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Impact of Propolis and Chitosan Applications on Keep Quality of Baladi Orange during Marketing at Room Temperature

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Abstract: Baladi Oranges are widely consumed, whether fresh or in juice, for healthy nutrition, but the long storage period reduces the quality characteristics of the fruits. To save antioxidant effects in orange under storage. Chitosan and propalis in different concentrations on pre-harvest and post-harvest were studied. On the first subject of study, two weeks before harvest on the orchard in the Aga Region, the fruits were sprayed with chitosan 1%, chitosan 2%, propalis 1%, propalis 2%, acetic acid 5% (to review the outcomes were for chitosan or acetic acid as a solvent), ethanol 6% (to review the vestige were form propalis or for ethanol as a solvent). The second subject was dipping fruit after harvest with looks like solutions to compare the best spraying fruits before harvest or treatment it by dipping after harvest. In the two trials, fruits were harvested on the same day and in the same orchard at the physiologically mature stage with uniform appearance and without disease. The rustles declared the effects were chitosan and propolis, not acetic acid or ethanol. Rustles revealed that coating fruits for storage are better than treating them before harvest. The optimum treatment for good quality was propalis at 2%.

Key words: Chitosan, Propolis, Acetic acid, Ethanol, Orange, fruit quality.

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1. Introduction

Fresh fruits are highly liable to corruption when harvested, and when dealing with it utilize convenient technologies to extend at shelf life to excellent quality. (**Jafarzadeh, *et al.*, 2021**). Reducing losses and waste on fresh fruits and vegetables can help decrease the stress on food regulation within the situation of limited natural resources and climate change (**Nicastro and Carillo, 2021**).

Moreover, increased consumer information on pesticide residues in the food, has motivated the search for natural and friendly environmental substitution strategies to control pre-harvest and postharvest illness (**Rayees *et al.*, 2013**). Edible coatings have antifungal properties to protect vegetables and fruits from postharvest decay-causing fungi. Chitosan has been assured edible coating and safe protective for various food types because of its forming film properties, antimicrobial actions, and biochemical and biodegradability properties. Chitosan has significance for the plant to its safeguard as a fungicide, naturalistic, and its use worldwide for storage, fruits, and vegetables.

Chitosan hydrochloride was established in 2014 as a vital material for plant defense by the European Union (Reg. EU 2014/563) and (Reg. EU 2022/456 in 2022 (**Romanazzi *et al.*, 2022).**

Bee propolis has been recognized for a long era and used in national medicine. It is a product that comes from honeybees and consists of a resinous mixture with a complex chemical structure affected by different factors like vegetation, environmental conditions, climate zones, and season (**Silva *et al.*, 2015**). The propolis components are changeable depending on many factors, convergently 50% resin, 30% wax, 10% essential oils, 5% pollen, and 5% another organic component (**Falcao *et al.*, 2010**). Some of the biological features of propolis indicated by researchers are antibacterial, antifungal, antitumor, anti-inflammatory antiviral, immunomodulatory antioxidant, and antiprotozoal (**Daleprane and Abdalla, 2013; Ramos and Miranda 2007and Silva *et al.*, 2015**).

The study aims to prolong the marketing period of orange fruits while preserving vitamin C through the use of natural materials such as chitosan and propalis in an attempt to research new waxing materials that are at the same time anti-microbial and anti-viral.

2. Materials and Methods

The study was performed through the 2021 and 2022 seasons on Baladi Orange to survey the impact of chitosan and propalis in two concentrations as pre-harvest and postharvest treatments on conserving the quality of Baladi orange during marketing at room temperature. Treatments were Chitosan 1%, Chitosan 2%, Propalis 1%, Propalis 2%, Acetic acid 5% (to review the results from Chitosan or for Acetic acid as a solvent), and Ethanol 6% (to review the outcome from Propalis or for Ethanol as a solvent).

This study has two parts; the first part was the pre-harvest study, where fruits were sprayed two weeks before harvest. Second part: Dipping fruits on the solutions looks like used in the first part. The fruits for both parts came from particular orchards in the Aga Region, Dakahlia governate. Fruits were sent to the Experimental laboratory of Mansoura Research Station after harvest. Each part involves seven treatments, each with three replicates. Fruits were treated by dipping into the respective solution for 5 min and allowed to air dry with the assistance of a standing fan, at next, the fruits were packed in plastic boxes every box containing (2 kg) and kept at room temperature (24°C).

