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Annals of Agricultural Science, Moshtohor (ASSJM)
https://assjm.journals.ekb.eg/

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Original Article Vol. 63(1) (2025), 1 – 8 DOI: 10.21608/assjm.2025.345633.1328

Effect of Coating Treatments by Chitosan and Some Natural Oils as Normal and Nano Forms on Wonderful Cultivar Pomegranate Fruits under Cold Storage

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Abstract

This research was carried out on a Wonderful pomegranate cultivar fruits at the National Research Centre, Researches and Production Station, at El-Nobaria district, El-Behaira Governorate, Egypt. after harvest in the cold storage of Agriculture of Cairo University during two seasons (2020-2021 and 2021-2022). The treatments were arranged in a completely randomized design including seven coating treatments after harvest on Wonderful cultivar pomegranate fruits under storage refrigerated at 7°C and RH 90%, all treatments three replicates. This study aimed to obtain the effect of some natural and chemical materials on Wonderful pomegranate fruits during storage while increasing their nutritional and marketing value and the shelf life of fruits. Wonderful cultivar pomegranate fruits before storage treated by seven treatments as follows: Chitosan 2g/L, Nano Chitosan 1g/L, Clove oil 2%, Nano Clove oil 1%, Rosemary oil 1%, Nano Rosemary oil 0.5%and control. The transactions were carried out within six weeks by adding these materials to pomegranate fruits by coating after harvest. The results proved that Nano Rosemary 0.5% exhibited significantly the highest values in all chemical and physical characteristics of fruits compared to the control treatment and the other treatments.

Keywords: wonderful, pomegranate, post-harvest, shelf life, marketing

Introduction

One of the earliest edible fruits known to science is the pomegranate, *Punica granatum L.* (Punicaceae). Its origins can be traced back to ancient times. This fruit tree is frequently linked to fertility and is one of the species described in the Bible and the Koran. It is indigenous to Iran and possibly some of its neighboring regions. Ancient Egypt was the place where it was grown. Due to their ability to withstand drought, pomegranates are said to be a great tree for growing in desert regions. It is grown extensively in tropical, subtropical, and Mediterranean regions. According to botany, the pomegranate (*P. granatum L.*) belongs to the Punicaceae family, where 2n = 16 or 18. Two species, *P. protopunica* and *P. granatum*, are known to exist in the genus Punica **(Mars, 2000)**.

This fruit is a source of carbohydrates, minerals, crude fibers, various biologically active compounds such as vitamin C and certain phenolic compounds such as punicalagin, ellagic acid, gallotannins and anthocyanins, known to act as natural antioxidants **(Sabokbar & Khodaiyan, 2015)**. Pomegranate fruit is appreciated due to the presence of these biologically active compounds that have valuable properties such as antimutagenicity, antihypertension and reduction of liver injury **(Sabokbar & Khodaiyan, 2016)**.

The sensitivity of pomegranate fruit to cuts, sunburn, bruises, cracking and chilling injury occurring at low temperatures, makes externally defective pomegranates inappropriate for fresh sale and consumption, and hence they are generally destined for industrial applications or animal use **(Artés *et al.*, 2000)**. Therefore, minimal processing can be an extremely good way to acquire a commercial benefit from externally defective pomegranates with very good internal quality **(López-Rubira *et al.*, 2005)**. However, respiration rate and detrimental biochemical changes of processed pomegranate arils such as the development of off-flavors and texture breakdown are accelerated by their surface damages. Furthermore, surface microbial contamination can lead to fruit spoilage **(Brasil *et al.*, 2012)**.

The edible coating made from biodegradable ingredients has been considered a technology to extend the shelf life of coated products by modifying their internal atmosphere (**Perdones *et al.*, 2012)**. It slows down the respiration rate and acts as a good barrier to gas transport **(Varasteh *et al.*, 2012)** and

hence improves the visual and tactile features of coated fruits, also protects them from moisture migration and microbial growth on their surfaces **(Mohammadi *et al.*, 2016)**.

