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Response Postharvest Quality of Diyala Orange to Two Rootstocks and Some Plant Extracts

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ABSTRACT

This study was performed on Diyala orange fruits to investigate the role of sour orange and Lemon rootstocks and the dipping in (0, 2, 4, and 6) % from each aqueous extract of clove flower buds, thyme leaves, and pomegranate peel for four minutes on extending the storability and maintain postharvest quality of Diyala orange fruits. A factorial experiment was used within Randomized Complete Design with three replicates.

The fruits were placed in polyethylene bags, subsequently stored at 6±1 ºC and 85-95% relative humidity for two months. The results indicated that fruits were grown on sour orange rootstock significantly maintained the highest values in most of the chemical properties were studied, likewise reducing the weight loss and physiological disorders than fruits were grown on lemon rootstock. Concerning the plant extracts, fruits immersed in 2% clove extract had the maximum values of total soluble solids (TSS), vitamin C, and total phenol than control. Furthermore, fruits immersed in 6% thyme extract had the highest values of TSS, total sugar, vitamin C, and total phenol, whereas, minimized physiological disorders than control. Likewise, fruits immersed in 2% Pomegranate peel extract had the highest values of TSS and vitamin C but had lower physiological disorders than control.

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Keywords: thyme leaves, clove buds, pomegranate peel, vitamin C, physiological disorders.

INTRODUCTION

Citrus fruit is a significant fruit and is extremely com in worldwide due to its abundant nutrition as well as its juicy, sweet, and desirable flavor (El-Otmani *et al.,* 2011). In Iraq, all citrus cultivars are mainly grafted on Sour orange because their impedance to gummosis fungi, height adaptability to the broad domain of soil conditions, and the capacity to produce height fruits quality (Castle, 2010). However, some studies have shown that the Sour orange rootstock has some problems like its sensitivity to citrus Tristeza virus, poor agreement with some citrus kinds, and sometimes low production compared to other rootstocks (Georgiou and Gregoriou, 1999; Castle, 2010), like appears that Volkamer lemon rootstock to be one of the more hopeful rootstocks due to its resistance to Tristeza (Shafieizargar *et al.,* 2012) can impact the

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nutrient content of fruit like Mg, Ca, P, N and K. Thus, the rootstock may appear some postharvest disorders such as albido breakdown in orange fruits (Treeby *et al*., 2007).

After harvest, to preserve citrus fruits' postharvest life and quality, also, to minimize the decay caused to pathogen infection must be there are stored and handled in packing houses like treated fruits with (plant extracts, biocontrol agents, essential oils, hot water, salts, and irradiations). (Papoutsis *et al.,* 2019) indicated that using plant extracts to the dominance of the postharvest pathogens (Penicillium digitatum and Penicillium italicum) consider a good method. These pathogens ca to huge postharvest losses in citrus fruits. Most of the studies proved that storage temperature has big effects (Rapisarda *et al*., 2001; Marcilla *et al.,* 2006; Obenland et al., 2011), due to the tropical and subtropical regions are the native of citrus fruit and susceptible to low temperature, the fruits storing under low temperature but not freezing, usually susceptible to the chilling injury below 10 °C (Schirra *et al.,* 1998; Kader, 2002). It's physiological damage that overwhelmingly appears on the fruits roof, maybe due to the tear of the oil glands with due water loss. Fungal decay and weight loss are the major factors affecting the storage life of Orange. Chemical fungicides are used for Fungal diseases control, which is not safe for humans and the environment, wherefore is a clear want for alternative natural materials for post-harvest disease control in citrus fruits, such as essential oils treatments (Zigus and Erice, 2001; Saucedo-Pompa *et al*., 2007; Badawy, Ibtesam, *et al.,* 2011). On the other hand, Fatih and Aljabary, (2017) cited that treated immersing in pomegranate peels and thyme leaves extracts have significant effects on reduction of weight loss and maintained fruits with good quality than the control treatment. Therefore, the goal of the study extends the storability and maintain the postharvest quality of "Diyala" orange fruits by using two rootstocks and some plant extracts.