Chitosan was provided from El-Gomhouria Company for Drugs. Chitosan solutions were prepared in two levels 1% and 2%. Each level was come by solving 10 gm and 20 gm chitosan in 100 mL of acetic acid 5%, and solutions were completed to 1000 ml by distilled water.

Propolis was bought from a local market. Propolis in two concentrations was made by solving 10 gm and 20 gm in 100 ml ethanol 70% and completing the solutions to 1000 ml with distilled water.

In the two studies, the fruits harvest on the same day and in the same orchard at the physiologically mature stage with uniform appearance and without disease. Measuring traits of fruit quality was done during the storage period. Quality properties included the chemical and physical tests, made on harvest day, 7, 14, 21, and 28 days for each treatment.

2.1. Weight loss

Weight loss was determined by the following equation:

$$\text{Weight loss (\%)} = [(W1-W2)/W1] \times 100$$

W1 = fruit weight at harvest day while W2 = weighted fruit after storage intervals. **(A.O.A.C., 2000)**

2.2. Firmness (Kg/cm^3)

Firmness was estimated at two different sites to assess the force for breakthrough using a hand-held fruit firmness tester.

2.3. Decay (%)

Decay (%) = (Decayed fruit / Total fruit) X 100

2.4. Respiration rate (RR)

Production of Co_2 in orange was measured after 10 hrs from treatments and then every seven days.

The air flowing through concentrated sodium hydroxide to ensure that airflow was off on carbon dioxide before passing into a 1-liter jar fruit container (fruit ambient) 1 fruit/ jar was considered one replicate. The air was influx was into 100 ml. NaOH of 0.1 N for an hour. Such solution was calibration against 0.1 N HCl, and levels of Co_2 production by the fruits were calculated as mg Co_2 /kg fruits/h **(A.OA.C., 2000).**

2.5. Juice weight (%)

Juice weight percentage = Juice weightiness (ml) / Fruit weightiness (g) X 100

2.6. Total soluble solid (TSS)

Estimated with a hand refractometer suggested **(A.OA.C., 2000).**

2.7. Total acidity (%)

The total acidity percentage was measured as citric acid by titrating with 0.1 N NaOH according to **(A.OA.C., 2000)**

2.8. Ascorbic acid content

Ascorbic acid was methodized by using the 2, 6- dichloroindophenol method **(A.OA.C., 2000).**

2.9. Statistical analysis

The trial was in a completed randomized design (CRD). The results obtained were subjected to analysis of variance (ANOVA) at $P< 0.05$ level of significance using AGRES software **(Gomez and Gomez, 1984).**

3. Results and Discussion

3.1. Loos in weight (%)

The loss in weight percentage of Baladi Orange fruits shown in Tables 1 and 2**,** increased gradually over time. After a week of storage, the loss in weight was significantly higher in control samples than in treated fruit. The effects of chitosan or propolis are more evident than control or acetic acid and ethanol. The highest loss in weight was for the untreated (control) followed by ethanol and acetic acid. Although acetic acid and ethanol were disinfectants, they did not reduce weight loss like chitosan and propolis. Chitosan and propolis have perfect effects for reducing loss in weight. Results also showed that chitosan is better than propalis while a 2% concentration is slightly better than the concentration of 1%. Also, dipping fruits after harvest saves fruits longer than spraying fruits before harvest. Oranges, non-climacteric fruit, have a lowered respiratory rate after harvesting, which is sufficient to continue the transpiration process, resulting in water loss and, as a result, diminished brightness (**Chitarra and Chitarra, 2005).** These results are logical because respiration and transpiration have a fundamental role in the weight loss of fruits during storage **(Maftoonazad *et al.*, 2008).** Chitosan can create a semipermeable impediment against the activity of gases (oxygen, carbon dioxide) and moisture. The decreased loss in weight by using chitosan is also related to the eclectic barrier forming around the fruit surface, which slows moisture loss and lowers respiration (**Baldwin *et al.*, 1999**). Also (**Silva *et al.*, 2015**) reported that propolis content with high phenolic condensation is eligible for making a bio-impediment on fruit surfaces that stops the activity of gaseous and water through the surface of the food and lowers the loss in weight to the characteristics of propolis about the protection of respiration and transpiration. , **(Ali *et al.*, 2014)** noted that ethanol, which is the resolution used for propalis, alone provided a plug at stomata and produced decreasing transpiration and respiration conclusion in weight loss. Using ethanol alone does not affect the fruit quality due to its volatile nature (**Gabler *et al.*, 2005**). That explains why weight loss was higher in spray treatment than in coating treatment.