The demand for healthy and environmentally friendly production systems of fruits and vegetables has increased during the past few years. For this purpose, essential oils (EOs), generally recognized as safe (GRAS), have been considered promising alternatives to chemical-based preservatives due to their good antimicrobial properties **(Linde *et al.*, 2010, Sánchez-González *et al.*, 2011).**

Chitosan an ideal semipermeable film on the fruit surface, modifies the fruit's internal atmosphere, regulates gas exchange, reduces transpiration losses, delays the ripening, and maintains the quality of harvested fruit **(Shahidi *et al.*, 1999, Li and Yu, 2000; Jiang *et al.*, 2005; Bautista-Banos *et al.*, 2006 and Kaya *et al.*, 2016)**. Clove oil was extracted from the spice known for its therapeutic properties, and characteristics change during conventional storage, as the components present in essential oils easily undergo oxidation, isomerization, cyclization, or dehydrogenation reactions, triggered either by an enzymatic or chemical reaction. Also, degradation during storage, processing and encapsulation in carrier materials such as lecithin, arabica gum-whey protein concentrate, and poly-lactic glycolic acid resulted in an enhancement of its water solubility **(Cortés *et al.*, 2014)**.

This study aimed to investigate increasing the shelf life of wonderful pomegranate fruits during storage while increasing their nutritional and marketing value by using some natural and chemical materials that improve the physical and chemical properties of the fruits.

Materials and Methods

This study was carried out at the National Research Center, Dokki, Giza, Egypt, during two successive seasons (2020-2021 and 2021-2022). The pomegranate (Wonderful cv.) trees were the plant material used in this study. Pomegranate fruits were carefully selected approximately as normal growth, healthy, and uniform as possible as well as free of farm diseases and disorders. The purpose of this investigation was to evaluate treatments that keep the good quality of pomegranate fruits (Wonderful cv.) for a longer period with less weight loss %, decay % and enhance fruits storability while improving fruit firmness under the storage condition. In this regard, this was concluded the different seven chemical substances treatments were applied as follows:

1- Chitosan 2g/L.
2- Nano Chitosan 1g/L.
3- Clove oil 2%.
4- Nano Clove oil 1%.
5- Rosemary oil 1%.
6- Nano Rosemary oil 0.5%.
7- Control.

The responses of the tested fruits to the coating treatments were evaluated through the following characteristics:

a. Fruit weight (g).

b. Decay percentage: Fruit that showed any sign of decay or visual disorders were weighted. The percentage of decaying wonderful pomegranate was calculated based on total fruit weight using the following formula:

$$\text{Decay \%} = \frac{\text{decayed fruit weight (g)}}{\text{initial fruit weight (g)}} \text{ X } 100$$

c. Fruit weight loss percentage: The difference between the initial weight of the clusters and that recorded at the date of sampling was translated as weight loss percentage according to the following equation

$$\text{weight loss \%} = \frac{\text{Initial fruit weight} - \text{Weight at sampling date (g)}}{\text{Initial fruit weight at the beginning of storage (g)}} \text{ X } 100$$

d. Firmness: is an important physical property of fruits, the mechanical properties and elastic modulus of fruit were measured by using a compression test apparatus **(Magness and Taylor, 1925).**

Statistical analysis

The analysis of variance (ANOVA) was done for each season separately as a completely randomized design, according to procedures reported by Gomez and Gomez, (1984). The differences between mean values of treatments were compared by the least significant difference (LSD) test at 0.05 level of probability. Data were analyzed using (ANOVA) in the MSTAT-C software package **(Freed *et al.*, 1989)**.

Results and Discussion

a. Effect of coating application treatments on fruit weight (g) in the post-harvest stage of Wonderful pomegranate fruits.