Materials and Methods

This study was carried out in 2018 on Diyala Orange fruits which were obtained from trees budded on sour orange (*Citrus aurantium* L.), and Lemon (*Citrus limon* L.), rootstocks. The trees were grown in a private orchard in the Diyala governorate. The fruits were harvested during the last week of November at the uniform stage of maturity, and the size, free of diseases, insects, and damage were selected randomly.

The harvested fruits from each rootstock were immediately randomly divided into ten equal groups (treatments). Each group was replicated thrice; each replicate consists of 15 fruits. The fruits were dipped in (2, 4, and 6) % clove flower buds, thyme leaves and pomegranate peels aqueous extracts plus control treatment for four minutes. These extracts were purchased ready-made from the market. For the preparation of (2, 4, and 6) % aqueous solution (20, 40, and 60) gm of each materials powder were taken and placed in the conical flask, then the distillate water is added up to the mark point 1000ml. The flasks were put in the water bath at 60 °C for 4 hours (Hama-salih *et al*. 2014). Then, the fruits were placed in polyethylene bags after being dried from excess solution after dipping. Then, the bags were placed in cold storage at 6±1 ºC and 85-95% RH for two months. At the end of the storage period, the following parameters were measured:

A total soluble solid (TSS) % was measured by Hand Refractometer (Atago, Japan) (Horwitz, 2010). For Titratable Acidity (TA) % samples (fruit juice) were titrated with NaOH (0.1N) using phenolphthalein indicator and the acidity was expressed as citric acid content followed by the method of (Horwitz, 2010). Total sugars were determined by using one mL of the sample in the test tube followed by adding one mL of phenol 5%, shaking well, and then adding 5 ml of 97% H_2SO_4. Afterward, the solution was put in the water bath for thirty minutes at 60 ˚C. Before it was centrifuged at 3000 rpm, for 15 minutes, finally, total sugars were estimated by spectrophotometer (UV-1700, Shimadzu, Japanese origin) at 490 nm as mentioned in (Joslyn, 1970). Ascorbic acid in the juice was estimated by titration against 2,6 dichlorophenol indophenol blue dye, as mentioned in (Horwitz, 2010).

Total phenol (mg.100 ml^{-1} juice) was estimated according to (Ranganna, 2015) by adding 1 ml of juice and 20 ml of the solution (95% ethanol and 1.5 N hydrochloric acids (HCl) at 85:15 each respectively), and the mixture was mixed well. Then, it was stored overnight in a refrigerator at 4°C, after that, it was placed in the centrifuge for 15 minutes at 3000 rpm. It was measured by using a spectrophotometer (UV-1700, Shimadzu, Japanese origin) at the wavelength of 280 nm. The proportion of flavonoids in the peel was estimated according to (Bohm and Koupai-Abyazani, 1994) by extracting 10 g of the sample with 100 ml of methanol (80% v/v) at room temperature followed by solution filtration through the filter paper (Whatman No.42). The residue was evaporated until drying on a water bath and the residual weight of the precipitate was calculated based on a percentage.

Carotene in juice content was measured by mixing 2 ml of juice with 20 ml of acetone (80%), mixed in an electric mixer and added to it 0.1 g of sodium bicarbonate and then transferred the solution after filtering to a volumetric flask 100 ml and the volume was completed with 80% acetone and mixed well. Then the sample was read by a spectrophotometer (UV-1700, Shimadzu, Japanese origin) at 480 nm as mentioned in (Fatih and Aljabary, 2017).

The percentage of weight loss (%) was calculated from initial weight (Al-Jabary, 2007). Fruit physiological disorder (%), the number of damaged fruits (skin pit browning) was measured as a percentage from the total number of each replicate (AL-Jabary and Fadil, 2017), it was calculated after two months in cold storage and in addition to seven days of shelf life at room temperature.

Statistical Analysis:

The Complete Randomized Design within the factorial experiment (two factors (rootstock and plant extracts)) was used for and the collected data were submitted to the analysis of variance (ANOVA) by using (SAS 9.1 software). Mean comparisons were carried out by using Duncan multiple range test at $p \leq 0.05$.