Table (1). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on loss in weight percentage on season 2021

Loss in weight (%) Season 2021												
Season	**Spray**						**Dipping**					
Treatments	**Period in days**											
	H	**7**	**14**	**21**	**28**	**Mean**	**H**	**7**	**14**	**21**	**28**	**Mean**
Chitosan 1%	0.0	4.61	7.26	11.0	15.27	**7.62 d**	0.0	3.41	5.92	9.40	15.47	**6.84 d**
Chitosan 2%	0.0	4.30	6.83	10.22	14.62	**7.19 e**	0.0	3.36	6.15	9.18	14.20	**6.57 e**
Propalis 1%	0.0	4.46	8.26	13.16	18.73	**8.92 b**	0.0	3.86	6.79	8.50	15.15	**6.86 d**
Propalis 2%	0.0	5.11	7.32	10.47	17.58	**8.09 c**	0.0	3.29	6.69	9.76	15.33	**7.01 d**
Acetic acid 5%	0.0	2.19	5.13	9.46	13.63	**6.08 f**	0.0	4.56	8.50	12.01	18.50	**8.71 b**
Ethanol 6%	0.0	4.36	8.35	11.03	21.79	**9.10 b**	0.0	4.96	7.92	11.20	17.86	**8.38 c**
Control	0.0	3.65	6.25	14.09	26.74	**10.21 a**	0.0	5.06	9.76	16.12	23.06	**10.80 a**
Means	**0.0 e**	**4.09 d**	**7.06 c**	**11.34 b**	**18.34 a**		**0.0 e**	**4.07 d**	**7.39 c**	**10.88 b**	**17.08 a**	

Table (2). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on loss in weight percentage on season 2022

Loss in weight (%) Season 2022												
Spray							**Dipping**					
Treatments	**Period in days**											
	H	**7**	**14**	**21**	**28**	**Means**	**H**	**7**	**14**	**21**	**28**	**means**
Chitosan 1%	0.0	4.10	6.91	10.76	14.91	**7.33 d**	0.0	3.19	5.85	10.92	16.53	**7.30 cd**
Chitosan 2%	0.0	3.98	6.69	10.18	14.39	**7.05 e**	0.0	3.24	5.93	10.57	15.70	**7.09 d**
Propalis 1%	0.0	4.24	7.86	12.44	18.43	**8.59 b**	0.0	3.50	6.90	10.83	16.72	**7.59 c**
Propalis 2%	0.0	4.85	7.16	10.90	16.91	**7.96 c**	0.0	3.08	6.66	10.44	16.25	**7.29 cd**
Acetic acid 5%	0.0	3.34	4.79	8.95	12.99	**6.01 f**	0.0	4.08	7.58	11.57	17.45	**8.13 b**
Ethanol 6%	0.0	4.00	7.96	10.87	20.07	**8.58 b**	0.0	4.37	7.83	10.93	17.83	**8.19 b**
Control	0.0	3.37	5.45	13.55	23.06	**9.08 a**	0.0	4.59	8.87	15.28	22.40	**10.22 a**
Means	**0.0 e**	**3.98 d**	**6.68 c**	**11.08 b**	**17.25 a**		**0.0 e**	**3.72 d**	**7.09 c**	**11.50 b**	**17.55 a**	

