus extracts in reducing waste after harvesting Washington Naol oranges. According to their results, both extracts had a significant effect on reducing the percentage of rot and preventing weight loss compared to control [2]. Tolly *et al*. (2007) examined the effect of thyme and ginger oil extracts on caries caused by the blue mold of orange fruit in the warehouse, and their results stated that thyme and ginger treatments reduced caries by 24, 48, and 72 hours. Comparing the effect of thyme extract with ginger extract did not show any statistically significant difference. All treatments significantly reduced caries compared to control [4]. Barznouni *et al*. (2013) examined the effects of heat pre-treatment and plant essential oils on the postharvest properties of blood orange. Treatments included hot water, steam, spraying the fruit with 2% thyme essential oil, and control. The results of data analysis showed that the type of treatment did not have a significant effect on qualitative characteristics, acidity, soluble solids, index, and sensory evaluation, and in these treatments; steam treatment had the highest role in preventing weight loss during storage [5].

Noor-Nature (2003 and 2004) has introduced a tea seed product that increases the yield of tomatoes, cucumbers, and strawberries and has antifungal effects. Tea seed powder is the remnant of tea seed after oil extraction, which is in the form of a cake or powder and contains 18-12% saponin, 70-60% organic matter, and more than 15% protein. This powder is used in aquaculture and fish farming to prevent the growth of harmful insects, rapid water disinfection that is not harmful to humans and cows. This powder has no harmful effects, is economical, and easy to use. In farms, it is also used as an organic insect repellent and does not harm the growth of plants and their roots. It is safer, easy to use, and more efficient than other toxins. It also can regulate the concentration of heavy metals, improve plant root growth, control and eliminate pests and diseases, and increase disease resistance [6,7].

The area under tea cultivation in Gilan and Mazandaran provinces is about 28,000 hectares. After the end of the leaf plucking season, around the end of October and early November, the tea plants begin to flower and produce seeds. On average, each plant can produce about 100 grams of seeds. In previous years, tea seedlings were produced from these seeds, but now, due to the promotion of research findings and farmers' awareness, cuttings are used for propagation. Therefore, due to the large number of seeds that are produced in tea gardens and currently have no use, if they can use for value-added products, it will help the garden income, develop and better manage the tea garden.

Thus the present study was done to introducing a native and safe material to coated *C. sinensis* L. Osbeck (Moro blood orange) to enhance the postharvest quality of fruit during storage.

Material and Methods

The effect of different concentrations of aqueous extract of tea seed powder [*Camellia sinensis* L. Kuntze] on the quantitative and qualitative characteristics of blood sweet orange *C. sinensis* was studied as CRD with five treatments including control (distilled water), commercial wax (XEDASOL), Made by Xeda International, and aqueous extract of tea seed powder as three concentrations of 5, 10, and 15% w/v with three replications in the cold storage. The study used the fruit of the Moro cultivar, which was grafted onto a regular orange base. 124 fruits, healthy, harmless, and uniform, were harvested from the garden of Liseh Rud village in Langrud, Guilan province after that ratio of total soluble solids in fruits reached about 8.93. The fruits were grouped into five groups (each group consisting of 24 fruits) to apply the desired treatments. The Tea seeds were collected from mother bushes in October 2017[8] from the Feshalam Tea Research station (37.264099, 49.426149), Tea Research Center of Iran, shaft-Guilan Province. The seeds were thoroughly dried, peel, and then oiling by the cold press method from the kernels of seeds. The tea seed oil characteristics from Iran are presented in table1. The powder was prepared by grounding the oiled-tea seed cake. The aqueous extract was provided by dissolving the required amount (5, 10, and 15%) in sterile distilled water. The suspension passed through a filter paper after 72 hours [8]. The fruits were immersed in the aqueous tea seed powder extract for one minute after rinsing with water and drying. For the wax treatment, to prevent the loss of materials, the fruits were coated using a brush with commercial wax. Each plastic basket contained eight fruits and a total of 24 fruits for each treatment.