Results and Discussion

Total Soluble Solids (%)

The enjoyable taste of citrus fruit juice comes back to the large part to TSS content, which consists of about 80% sugars (fundamentally glucose, sucrose, and fructose), 10% of organic acids (fundamentally citric acid), 1% nitrogen complexes, and 9% of vitamins, minerals and other substances soluble in water (Raddatz-Mota *et al*., 2019). Some authors have notified that the use of citrus rootstocks changes TSS in juice content (Fadel *et al*., 2018; Sau *et al*., 2018; de Carvalho *et al*., 2019). Furthermore, it has been notified that high fruit juice content in citrus of TSS is related to higher fruit quality (Cantuarias-Aviles *et al*., 2010; Ladaniya and Mahalle, 2011).

In this experiment, results show significant differences between rootstocks in TSS, while, Fruits were grown in Sour orange rootstock superior to Fruits were grown in Lemon rootstock (Table 1). These results agree with (Raddatz-Mota *et al*., 2019) who reported that fruit produced on Sour orange rootstock showed a higher percentage of TSS compared to the fruit produced on Volkamerian lemon rootstocks. Fruits on sour orange rootstock can be expected to make fruit with high total solids and acids, whilst fruits on lemon rootstock are usually low total solids and acids reported by (Wutscher, 1988). Also, in agreement with previous results obtained by (Al-Jaleel *et al*., 2005) who found that citrus trees grafted on sour orange rootstock produced fruits with high TSS%, while trees on lemon rootstocks produced low total soluble solids. The results are in line with the findings of (Rub *et al*., 2010) who found that TSS%, was increased by increasing the storage period in sweet orange, they add that TSS percentage is a function of total dissolved solids and moisture content of the fruit and the increase in TSS% may be due to loss of moisture content of the fruit during the cold storage period. Hydrolysis of cell wall constituents could also possibly contribute to the increase in degrees Brix (Burns, 1990).

With respect to the impact of the plant extracts treatments, data in Table (1) indicate that most plant extracts concentrations significantly increased the TSS% content in juice than control, especially all concentrations of pomegranate peel extract succeeded in raising the TSS percentage of fruit juice in comparison with control treatment also showed that superiority of treated with 4% thyme extract, followed descending by 2% clove extract as compared to control. This increase of TSS may be regarding the role of these extracts to retard metabolic activity and minimized respiration rate and vital process, so minimizing TSS loss during storage (Abd El Wahab, 2015).

Referring to the combined influence between the rootstocks and extracts, results in Table (2) indicate that the combination between fruits from Sour orange rootstock and dipping in 4% pomegranate peel extract (PPE) recorded the highest percentages of TSS, which significantly superior on most other interactions. While the lowest percentage was found in the interaction between the Sour orange rootstock and 6% clove flower bud's extract.

Titratable Acidity (%)

Acidity in fruit juice is fundamentally related to organic acids such as (citric, malic, ascorbic, tartaric, benzoic, oxalic, etc.) that are stored in the vacuoles of plant cells (Raddatz-Mota *et al*., 2019). In some cases of citrus fruit, the highest ratio of an acid present (from 85 to 95%) is citric acid (Zhang and Zhou, 2019). Juice acidity is determined fundamentally by a concentration of the prevalent organic acids (citric acid) in citrus juice, although some phenols, minerals, and amino acids may also influence the acidity perception (Zhou *et al.,* 2018). It has been notified that acidity reduction is due to entering the organic acids in a Krebs cycle during fruit ripening (Murr *et al*., 2008). Titratable Acidity that is determined by titration is a measurement of the number of organic acids existent in the fruit. In this work, results show non-significant differences between rootstocks in TA values (Table 1).

Regarding with influence of extracts, results in Table (1) show that most treatments maintained the acidity % of orange fruit. On the opposite, the minimum value of the acidity was gained from fruits treated with 6% thyme. This perhaps attributes to the slowing the respiration rate by coating with these extracts could explain minimizing of the organic acids consumption in the enzymatic reactions of respiration (Abd El Wahab, 2015).

About the combined influence between the rootstocks and extracts results in Table (2) explain that the combination of Sour orange rootstock and 4% PPE scored a higher value of this parameter. Whilst, the lower value scored in the interaction between the Lemon rootstock and 6% thyme extracts.