3.2. Decay percentage

Microbial decay caused by fungi or bacteria is a noteworthy issue for the postharvest storability of the food products, *Penicillium italicum* Wehmer (blue mold) was known to cause up to 80% loss in citrus fruits (**El-Otmani *et al.*, 2011**) Statically, from Tables 3 and 4 for the two seasons of the study found the control and ethanol treatment are the highest value of decayed fruits compared with other treatments. Similarly, loss in weight percentage for dipping fruits in propolis 2% after harvest is better

than spraying fruits two weeks before harvest; it is slightly near to dipping fruits in chitosan 2%. Also, dipping fruits in chitosan 1% was close to dipping propolis 1% in two seasons. Chitosan consistency of bergamot oil products an efficiency as an antimicrobial, and showed the most restraint of the respiration values in both O2 consumption and CO2 descent **(Sánchez-González *et al.*, 2011).** Chitosan contains antimicrobial effectiveness to decay caused by fungi, by the semipermeable film produced on a treated surface (**Romanazzi, *et al.*, 2018**). Chitosan has vast field antimicrobial resistance and effects on the extent of postharvest fungal pathogens (**Rajestary *et al.*, 2021**). Propolis contains many antifungal compounds that have activity against fungus that may inhibit mycelium growth and spore germination (**Oadi, 2015**). In the literature, the mechanisms were suggested (**Ali *et al.*, 2014; Al-Qurashi and Awad 2018**) The effect of propalis on microbes is through (1) a direct effect on pathogens, preventing some biological interactions (2) enhancing resistance to the production of pathogens by improving some biological interactions.

Table (3). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on decay percentage season 2021

Decay (%) Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	0.0	0.0	3.16	4.86	6.36	**2.88 c**	0.0	0.0	1.80	3.73	5.12	**2.13 cd**
Chitosan 2%	0.0	0.74	3.71	5.73	7.50	**3.53 b**	0.0	0.0	0.89	3.45	5.49	**1.96 cd**
Propalis 1%	0.0	0.0	2.53	3.13	5.58	**2.25 d**	0.0	0.0	0.33	3.35	6.71	**2.08 cd**
Propalis 2%	0.0	0.0	1.95	4.00	8.16	**2.82 c**	0.0	0.0	0.00	3.76	4.40	**1.63 d**
Acetic acid 5%	0.0	0.0	1.42	3.43	5.18	**2.00 d**	0.0	0.0	1.08	4.66	8.67	**2.88 ab**
Ethanol 6%	0.0	0.0	3.50	5.66	8.60	**3.55 b**	0.0	0.0	1.20	3.83	6.72	**2.35 bc**
Control	0.0	2.33	2.40	6.51	10.90	**3.43 a**	0.0	0.66	2.18	4.00	8.66	**3.10 a**
Means	**0.0 e**	**0.44 d**	**2.66 c**	**4.76 b**	**7.46 a**		**0.0 d**	**0.09 d**	**1.07 c**	**3.83 b**	**6.54 a**	

Table (4). The effect of chitosan and propalis in different concentrations on pre-harvest and postharvest for Baladi Orange on decay percentage season 2022

Decay (%) Season 2022												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	0.0	0.33	2.91	4.63	6.62	**2.90 c**	0.0	0.0	1.26	3.83	5.21	**2.06 d**
Chitosan 2%	0.0	0.0	2.48	4.45	7.01	**2.78 c**	0.0	0.66	1.64	3.41	5.35	**2.21 cd**
Propalis 1%	0.0	0.85	2.27	3.38	6.00	**2.50 e**	0.0	0.0	0.52	3.45	6.47	**2.09 d**
Propalis 2%	0.0	0.68	1.70	3.70	7.22	**2.66 d**	0.0	0.0	0.69	3.48	4.36	**1.70 e**
Acetic acid 5%	0.0	0.66	1.33	3.86	5.45	**2.26 f**	0.0	0.0	1.35	4.33	8.45	**2.82 b**
Ethanol 6%	0.0	0.79	2.83	5.33	8.45	**3.48 b**	0.0	0.0	1.48	4.16	6.59	**2.44 c**
Control	0.0	1.59	2.63	6.61	10.80	**4.32 a**	0.0	0.55	2.29	4.18	9.00	**3.20 a**
Means	**0.0 e**	**0.70 d**	**2.31 c**	**4.56 b**	**7.36 a**		**0.0 d**	**0.17 d**	**1.32 c**	**3.83 b**	**6.49 a**	

3.3. Firmness (Kg/cm^3)

Fruit firmness is a widely serious physical consideration to evaluate the advance of maturity. The firmness of fruit is an index of ripeness degree because it was known as the force required to break the flesh tissues. It is associated with various ripening stages. From Tables 5 and 6 the fruit firmness decreased significantly after seven days of storage. There are no significant differences between spraying treatments before and after harvest. Chitosan 2% is the best treatment for good rigidity followed by propolis 2%, the lowest value was for untreated treatment. Ethanol treatment can be stable to the insoluble pectic substance, which prevents the degradation of pectin by pectinmethylesterase (PME) and polygalacturonase (PG) (enzymes responsible for softening of fruit), **(Ali *et al.*, 2012)**