Data in Table (1) showed that the fruit weight (g) in the post-harvest stage was significantly affected by all treatments, time applications, and their interaction in both seasons. The highest significance of fruit weight was in concluded with Nano Rosemary oil 0.5%, treatment followed in descending order by treatment of Nano Clove oil 1%, Rosemary oil 1%, and Clove oil 2%, Nano chitosan 1 g/l, chitosan 2 g/l and the control treatment in the first season. On the other hand, data of fruit weight in the second one exhibited great results with Nano Rosemary oil 0.5%, followed in descending order by

Rosemary oil 1%, Nano Clove oil 1%, and Clove oil 2%, Nano chitosan 1 g/l, chitosan 2 g/l, and the control. Respectively also, the time applications in Table 1 showed that the fruit weight of pomegranates in the harvest stage gave the biggest weight at the start time of the study and decreased after weeks of the study. Data of interactions between treatments and time applications recorded that the maximum average of fruit weight with both Rosemary oil was 1% in the start time of study in the first season and Nano Rosemary oil 0.5% in the same time applications in the second season. As for the time of application, data in the same Table indicated that, the arrange of fruit weight decreases significantly with increasing the time application. It could be observed that the average fruit weight decreased from (475.83 g) to (309.25g) and from (517.97 g) to (330.80 g) in the 1st and 2nd seasons, respectively. In other words, it could be noticed that a gradual decrease in the average fruit weight with increasing the time of application from the start time (zero time) to the 6th week of appl. Claim time. The results were in harmony with **Chraibi *et al.*, 2020; Hassanzad *et al.*, 2019; Nieto *et al.*, 2018; Ramadan *et al.*, 2020** showed that antimicrobial edible coating is an emerging packaging technique with the ability to prolong the shelf-life of fresh horticultural produce. **Bashir *et al.* (2023)** found that increased the average fruit weight yield from coating to different concentrations of Rosemary oil 0.10 to 0.50%.

Table 1. The effect of coating application treatments on fruit weight (g) in the post-harvest stage of Wonderful pomegranate fruits (2020-2021/ 2021-2022).

Treatments	Storage periods (Weeks)							Means
	Fruits weight (g) 2020-2021							
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	466.0	443.2	427.2	425.8	396.7	353.0	331.6	**406.2**
Nano Chitosan 1g/L	499.1	473.2	427.2	425.8	396.7	353.0	298.5	**410.5**
Clove oil 2%	485.0	476.0	451.2	445.7	413.2	383.6	329.1	**426.3**
Nano Clove oil 1%	529.4	518.9	478.2	473.8	441.6	414.8	360.3	**459.6**
Rosemary oil 1%	532.1	491.1	463.9	430.5	413.5	380.3	311.8	**431.9**
Nano Rosemary oil 0.5%	525.6	500.7	480.6	450.8	445.8	423.0	368.5	**556.4**
Control	293.6	288.3	265.9	252.3	236.2	208.5	165.0	**244.25**
Means	**475.83**	**455.91**	**427.74**	**414.96**	**391.96**	**359.46**	**309.25**	------
LSD 0.05	Treatments (A)= 119.6				Time applications (B)= 89.36			
	A×B= 236.4							
treatments	Time applications (weeks)							Means
	Fruits weight (g) 2021-2022							
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	509.9	468.6	461.7	443.2	419.4	377.1	316.8	**428.1**
Nano Chitosan 1g/L	545.6	499.8	490.4	436.9	421.5	386.6	327.4	**444.0**
Clove oil 2%	536.3	526.0	489.7	438.9	432.2	392.7	324.5	**448.6**
Nano Clove oil 1%	519.3	511.3	480.5	445.1	421.7	419.6	372.8	**452.9**
Rosemary oil 1%	593.8	577.0	533.1	500.2	458.2	405.2	345.0	**487.5**
Nano Rosemary oil 0.5%	596.5	586.5	554.1	528.9	514.0	486.1	454.8	**531.6**
Control	324.1	317.0	284.1	272.9	256.5	228.8	174.3	**265.39**
Means	**517.97**	**498.02**	**470.51**	**438.01**	**417.64**	**385.16**	**330.80**	------
LSD 0.05	Treatments (A)= 110.6				Time applications (B)= 32.92			
	A×B= 87.10							

b. Effect of coating application treatments on decay percentage in the post-harvest stage of Wonderful pomegranate fruits.