Total Sugars (%)

Total sugar content is variable in citrus fruit juice. In general, these sugars are existing in fruit juice such as monosaccharides (glucose and fructose) and disaccharides (sucrose) (Deng et al., 2019). In this study, total sugar content significantly increased in fruit on Lemon, rootstock compared to fruits on Sour orange rootstock at the end of the storage period (Table 1). (Rub *et al*., 2010) who reported that TSS% is an index of total soluble solids (80% of TSS is sugars) and moisture content of the fruit, so this raises in total sugars perhaps as a result of the water loss of the fruit during the cold storage period.

As for the influence of extracts, results in Table 1 show that the highest value of total sugar in orange fruit was gained from fruits that were immersed in (4 and 6)% of thyme which was superior on other treatments.

Considering the combination influence between the rootstocks and extracts, the obtained results in Table (2) demonstrate that the combination between Lemon rootstock and 4% thyme is statistically superior to other interaction treatments of total sugar in fruit juice. On the opposite, the interaction between Lemon rootstock and 6% PPE gained the lowest value of total sugar in fruit juice.

Vitamin C Content (mg.100ml^{-1})

Raddatz-Mota et al., (2019) found very values of vitamin C content that about 200 to 230 mg.L^{-1} in Persian lime fruit juice was budded on several types of rootstocks. At the end of the storage time of this study, a significant increase occurred in vitamin C content in fruit on Sour orange rootstock compared to fruit grown on other rootstocks (Table 1). These results are in harmony with those obtained by (Hifny *et al*., 2012) harvested fruits from trees grafted on sour orange rootstock showed a significant increase in the vitamin C content than on volkameriana lemon rootstock**.** Vitamin C (ascorbic acid) in citrus juice is relatively low (30-60 mg.100 ml^{-1}), and notifies on rootstock impacts have been different (Hifny *et al*., 2012). Generally, the oranges content of vitamin C from trees grafted on different rootstocks grades is as follows: grapefruit> Cleopatra> sour orange > rough lemon, the grapefruit content of vitamin C from fruits on sour orange is higher than from fruits on rough lemon (Wutscher, 1988). The results were in line with those found by (Ordóñez-Santos and Vázquez-Riascos, 2010) who stated that extending the storage period decreased Vitamin C in guava. Likewise, (Coulomb and Meunier, 1984) claimed that the fruit postharvest behavior may be affected by rootstock since vitamin C is quickly lost during prolonged storage of citrus fruits knowing that its retention is of high importance in citrus fruits postharvest handling.

Concerning of influence of extracts, results in (Table 1) shows that most extracts treatments maintained the highest value of vitamin C in orange fruit compared to control, especially fruits that were immersed in 2% of clove flower buds, thyme leaves, and PPE which were gained maximum values of vitamin C. The obtained results of extracts in this parameter are in harmony with those mentioned by (Baiea and El-Badawy, 2013) on essential oils (clove and thyme oil) caused to maintained vitamin C at the end of storage duration. Furthermore, (Fatemi *et al*., 2011) found that the highest value of vitamin C was recorded in thyme treatment at 1000ppm on Valencia orange.

Regarding the combination influence between the rootstocks and extracts, the obtained results in Table (2) reveal that the combination between Sour orange rootstock and (2% clove flower buds or 2% thyme leaves) is statistically superior on most of the other interaction treatments of vitamin C content in fruit juice. On the contrary, the interaction between Lemon rootstock and 6% of PPE gained the lowest value of vitamin C content in fruit juice.

Total Phenol (mg.100ml^{-1})

Phenolic materials can be classified in citrus into 2 groups: phenolic acids and related complexes, and flavonoids (Cupane, 2015). In citrus, the more representative of the hydroxybenzoic acid is gallic acid, even it was reported that its existence and quantum is severely dependent upon the conditions of growing and by the cultivar (Tounsi *et al.,* 2011). Furthermore, presence of hydroxycinnamic acid and its derivatives in citrus fruits: p-coumaric, sinapic, ferulic, chlorogenic, and caffeic acids (Robards and Antolovich, 1997).

Concerning the effects of rootstock on total phenol content, we found a significant increase in total phenol occurred in fruit on Sour orange rootstock compared to fruit on Lemon rootstock (Table 3). Concerning the influence of extracts results in (Table 3) indicate that at the end of the storage period, all extracts treatments maintained the highest values of total phenol in fruit juice compared to control, especially fruits were immersed in 4% of PPE which was superior to other treatments.