Firmness lowering after harvest can be related to cell wall deterioration and loss of turgor pressure. (**Perdones *et al.*, 2014 and Mebratie *et al.*, 2015**). While, (**Salunkhe *et al.*, 1991**) indicated that decreases due to the low rate of respiration caused by chitosan coating, doing a barricade to gaseous exchange along the fruit surface. Transpiration due to loss of water results in loss of turgidity and cell wall breakdown due to enzymatic activities in the end fruits were soft (**Kweon *et al.*, 1998**). The same action was done by propolis as suggested (**Martínez *et al.*, 2020 and Valencia *et al.*, 2009**) coating adjusted the fruit interior gas composition by creating an impediment to gases, also pointed out that the influence of coatings on fruit firmness is not only vassal on the coating composition but also on correlative the type of citrus is also influential are also influential, in mandarins are better than in oranges. Observation by (**Ramadhani *et al.*, 2018)** on the hardness of the mesocarp and the endocarp showed that the level of the degradation of the mesocarp was higher than the endocarp. Although propolis coating did not prevent degradation of the exocarp, it maintained the hardness of the mesocarp. The higher level of loss of the mesocarp and the endocarp firmness in the control group could be caused by higher respiration rate and attack by microbe and fungi as infestation by fruit flies as showed by the result of morphological changes **(Atkinson *et al.*, 2012 and Maqbool *et al.*, 2011)**.

Table (5). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on firmness (kg/cm^3) Season 2021

Firmness (kg/cm3) Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	mean
Chitosan 1%	2.70	2.73	2.80	2.90	3.03	**2.83 a**	2.60	2.66	2.80	3.46	4.73	**3.25 bc**
Chitosan 2%	2.70	2.76	2.83	2.96	3.06	**2.86 a**	2.60	2.63	2.76	3.33	5.00	**3.26 bc**
Propalis 1%	2.70	2.80	2.86	3.00	3.00	**2.87 a**	2.60	2.74	2.93	3.60	4.90	**3.35 bc**
Propalis 2%	2.70	2.80	2.86	2.96	2.96	**2.86 a**	2.60	2.66	2.80	3.20	4.66	**3.16 c**
Acetic acid 5%	2.70	2.76	2.80	2.93	3.13	**2.86 a**	2.60	2.66	2.86	3.80	5.00	**3.38 b**
Ethanol 6%	2.70	2.76	2.86	2.93	3.16	**2.88 a**	2.60	2.50	2.73	3.90	5.26	**3.40 b**
Control	2.70	2.70	2.73	2.96	3.26	**2.87 a**	2.60	2.43	2.73	3.76	7.00	**3.70 a**
Means	**2.70 d**	**2.76 cd**	**2.82 c**	**2.95 b**	**3.09 a**		**2.60 d**	**2.61 d**	**2.80 c**	**3.58 b**	**5.22 a**	

Table (6). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on firmness (kg/cm3) Season 2022

Firmness (Kg /cm^3) Season 20.22												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	2.70	2.76	2.86	2.93	3.10	**2.87 a**	2.60	2.63	2.83	3.66	4.66	**3.24**
Chitosan 2%	2.70	2.86	2.93	3.10	3.00	**2.91 a**	2.60	2.70	2.80	3.53	5.03	**3.33**
Propalis 1%	2.70	2.86	2.80	3.20	3.10	**2.93 a**	2.60	2.76	2.86	3.73	5.13	**3.39**
Propalis 2%	2.70	2.76	2.93	3.06	3.06	**2.90 a**	2.60	2.73	2.93	3.33	4.80	**3.26**
Acetic acid 5%	2.70	2.80	2.86	2.93	3.16	**2.89 a**	2.60	2.73	2.96	3.83	5.00	**3.40**
Ethanol 6%	2.70	2.76	2.90	2.90	3.23	**2.89 a**	2.60	2.63	2.90	3.83	5.20	**3.42**
Control	2.70	2.83	2.96	3.10	3.33	**2.98 a**	2.60	2.60	3.03	4.00	6.30	**3.70**
Means	**2.70 a**	**2.80 a**	**2.89 a**	**3.03 a**	**3.14 a**		**2.60 d**	**2.68 d**	**2.90 c**	**3.70 b**	**5.16 a**	