The results of the decay of treatments in Table 2 showed that the fruit decay did not have significance with Nano Rosemary oil 0.5% or Nano Clove oil 1% also, Rosemary oil 1% or Clove oil 2%, and Nano chitosan 1 g/l or chitosan 2 g/l in both seasons. In addition, the lowest decay percentage on fruits was recorded significantly with both the treatments of Nano Rosemary oil 0.5% and Nano Clove oil 1% in two seasons, respectively than the control and the other remailer treatment.

Also, Table 2 recorded that the time applications of the fruit decay have the lowest data in the start time of study to four weeks in both seasons compared to data of other weeks under study. Data of interactions between treatments and the time

applications recorded that the highest fruit decay with control treatment after six weeks under post-harvest study in two seasons compared to other interactions under study. The coatings create a modified atmosphere by forming a semi-permeable shield against the moisture, oxygen, carbon dioxide and solutes, lowering the respiration rate, oxidation reactions, and moisture loss, thereby keeping the product rigid, fresh and nutritious for an extended period **(Embuscado and Huber, 2009).** Also, the coating material of hydrophobic substances throughout the polysaccharide matrix tends to reduce possible interactions between water and functional groups of the polymer **(Vianna *et al.*, 2021). Bashir *et al.* (2023)** showed that an increase in rosemary essential oil concentration from 0.10 to 0.50% in starch coating formulations resulted in reduced decay of fruit percentage in coated samples under both storage conditions. On the other hand, **Kasnazany (2018)** found that the decay % of treated fruits was significantly decreased by clove oil at (0, 1 and 2%).

a. Effect of coating application treatments on fruit weight loss (g) in the post-harvest stage of Wonderful pomegranate fruits.

Loss of fruit weight In Table 3, the results of Loss of fruit weight were significantly affected by all treatments, time applications, and their interaction in both seasons. Data of treatments in the table showed that the fruit weight loss was significant with Nano Rosemary oil 0.5%, Nano Clove oil 1%, Rosemary oil 1%, Clove oil 2%, and Nano chitosan 1 g/l compared to chitosan 2 g/l or control treatments in the first season and they were significant in all treatments compared to control in the second season. In general, the lowest average of weight loss with Nano Clove oil was 1% in the first season but the Nano Rosemary oil at 0.5% gave the lowest average in the second season. Data of interaction between the treatment and the time applications under study recorded the minimum average of fruit weight loss (g) with Nano Clove oil in the first season and Nano Rosemary oil in the second season under the start time application in the study than control and the other interactions. **Banos *et al.* (1994)** reported that chitosan can extend shelf life due to its ability to form a semi-permeable coating minimizing the rate of respiration and reducing water loss. Increased the concentration of formulation reduced weight loss possibly due to covalent and H-bond interactions among starch and REO. This limits the accessibility of hydroxyl groups to create hydrophilic bonds with water and as a result, retain moisture content **(Wu *et al.*, 2015).** Rosemary oil has proven antifungal effects and the persistence of carnosic acid, carnosol, and rosemarinic acid, a class of phenolic diterpenes with a phenolic group in its molecule linked to its antibacterial action. Recently, the antioxidant and antimicrobial properties of rosemary essential oil have been reported in some studies **(Bashir *et al.*, 2023).**

Table 2. The effect of coating application treatments on decay% in the post-harvest stage of Wonderful pomegranate fruits (2020-2021/ 2021-2022).