As for the combination influence between the rootstocks and extracts, the obtained results in (Table 4) refer to that the combination between Sour orange rootstock and 4% PPE statistically ($p < 0.05$) superior on all of the other interaction treatments of total phenol content in fruit juice. On the contrary, the lowest value of total phenol content in fruit juice was observed in the interaction between Lemon rootstock with 4% clove or 2% thyme or 6% PPE.

Flavonoids (%)

Flavonoids are aromatic compounds secondary plant metabolites that have pharmacological and physiological activities (Del Rıo et al., 2004; Tusa *et al.,* 2007). In citrus, can be classified the more significant flavonoids into various groups, based on their carbon skeleton: flavones, flavanones, flavonols, and anthocyanins (Tusa *et al.,* 2007). Can found flavonoids in the aglycone or glycoside forms, also more of them exist as C- or O-glycosides (Gattuso *et al*., 2007). Regarding the effects of rootstock on flavonoids content, fruit on Sour orange rootstock significantly increased flavonoids content compared to fruit on Lemon rootstock (Table 3).

Evaluating the influence of extracts, results presented in (Table 3) indicate that at the end of the storage period, all extracts treatments significantly decreased flavonoids in fruit peel compared to control fruits.

As for the combination influence between the rootstocks and extracts, results in Table (4) indicate that the highest value of flavonoids content in fruits was observed in the combination between Sour orange rootstock with 4% clove. On the contrary, the lowest value of flavonoids content in fruit was observed in the interaction between Lemon rootstock with 2% PPE.

Carotene (mg.100ml^{-1})

A big number of complicated carotenoids are existing citrus fruits. That reported nearly 115 various carotenoids, and their synthesis can differ according to the site in the pulp or the peel (Goodner *et al.,* 2001). This difference is significantly high in orange, lemon, and clementine (Agócs *et al*., 2007). Most of the carotenoids that exist in citrus are lycopene, α- and β-carotene, lutein, and β-cryptoxanthin. Their content differs with maturation, postharvest treatments, and growing situations, and it is more dependent upon cultivars (Alós *et al.,* 2006; Kato *et al.,* 2004; Rodrigo and Zacarias, 2007; Navarro *et al.,* 2010).

Color is one of the more significant quality properties in fruit and vegetables because it immediately affects visual and appearance quality (Schifferstein et al., 2019; Vadiveloo *et al*., 2019). Colour spread of the edible part of fruit and vegetables reverses the existence of pigments, which are as well bioactive components, like anthocyanidins, flavonoids, and carotenoids (Oude *et al.,* 2011). The flavedo color (rind) in acid limes and lemons is one of the major properties for quality and it is a defining attribute for its commercialization (Zhang and Zhou, 2019). We examined the effects of rootstock on carotene content in fruit juice, observed a significant increase in carotene occurred in fruit on the Lemon rootstock compared to fruit on Sour orange rootstock (Table 3).

With respect to the influence of extracts, results presented in the same table show that at the end of the storage period, the highest value of carotene was gained from fruits were immersing in 4% of PPE, which was the superiority compared with control fruits in this parameter. Regarding the combination influence between the rootstocks and extracts, the obtained results in Table (4) explain that the combination of Sour orange rootstock and 4% PPE is statistically superior on all of the other interaction treatments of carotene in fruit juice. On the opposite, the lowest values of carotene in fruit juice were observed in the interaction between Sour orange rootstock combined with 2% clove or 2% PPE.

Weight Loss (%)

Considered weight loss is one of the major problems for the marketing of fresh products (fruit and vegetables) through storage (Nayak et al., 2018). After harvest, weight loss in fruit increases because of transpiration. Transpiration increases in environmental conditions with high temperatures and low relative humidity, which leads to higher water loss, so hastens senescence and minimizes fruit quality (Yadav *et al*., 2013). In the present study, fruit is grown on Sour orange rootstock significantly decreased weight loss compared to fruit grown on Lemon rootstock (Table 3). These results are reverse with finding by (Hifny *et al*., 2012) harvested fruits from trees grafted on sour orange, rootstock showed a significant increase in the fruit weight loss compared to on volkameriana lemon rootstock.