3.4. Respiration Rate

The respiration of the fruits is vital for physiological metabolic efficiency during their growth and development, and ripening is the first index to referee the convenient storage life of horticultural crops. (**Lado *et. al.*, 2018 and Saberi *et al.*, 2018**). As illustrated in Tables (7 and 8) the first note that coating fruits after harvest for having acceptable fruit quality was for coating fruits after harvest, the respiration rate decreased gradually at 14 days after storage and recovered in the subsequent storage period. During storage, the respiration rate of coated fruits (Chitosan or propolis) was lower respiration rates compared to the control, which could be due to their effect on gas exchange (CO_2 accumulation and O_2 decrease) and modification in the interior atmosphere of the fruit **(Arnon *et al.*, 2014).** Acetic acid and ethanol alcohol cause volatilization, whether when treating the fruits before collecting or coating them after collecting, which gives similar results to the control, and there is no effect on gas exchange and reducing respiration. (**Ganduri, 2020**). A similar adjustment done by porpalis **(El-Ramady *et al.*, 2015)** declared that the coatings Chitosan are a biopolymer can shape a semipermeable cover fruit that reduces respiration average by adjusting the permeability of O2 consumption and CO2 production and increases the activity of antioxidant stimulate changes in the gas exchange between the product and the environment, which could make some reduction in the production of the changeful substances responsible for the sensory characteristics. Edible coatings like Propalis, paraffin, carnauba wax, vegetable and mineral oils, and others were formed of polysaccharides, lipids, and proteins. Such materials promote the production of a modified environment on the surface of the fruit, allowing edible coatings to replace plastic ones. As a result, a semipermeable barrier to water vapor and gases was composed. They also allow for the introduction of chemicals like antioxidants and antimicrobials, which are pivotal in maintaining the mechanical safety of plants **(Antonio *et al.*, 2023).**

Table (7). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on respiration rate season 2021

Respiration (mg CO2 kg−1 h−1) Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	Mean
Chitosan 1%	9.80	7.88	7.47	6.89	8.71	**8.15 d**	10.78	7.85	8.24	8.61	9.28	**8.89 a**
Chitosan 2%	9.91	8.33	7.67	7.30	8.45	**8.33 d**	10.78	7.60	7.71	7.96	8.28	**8.46 a**
Propalis 1%	10.78	7.40	6.66	6.34	7.48	**7.73 e**	10.78	7.53	7.19	7.42	7.81	**8.14 a**
Propalis 2%	10.22	7.80	7.51	7.09	8.47	**8.22 d**	10.78	8.34	8.69	8.10	9.51	**9.88 a**
Acetic acid 5%	12.12	9.38	8.93	8.36	9.84	**9.72 b**	10.78	10.13	10.72	11.39	12.16	**11.04 a**
Ethanol 6%	11.86	6.31	7.15	8.88	10.33	**8.90 c**	10.78	8.86	9.18	10.65	11.26	**9.74 a**
Control	12.42	10.35	9.76	10.4	12.44	**11.07 a**	10.78	11.08	11.50	12.65	13.76	**11.95 a**
Means	**11.01 a**	**8.20 c**	**7.88 d**	**7.89 d**	**9.39 b**		**10.78 a**	**8.77 a**	**9.17 a**	**9.68 a**	**10.27 a**	

Table (8). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on respiration rate season 2022