Treatments	Storage periods (Weeks) decay% (2020-2021)							Means
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	0.00	0.00	0.00	0.00	0.00	20.00	40.00	8.571
Nano Chitosan 1g/L	0.00	0.00	0.00	0.00	9.333	20.00	30.00	8.476
Clove oil 2%	0.00	0.00	0.00	0.00	0.00	20.00	30.00	7.143
Nano Clove oil 1%	0.00	0.00	0.00	0.00	0.00	10.00	20.00	4.286
Rosemary oil 1%	0.00	0.00	0.00	0.00	0.00	20.00	30.00	7.143
Nano Rosemary oil 0.5%	0.00	0.00	0.00	0.00	0.00	10.00	20.00	4.286
Control	0.00	0.00	0.00	10.00	30.00	40.00	60.00	20.00
Means	0.000	0.000	0.000	1.429	5.619	20.00	32.86	------
LSD 0.05	Treatments (A)= 1.514			Time applications (B)= 1.080				
	A×B= 2.858							
Treatments	Time applications (weeks) decay% (2021-2022)							Means
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	0.00	0.00	0.00	0.00	0.00	17.33	34.67	7.429
Nano Chitosan 1g/L	0.00	0.00	0.00	0.00	0.00	19.00	24.67	6.238
Clove oil 2%	0.00	0.00	0.00	0.00	5.333	15.33	18.33	5.571
Nano Clove oil 1%	0.00	0.00	0.00	0.00	0.00	8.000	17.33	3.619
Rosemary oil 1%	0.00	0.00	0.00	0.00	0.00	15.00	20.00	5.048
Nano Rosemary oil 0.5%	0.00	0.00	0.00	0.00	0.00	6.333	13.33	2.810
Control	0.00	0.00	0.00	11.67	30.67	40.67	61.67	20.67
Means	0.000	0.000	0.000	1.667	5.143	17.38	27.19	------
LSD 0.05	Treatments (A)= 0.9978			Time applications (B)= 1.054				
	A×B= 2.790							

Table 3. The effect of coating application treatments on fruit weight loss (g) in the post-harvest stage of Wonderful pomegranate fruits (2020-2021/ 2021-2022).

treatments	Storage periods (Weeks)						Means
	fruit weight loss (g) (2020-2021)						
	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	2.110	22.03	15.08	17.60	22.41	35.08	**19.05**
Nano Chitosan 1g/L	1.810	7.593	11.90	15.53	29.78	43.35	**18.33**
Clove oil 2%	1.920	7.763	12.87	15.33	20.43	31.04	**14.89**
Nano Clove oil 1%	1.210	7.987	11.67	13.56	17.86	30.23	**13.75**
Rosemary oil 1%	2.110	9.743	14.99	17.98	23.99	36.78	**17.60**
Nano Rosemary oil 0.5%	1.490	14.63	14.55	16.87	21.29	31.73	**16.76**
Control	3.563	11.95	17.13	24.26	33.95	44.62	**22.58**
Means	**2.030**	**11.67**	**14.03**	**17.30**	**24.24**	**36.12**	--------
LSD 0.05	Treatments (A)= 4.970			Time applications (B)= 2.901			
	A×B = 7.674						
treatments	Time applications (weeks)						Means
	fruit weight loss (g) (2021-2022)						
	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	1.720	9.357	14.84	18.84	25.90	37.76	**18.07**
Nano Chitosan 1g/L	2.207	9.763	14.12	16.31	20.37	29.53	**15.38**
Clove oil 2%	1.870	11.56	17.02	18.95	23.26	32.05	**17.45**
Nano Clove oil 1%	1.497	6.143	10.15	14.81	22.61	34.78	**15.00**
Rosemary oil 1%	7.957	10.14	14.54	16.90	21.62	31.66	**17.14**
Nano Rosemary oil 0.5%	1.683	10.39	11.65	14.34	19.76	30.32	**14.69**
Control	3.700	12.88	21.99	27.39	35.74	47.41	**24.85**
Means	**2.95**	**10.03**	**14.90**	**18.22**	**24.18**	**34.79**	--------
LSD 0.05	Treatments (A)= 6.393			Time applications (B)= 2.529			
	A×B =6.692						