Evaluating the influence of extracts data presented in the same Table explains that at the end of the storage period, all extracts treatments cause to raising weight loss (%) of orange fruits in comparison with untreated fruits (control).

With respect to the combined influence between the rootstocks and extracts, results in Table (4) reveal that most of the combination treatments succeeded in reducing weight loss in fruits. Especially, the combination between Sour orange rootstock with 4% clove or 6% thyme or 2% PPE, in addition, the combination between Lemon rootstock with 2% PPE. While the highest percentage of weight loss was observed in the interaction between Sour orange or Lemon rootstock combined with 2% clove.

Physiological Disorders (%)

Physiological disorders are one of the major problems for marketing citrus fruit during storage. As external discoloration and surface lesions formation (depressions formation black or browning pit-like in the flavedo, the outer colored portion of the peel which reported by (Raddatz-Mota *et al.,* 2019). The current study also observed fruit grown on Sour orange rootstock significantly decreased physiological disorder compared to fruit grown on Lemon rootstock after cold storage in addition to 3 days at room temperature (Table 3). These results are in line with finding by (Özdemir *et al.,* 2019) that showed a significant decrease in physiological disorder percentage in harvested fruits from trees grafted on sour orange rootstock than other rootstocks, which was used in its study.

Concerning of influence of extracts, results in the same Table indicate that at the end of the storage period, most treatments succeeded in reducing physiological disorders of orange fruits, especially, fruits immersing in 2% of PPE, 4% clove, and (4 and 6) % thyme respectively, which were gained lowest values of the physiological disorders.

Conclusion

The "Diyala" orange is an economic and advantageous important fruit in Iraq. Wherefore, it’s important to evaluate the influence of rootstocks and postharvest treatments such as plant extracts which allow maintaining the postharvest quality standards of Diyala orange fruit. In this study, results showed that there was a significant ($p < 0.05$) effect of the rootstocks on the most studied parameters of Diyala orange fruit, especially, fruits from sour orange rootstocks had the lowest percentage of weight loss and physiological disorders than fruits from lemon rootstock that is directly associated with the best fruit quality after harvest. Regarding the plant extracts, the results showed that fruits immersed in 2% clove or 6% thyme or 2% Pomegranate peel extract had the highest values in most of the chemical properties than control. Furthermore, fruits immersed in 6% thyme or 2% Pomegranate peel extract had lower physiological disorders compared to control. According to the results, we can suggest using fruits from sour orange rootstocks instead of lemon rootstocks, as well as, using other levels of these plant extracts to minimize weight loss and physiological disorders and prolong the storage period.

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Appendixes

Table (1): Effect of rootstocks and plant extracts and their interactions on TSS (%), TA (%), total sugar (%) and vitamin C (mg.100 ml^{-1}) in "Diyala" orange juice.

Treatments	TSS	TA	Total Sugar	Vitamin C
Sour Orange	**9.42 a**	**1.18 a**	**0.59 b**	**39.58 a**
Lemon	**9.02 b**	**1.16 a**	**0.76 a**	**32.75 b**
Control	**8.65 f**	**1.23 abc**	**0.65 bc**	**34.00 c**
%2 Clove	**9.25 bcd**	**1.15 bcd**	**0.62 bcd**	**39.41 a**
%4 Clove	**8.73 ef**	**1.12 cd**	**0.51 de**	**32.90 c**
%6 Clove	**8.57 f**	**1.23 abc**	**0.65 bc**	**32.44 c**
%2 Thyme	**9.18 cde**	**1.15 bcd**	**0.45 e**	**39.87 a**
%4 Thyme	**9.62 abc**	**1.31 ab**	**0.96 a**	**38.40 ab**
%6 Thyme	**9.08 def**	**0.96 e**	**0.89 a**	**37.85 ab**
%2 Pomegranate Peel	**9.63 abc**	**1.04 de**	**0.70 b**	**39.13 a**
%4 Pomegranate Peel	**9.80 a**	**1.37 a**	**0.72 b**	**35.05 bc**
%6 Pomegranate Peel	**9.70 ab**	**1.17 bcd**	**0.55 cde**	**32.63 c**

Values in the same factors and column with different letters are statistically different ($p < 0.05$)

Table (2): The interactions between rootstocks and plant extracts on TSS (%), TA (%), total sugar (%), and vitamin C (mg.100 ml^{-1}) in "Diyala" orange juice.