Respiration (mg CO2 kg−1 h−1) Season 2022												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	Means
Chitosan 1%	10.0	7.79	8.38	7.95	8.29	**8.48 b**	11.33	8.40	8.61	9.03	9.12	**9.36 d**
Chitosan 2%	9.96	8.37	8.00	7.74	8.23	**8.46 b**	11.33	8.17	8.39	8.81	9.17	**9.21 d**
Propalis 1%	10.66	7.12	6.73	6.85	7.36	**7.75 d**	11.33	8.40	8.66	9.01	9.43	**9.36 d**
Propalis 2%	10.26	7.51	7.03	6.67	7.27	**7.74 d**	11.33	7.48	7.72	8.05	8.45	**8.60 e**
Acetic acid 5%	10.54	7.64	7.36	7.48	8.04	**8.21 c**	11.33	10.22	10.55	11.00	11.79	**10.97 b**
Ethanol 6%	10.74	6.23	5.93	6.40	6.90	**7.24 e**	11.33	8.78	9.09	9.73	10.55	**9.92 c**
Control	10.82	8.85	8.53	8.91	9.61	**9.34 a**	11.33	11.78	12.37	13.16	14.11	**12.55 a**
Means	**10.43 a**	**7.64 c**	**7.42 d**	**7.43 d**	**7.95 b**		**11.33 a**	**9.03 e**	**9.34 d**	**9.84 c**	**10.45 b**	

3.5. Juice Weight Percentage

Orange juice is a large root of minerals, vitamins, flavonoids, phenolic acids, benzoic, and other bioactive compounds. These compounds have positive benefits for chronic diseases like cancer and arteriosclerosis **(Habibi and Ramezanian, 2017).** So, it is most substantial to collocate Juice weight (%) duration storage. Juice (%) of fruits under storage illustrated in Tables 9 and 10 reduced considerably with the prolonged storage duration during two seasons. It reaches the minimum values at the end of the storage period (4 weeks). There were significant differences between all treatments in

both seasons. Propalis 2% treated fruits had the highest value in percentage of juice; meanwhile, untreated fruits had the lowest value of juice % compared with the other treatments during the 2021 and 2022 seasons. This result agrees with (**Elaryan, 2015 and Thana *et al.*, 2017).**

Table (9). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on juice weight percentage season 2021

Juice Weight (%) 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	Mean
Chitosan 1%	93.3	94.1	90.1	82.0	75.4	**86.9 a**	87.1	88.5	87.8	86.1	82.9	**86.5 a**
Chitosan 2%	93.3	92.3	90.0	86.4	79.1	**88.2 a**	87.1	87.8	86.8	84.3	80.6	**85.3 a**
Propalis 1%	93.3	89.9	85.3	83.9	79.0	**86.3 a**	87.1	86.4	85.1	82.3	78.7	**83.9 b**
Propalis 2%	93.3	93.0	89.6	87.6	80.4	**88.7 a**	87.1	86.8	85.9	84.0	81.5	**85.0 a**
Acetic acid 5%	93.3	90.1	86.7	82.2	76.6	**85.7 b**	87.1	85.9	82.7	76.1	70.7	**80.5 c**
Ethanol 6%	93.3	92.4	88.3	84.4	79.5	**87.6 a**	87.1	85.7	80.3	73.8	67.4	**78.8 d**
Control	93.3	90.6	84.7	77.6	73.3	**83.9 c**	87.1	85.4	79.4	74.9	66.3	**78.6 d**
Means	**93.3 a**	**91.7 b**	**87.8 c**	**83.4 d**	**77.6 e**		**87.1 a**	**86.4 a**	**84.0 b**	**80.2 c**	**75.4 d**	

Table (10). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on juice weight percentage season 2022

Juice Weight (%) 2022												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	Mean
Chitosan 1%	87.1	86.4	85.8	83.5	81.7	**84.9 a**	86.1	85.8	85.0	83.3	80.7	**84.1 b**
Chitosan 2%	85.7	85.3	84.7	82.2	80.9	**83.7 b**	86.1	86.5	85.7	84.3	81.7	**85.0 a**
Propalis 1%	86.1	86.8	86.0	84.4	82.1	**85.0 a**	86.1	85.8	85.0	83.8	81.3	**84.4 b**
Propalis 2%	86.1	86.2	85.7	83.5	81.4	**84.5 a**	86.1	86.1	85.5	84.2	81.9	**84.7 b**
Acetic acid 5%	85.4	85.0	83.7	81.4	78.1	**82.7 c**	86.1	85.0	82.2	79.0	74.8	**81.4 c**
Ethanol 6%	85.4	84.8	83.7	81.3	77.8	**82.6 c**	86.1	84.4	81.3	77.2	72.4	**80.5 d**
Control	88.4	86.3	82.6	78.3	74.0	**81.9 d**	86.1	82.8	78.0	74.8	69.7	**78.3 e**
Means	**86.3 a**	**85.8 a**	**84.6 b**	**82.0 c**	**78.4 d**		**86.1 a**	**85.2 b**	**83.2 c**	**82.8 c**	**77.5 d**	