Also, the incorporation of hydrophobic REO may have reduced the migration of moisture across edible coatings since moisture migration occurs primarily through the hydrophilic component of coating formulations and is influenced by the hydrophilic–hydrophobic proportion of emulsion coatings **(Antunes *et al.*, 2012)**. **Chen (2016)** reported that the weight loss of all samples increased gradually in both coated and uncoated fruit throughout the cold storage. **Arzani *et al.* (2017)** reported that chitosan from 1 to 2% significantly greater weight retention and the weight loss on stored fruit at 2˚C was lower than 5˚C.

d. Effect of coating application treatments on fruit firmness in the post-harvest stage of Wonderful pomegranate fruits.

Results of treatments in Table 4 recorded that the firmness increased as general with Nano Rosemary oil at 0.5% in the first and the second seasons. Also, all treatments were not as significant as the control treatment under study. Data of interactions recorded that the firmness fruits gave the biggest average with Nano Rosemary oil at 0.5% at zero time application also, after six weeks under study compared to the other interactions under study. Whereas the lowest average was recorded with the same treatment after three weeks in both seasons. **Banos *et al.* (2006)** reported that chitosan can extend shelf life due to its ability to form a semi-permeable coating minimizing the rate of respiration and reducing water loss. Also, **Paniagua *et al.* (2013)** reported that the fruit firmness and softening were affected by transpiration-induced water loss. Moisture loss as a state of stress can trigger a senescence-like response, which could describe or lead to firmness alterations. The reduced activity of oxidizing enzymes (pectin methyl esterase polygalacturonase and β-galactosidase) is important for the firmness of coated fruits. Another key factor that influences fruit firmness is moisture loss amid storage **(Mahfoudhi and Hamdi, 2015 and Tesfay *et al.*, 2017)**. **Arzani *et al.* (2017)** reported that chitosan from 1 to 2% significantly greater firmness on stored fruit at 2˚C was lower than 5˚C. Whereless, **Kasnazany (2018)** used potassium metabisulphite (KMS) at (0, 2 and 4) % and clove oil (CLV) at (0, 1 and 2) %. He recorded that the fruit hardness had no significant differences between all interaction treatments. **Antunes *et al.* (2012)** found that coating with rosemary essential oil increased the fruit firmness under storage and gave the highest shelf life. **Abd El-wahed *et al.* (2021)** evaluated the effect of some nutrients on the fruit quality of "Wonderful" cultivar pomegranate. The results showed that sprayed with calcium chloride at 4% followed by zinc sulfate in both seasons gave the lowest value of

loss of fruit weight from pomegranate trees compared to other treatments and control. On the other hand, data showed that sprayed with calcium chloride at 4% followed by zinc sulphate at 0.4%, copper sulphate at 0.4% and calcium chloride at 2% in both seasons gave the highest value of fruit hardness from pomegranate trees compared to other treatments and control.

Table 4. The effect of coating application treatments on fruit hardness (firmness) in the post-harvest stage of Wonderful pomegranate fruits (2020-2021/ 2021-2022).