Treatments		TSS	TA	Total Sugar	Vitamin C
Sour Orange	Control	8.60 efgh	1.39 ab	0.43 fgh	37.85 cde
	%2 Clove	9.33 cde	0.96 fg	0.57 defg	44.63 a
	%4 Clove	8.93 defgh	1.01 efg	0.44 fgh	30.15 gh
	%6 Clove	8.33 h	1.17 bcdef	0.55 defgh	34.36 defg
	%2 Thyme	9.27 cdef	1.07 defg	0.51 efgh	44.63 a
	%4 Thyme	10.30 ab	1.39 ab	0.58 defg	44.08 ab
	%6 Thyme	9.73 abc	1.01 efg	0.84 bc	41.52 abc
	%2 P. Peel	9.60 bcd	1.12 cdefg	0.58 defg	43.17 ab
	%4 P. Peel	10.400 a	1.52 a	0.60 def	35.92 de
	%6 P. Peel	9.667 bcd	1.17 bcdef	0.75 bcd	39.50 bcd
Lemon	Control	8.70 efgh	1.07 defg	0.87 bc	30.15 gh
	%2 Clove	9.17 cdefg	1.33 abc	0.68 cde	34.18 defg
	%4 Clove	8.53 fgh	1.23 bcde	0.58 defg	35.65 def
	%6 Clove	8.80 efgh	1.28 bcd	0.75 bcd	30.52 fgh
	%2 Thyme	9.10 cdefgh	1.23 bcde	0.39 gh	35.10 defg
	%4 Thyme	8.93 defgh	1.23 bcde	1.35 a	32.72 efg
	%6 Thyme	8.40 gh	0.91 g	0.94 b	34.18 defg
	%2 P. Peel	9.65 bcd	0.96 fg	0.82 bc	35.10 defg
	%4 P. Peel	9.20 cdef	1.23 bcde	0.83 bc	34.18 defg
	%6 P. Peel	9.73 abc	1.17 bcdef	0.35 h	25.75 h

Values in the same column with different letters are statistically different ($p < 0.05$)

Table (3): Effect of rootstocks and plant extracts on total phenol (mg.100ml^{-1}), flavonoids (%), carotene (mg.100ml^{-1}), weight loss (%) and physiological disorders (%) in "Diyala" orange.

Treatments	Total Phenol	Flavonoids	Carotene	Weight Loss	Physiological Disorders
Sour Orange	301.89 a	121.67 a	0.023 b	3.46 b	0.97 b
Lemon	230.55 b	114.83 b	0.025 a	4.37 a	1.27 a
Control	229.39 e	135.00 a	0.026 b	3.25 d	1.00 b
%2 Clove	297.04 b	118.33 de	0.020 c	3.64 bcd	1.83 a
%4 Clove	234.02 de	121.67 d	0.026 b	3.80 bc	0.67 bc
%6 Clove	282.21 bc	128.33 bc	0.022 bc	4.89 a	1.83 a
%2 Thyme	280.99 bc	110.00 f	0.020 c	4.06 b	1.17 b
%4 Thyme	248.22 de	133.33 ab	0.021 bc	3.84 bc	0.67 bc
%6 Thyme	261.68 cd	113.33 ef	0.022 bc	3.71 bcd	0.67 bc
%2 Pomegranate Peel	257.15 cde	97.50 g	0.023 bc	4.63 a	0.33 c
%4 Pomegranate Peel	428.95 a	123.33 cd	0.034 a	3.36 cd	1.17 b
%6 Pomegranate Peel	242.58 de	101.67 g	0.025 b	4.01 b	1.83 a

Values in the same factors and column with different letters are statistically different ($p < 0.05$)

Table (4): Effect of rootstocks and plant extracts on total phenol (mg.100ml^{-1}), flavonoids (%), carotene (mg.100ml^{-1}), weight loss (%) and physiological disorders (%) in "Diyala" orange.