Table 1 Characteristics of tea seed oil from Iran [9]

Kernel/seed coat ratio	Oil content	Iodine Value	Saponification Value	Fatty acids content						
				Physical appearance	C16:0	C18:0	C18:1	C18:2	C18:3	C20:0
%			mg KOH/g	%						
65:35	30.5	85	194.9	Clear, Liquid	16.5	3.343	56.97	22.17	0.3	0.533

The fruits were stored in cold storage at 80 C and 85% humidity for 60 days. After 60 days, the weight of the fruit shell was separately measured by peeling and weighing the shell of three fruits from each treatment. During the peeling, all the shell tissue and albedo were removed from the endocarp and weighed. The weight of the three fruits was separately recorded and manually juiced for each treatment. The fruits that peeled for shell weight used for juicing. The total soluble solids (TSS) were measure in the purified fruit extract with a PAL-1 refractometer. The percentage of titratable acidity in fruits was measure using a calibration method by a 1 N alkaline solution [10]. The total flavonoid content (TFC) of the extracts was measure by the method provided by Khatiwora *et al*., (2017) [11]. The pH difference method was used to measure anthocyanin levels. The total anthocyanin concentration was expressed using the formula in milligrams of cyanidin 3-glucoside per liter [12]. Data analysis was performed using SAS.V9.4 software. Duncan's multi-domain test was used to compare means ($p \leq 0.05$).

Results and Discussion

Initial Weight Loss of Fruit

The results of the analysis of variance showed that the experimental treatments at the statistical level of one percent had a significant effect on preventing the initial weight loss of the orange fruit of the Moro cultivar. Comparing the average of the cover treatments showed that fruits soaked in commercial wax (XEDASOL-MX20) had the lowest fruit weight loss with 1.8% (Figure 1). After wax treatment, there are tea seed powder extract treatments that have a significant difference with control. Among the tea seed powder extracts, the lowest weight loss is related to the 15% tea seed extract.

El-Eleryan (2015) reported that the weight loss of Washington navel orange significantly reduced with a coating of green tea and chitosan either alone or in combination as post-harvest application than the control treatment [13]. The weight loss of treated Date fruits with jasmine oil and green tea extract (2%) was lower than untreated fruits [14]. The citrus shell weight is one of the important characteristics in storage. During the storage, fruit juice decreases, and in fact, most of the fruit weight is the shell of the fruit. Therefore, the less this parameter is reduced, the greater the fruit weight (edible part). According to Turhan (2009), edible coatings by changing atmospheric storage of coated fresh fruits can decrease and slowing down quality and quantity changes by regulation of the internal atmosphere of the fruit [14].

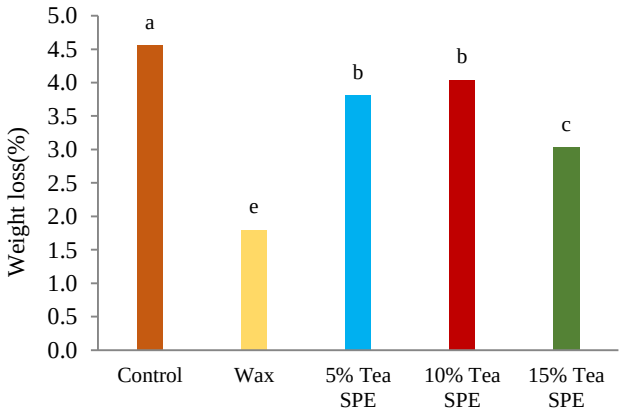

Fig. 1 Effect of coating type on weight loss of Orange, Moro cultivar (*P = 0.01)*
Similar letters do not differ significantly from each other

Juice Weight

The results of the analysis of variance showed that the application of different treatments did not have a significant effect on the amount of orange juice. The amount of juice is one of the most important substances that is reduced during storage in fruits. During storage, monitoring this feature can help better management of citrus postharvest.

Titratable Acidity

The results of the analysis of variance showed that the application of different compounds statistically had a significant effect on the titratable acidity of oranges. Mean comparison, it was found that fruits impregnated with commercial wax have the highest acidity (Figure 2), but there is no significant difference with control treatment. The lowest titratable acidity was observed in fruits infused with 10% tea seed powder (Fig. 2). The same results were observed in the study of Hamedani *et al.* (2014) [16]. Barzanoni *et al.* (2013), also Fallico, *et al.* (1996) reported a similar trend [5,17].

The reason for the decrease in titratable acidity is due to its consumption in respiration and consumption of organic acids for energy production and alcoholic fermentation during storage [18].