treatments	Storage periods (Weeks)							Means
	firmness (2020-2021)							
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	8.500	7.150	7.100	6.557	4.850	8.950	9.700	**7.544**
Nano Chitosan 1g/L	8.500	7.150	6.670	6.400	6.250	8.650	9.550	**7.596**
Clove oil 2%	8.800	7.827	6.017	5.700	7.050	7.900	9.450	**7.535**
Nano Clove oil 1%	8.050	8.050	7.800	6.300	6.850	7.950	10.45	**7.921**
Rosemary oil 1%	8.077	7.717	7.717	6.827	8.300	8.350	8.817	**7.886**
Nano Rosemary oil 0.5%	7.850	7.000	7.000	5.527	7.727	9.800	11.95	**8.122**
Control	7.550	6.600	6.600	7.200	7.327	8.300	8.650	**7.461**
Means	**8.189**	**7.356**	**6.986**	**6.359**	**6.908**	**8.557**	**9.795**	------
LSD 0.05	**Treatments (A)=** 0.6981			**Time applications (B)=** 0.5714				
	A×B= 1.512							
treatments	Time applications (weeks)							Means
	firmness (2021-2022)							
	zero	1st	2nd	3rd	4th	5th	6th	
Chitosan 2 g/L	7.550	7.500	7.200	5.650	7.800	8.477	8.500	**7.525**
Nano Chitosan 1g/L	9.477	8.100	7.550	7.167	4.900	8.317	8.527	**7.720**
Clove oil 2%	9.750	8.700	7.100	6.950	5.510	7.650	7.827	**7.641**
Nano Clove oil 1%	9.100	7.727	7.650	7.557	6.850	6.927	12.00	**8.259**
Rosemary oil 1%	9.327	8.450	7.900	6.150	6.450	9.600	11.50	**8.482**
Nano Rosemary oil 0.5%	8.950	8.427	8.000	7.700	7.650	9.900	11.45	**8.868**
Control	8.050	7.500	7.500	4.800	6.700	6.850	8.300	**7.100**
Means	**8.886**	**8.058**	**7.557**	**6.568**	**6.551**	**8.246**	**9.729**	------
LSD 0.05	**Treatments (A)=** 0.7017			**Time applications (B)=** 0.5786				
	A×B= 1.531							

Conclusion

Recently, the agriculture sector aimed to produce foods using natural products, which is considered more useful for ecology maintenance. The obtained results are more useful for promoting and enhancing the growth parameters in horticultural sectors. In applying post-harvest under storage, the fruits recorded great results under this study in both seasons when using Nano Rosemary 0.5% in all chemical and physical characteristics of fruits compared to the control treatment and the other treatments with interaction from time applications.

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تأثير معاملات التغطية بالشيتوزان وبعض الزيوت الطبيعية بأشكالها العادية والنانوية على ثمار الرمان صنف وندرفول تحت التخزين البارد

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أجري هذا البحث على اشجار الرمان صنف الوندرفل النامية بمزرعه المركز القومي للبحوث خلال موسمين (2020−2021) و (2021−2022). تهدف هذه الدراسة إلى معرفة تأثير بعض المواد الطبيعية والكيميائية على ثمار الرمان وندرفل أثناء فترة التخزين مع زيادة قيمتها الغذائية والتسويقية وفترة عرضها. بعد الحصاد نقلت الثمار الي مخازن التبريد التابعة لقسم الزراعة بجامعة القاهرة. وتم ترتيب المعاملات وفقا للتصميم العشوائي التام متضمنة سبع معاملات طلاء بعد الحصاد على ثمار صنف الرمان الرائع تحت التخزين المبرد عند درجة حرارة 7°م ورطوبة نسبية 90%، كل المعاملات ثلاث مكررات. تمت معاملة ثمار الرمان وندرفل قبل التخزين بسبعة معاملات على النحو التالي: شيتوزان 2جم/لتر، نانو شيتوزان 1جم/لتر، زيت القرنفل 2%، زيت القرنفل النانو 1%، زيت إكليل الجبل 1% وزيت إكليل الجبل النانو 0.5% بالأضافة لمعاملة الكنترول. تم تنفيذ المعاملات خلال ستة أسابيع بإضافة هذه المواد إلى ثمار الرمان عن طريق الطلاء بعد الحصاد. أثبتت النتائج أن نانو إكليل الجبل 0.5% أظهر أعلى القيم معنويا في جميع الصفات الكيميائية والطبيعية للثمار مقارنة بمعاملة الكنترول والمعاملات الأخرى.