Treatments		Total Phenol	Flavonoids	Carotene	Weight Loss	Physiological Disorders
Sour Orange	Control	238.23 efghi	130.00 c	0.027 bc	2.61 h	1.00 cde
	%2 Clove	316.78 c	136.67 abc	0.016 e	3.36 fg	1.33 bcd
	%4 Clove	257.76 efgh	143.33 a	0.023 bcde	2.64 h	0.33 e
	%6 Clove	303.95 cd	116.67 d	0.019 cde	3.80 ef	2.33 a
	%2 Thyme	353.69 b	110.00 d	0.020 cde	3.62 fg	1.00 cde
	%4 Thyme	274.18 de	133.33 bc	0.019 de	3.98 cdef	0.67 de
	%6 Thyme	305.23 cd	113.33 d	0.018 de	3.62 fg	0.33 e
	%2 P. Peel	263.04 ef	110.00 d	0.016 e	4.60 bcd	0.33 e
	%4 P. Peel	429.23 a	130.00 c	0.044 a	3.00 gh	0.67 de
	%6 P. Peel	276.864 de	93.33 ef	0.026 bcd	3.41 fg	1.67 abc
Lemon	Control	220.55 ghi	140.00 ab	0.025 bcd	1.00 cde	1.00 cde
	%2 Clove	277.29 de	100.00 e	0.024 bcd	2.33 a	2.33 a
	%4 Clove	210.29 i	100.00 e	0.029 b	1.00 cde	1.00 cde
	%6 Clove	260.47 efg	140.00 ab	0.024 bcd	1.33 bcd	1.33 bcd
	%2 Thyme	208.29 i	110.00 d	0.019 cde	1.33 bcd	1.33 bcd
	%4 Thyme	222.26 fghi	133.33 bc	0.023 bcde	0.67 de	0.67 de
	%6 Thyme	218.13 hi	113.33 d	0.026 bcd	1.00 cde	1.00 cde
	%2 P. Peel	251.27 efgh	85.00 f	0.030 b	0.33 e	0.33 e
	%4 P. Peel	228.68 fghi	116.67 d	0.024 bcd	1.67 abc	1.67 abc
	%6 P. Peel	208.29 i	110.00 d	0.025 bcd	2.00 ab	2.00 ab

Values in the same column with different letters are statistically different ($p < 0.05$)

استجابة جودة ما بعد الحصاد لبرتقال ديالى لاثنين من الاصول وبعض المستخلصات النباتية

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ملخص

أجريت هذه الدراسة على ثمار برتقال ديالى للتحقيق في دور اصول النارنج والليمون المغمورة في مستخلصات القرنفل والزعتر وقشر الرمان بتراكيز (0، 2، 4 و6) ٪ لكل مستخلص ولمدة أربع دقائق على توسيع قابلية التخزين والحفاظ على جودة ما بعد الحصاد. استخدمت تجربة عاملية ضمن التصميم العشوائي الكامل وبثلاث مكررات. وبعد ذلك وضعت الثمار في أكياس بولي إيثيلين، ثم خزنت في درجة حرارة 6 ± 1°م ورطوبة نسبية 85–95٪ لمدة شهرين. أشارت النتائج إلى أن الثمار التي نمت على أصل النارنج حافظت معنويا على أعلى القيم في معظم الصفات الكيميائية التي تمت دراستها، وكذلك قل الفقدان بالوزن والاضرار الفسيولوجية مقارنة بالثمار النامية على أصل الليمون. وفيما يتعلق بالمستخلصات النباتية، فإن الثمار المغمورة في 2٪ من مستخلص القرنفل سجلت أعلى قيم من المواد الصلبة الذائبة الكلية وفيتامين C والفينول الكلي مقارنة بالشاهد. علاوة على ذلك، كانت الثمار المغموسة في 6٪ من مستخلص الزعتر تحتوي على أعلى قيم من المواد الصلبة الذائبة والسكر الكلي وفيتامين C والفينول الكلي، كما قللت الاضرار الفسيولوجية مقارنة بمعاملة الشاهد. وبالمثل، فإن الثمار المغمورة في 2٪ من مستخلص قشور الرمان كان لها أعلى قيم من المواد الصلبة الذائبة وفيتامين C وكذلك قللت الاضرار الفسيولوجية مقارنة بمعاملة الشاهد.

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