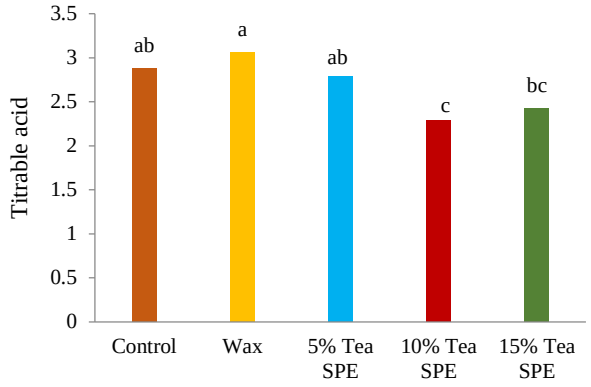

Fig. 2 Comparison of the effect of type of coating on titratableacid of Moro cultivar (*P = 0.01*)
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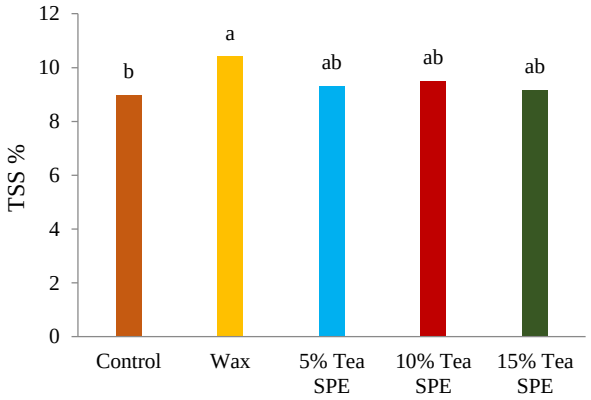

Fig. 3 Comparison of the effect of the type of coating on the TSS of Moro cultivar (*P = 0.01*)
Similar letters do not differ significantly from each other

Total Soluble Solids (TSS)

The results of the analysis of variance showed that the application of different compounds had a significant effect on the TSS in oranges. Comparing the means discovered that fruits soaked in commercial wax have the highest content of TSS with 10.42% (Fig. 3). there was no statistically significant between commercial wax and the extracts of tea seed powder extract, but the aqueous extract of tea seed powder, compared to the control treatment, be able to improve about 15% of the amount of total soluble solids.

TSS in Washington navel orange treated with green tea extract or in combination with jasmine oil was higher than other treatments. Also, Chen *et al*. (2014) reported that litchi fruit treated with tea polyphenols has a higher TSS after 30 days of cold storage, and it was 13.4% higher than the control fruit [19].

Tea polyphenols have a ROS scavenging effect that is higher than vitamin E and vitamin C [20]. Thus, suggested that reducing lipid peroxidation of pericarp tissues resulted in delayed pericarp browning of litchi fruit during storage was associated with the intense antioxidant activity of tea polyphenols [19].

Anthocyanin Concentration

The results of the analysis of variance showed that amount of anthocyanin was significantly different between treatments. The means Comparison revealed that fruits soaked in commercial wax have the highest amount of anthocyanins, but it was not significantly different with 5% Tea seed extract treatment (Figure 4). The use of tea seed extract had a positive and significant effect on the concentration of anthocyanins compared to the control Hamedani *et al*. (2014) also reported that after 75 days of storage compared to harvest time and before storage, more anthocyanins are synthesized and accumulated [16]. Other researchers have reported an increase in anthocyanins during storage [18]. Also, Dela *et al*. (2003) reported that lowering the temperature increased the synthesis of anthocyanins in the fruit [21].

Polyphenol oxidase inactivation in green tea processing leads to decreased anthocyanin degradation due to no formation of the reactive O-quinones. As reported by Kerio *et al*. (2012), there was an inverse relationship between total anthocyanins and total catechins [22]. The anthocyanins found in the tea plant are similar to those found in nature [23], which is a reason to increase the consumption of tea and its products.

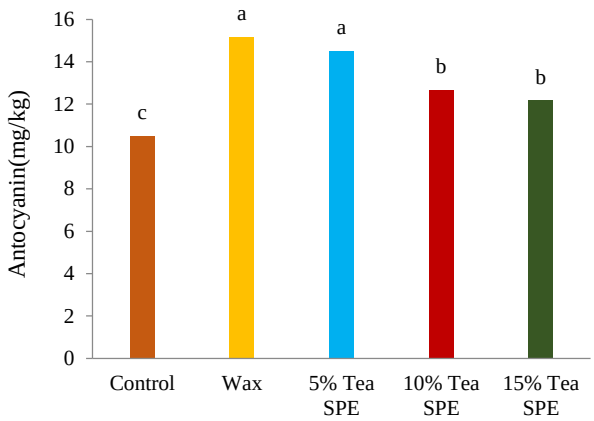

Fig. 4 Comparison of the effect of coating type on the amount of anthocyanin in Moro oranges
Similar letters do not differ significantly from each other

Conclusion

Concerning our finding, it can be concluded that the efficiency of aqueous tea seed extract is somewhat equal to commercial wax. Tea seed cake extracts have also improved and retained the properties of the blood orange of the Moro cultivar during the post-harvest period compared to the control.

Due to the mixed plantation of tea and citrus in Northern Province, tea seeds and by-products can be used as tea products can be used as a natural compound, an alternative to pesticides, to control pests and diseases in cold storage and conventional storage.

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