3.6. Total Soluble Solids (TSS)

In non-climacteric fruits, like oranges, chemical divergence is not very significant, after the harvest, these fruits do not present considerable alterations, either in the content of soluble solids, vitamin C, or acidity. Total soluble solids are a substantial interior quality parameter for fruits, and, according to data from this study (Tables 11 and 12), variations were not considerable in such parameters in all treatments, with little increase along the storage period, thus indicating no effect for coating treatments. This rustle agrees with (**Antonio *et al.*, 2023**) found that oranges treated with an alcoholic extract of propolis increased linearly throughout the evaluation period, with intermediate values obtained at 10 and 20 days of refrigerated storage. Similar results, in the mango fruit treated by dipping on chitosan was less soluble solids than untreated fruits. **(Candir *et al.*, 2009)** who indicated that increasing TSS is found in fruits and can be ascribed to the hydrolytic of insoluble carbohydrates into soluble sugars (**Mortazavi, *et al.*, 2010**) minimizing H2O by transpiration improves the TSS concentration.

Resolution TSS values were systematic suggested by **(Pereira *et al.*, 2014 and Vieites *et al.*, 1996)** that non-climacteric fruits do not let amount changes TSS promptly after harvest. Refrigerated therapy showed reduces in TSS values than those after control postharvest treatment due to lowering metabolic operation and respiration efficacy.

Table (11). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on T.S.S season 2021

T.S.S Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	11.0	11.1	11.2	11.0	11.1	**11.1 b**	12.0	12.5	12.5	12.7	12.9	**12.5 a**
Chitosan 2%	10.5	10.8	11.0	11.3	11.3	**10.9 c**	12.0	12.1	12.2	12.4	12.6	**12.3 ab**
Propalis 1%	10.6	10.7	11.0	11.0	11.0	**10.8 c**	12.0	11.7	12.0	12.3	12.6	**12.1 ab**
Propalis 2%	11.0	11.0	11.3	11.5	11.6	**11.3 a**	12.0	12.0	12.4	12.6	12.3	**12.2 ab**
Acetic acid 5%	10.5	10.5	10.6	11.2	11.9	**10.9 c**	12.0	11.7	11.7	11.9	12.4	**11.9 b**
Ethanol 6%	11.0	11.1	11.0	11.0	11.0	**11.0 b**	12.0	12.1	12.2	12.4	12.3	**12.2 ab**
Control	11.0	11.1	11.6	11.6	11.6	**11.3 a**	12.0	12.3	12.5	12.7	12.6	**12.4 a**
Means	**10.8 d**	**10.9 cd**	**11.1b c**	**11.2 ab**	**11.3 a**		**12.0 b**	**12.0 b**	**12.2 ab**	**12.4 a**	**12.5 a**	

Table (12). The effect of chitosan and propalis in different concentrations on pre-harvest and postharvest for Baladi Orange on T.S.S season 2022

T.S.S Season 2022												
Spray							Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	11.0	10.5	10.7	10.8	11.0	**10.8 c**	12.0	12.3	12.2	13.1	14.0	**12.5 a**
Chitosan 2%	11.0	11.0	11.2	11.5	11.6	**11.3 ab**	12.0	11.8	12.4	12.6	13.3	**12.3 ab**
Propalis 1%	11.0	10.8	11.0	11.2	11.5	**11.1 b**	12.0	11.8	12.2	12.6	13.3	**12.1 ab**
Propalis 2%	11.0	11.0	11.1	11.3	11.7	**11.2 ab**	12.0	12.0	12.2	12.9	14.0	**12.3 ab**
Acetic acid 5%	11.0	11.1	11.3	11.5	11.3	**11.2 ab**	12.0	11.3	11.7	12.1	13.3	**12.4 a**
Ethanol 6%	11.0	12.0	12.0	12.5	11.3	**11.5 a**	12.0	11.6	12.0	12.7	14.0	**12.2 ab**
Control	11.0	11.1	11.3	11.6	11.7	**11.2 ab**	12.0	11.0	11.6	12.0	12.3	**11.9 b**
Means	**11.0 c**	**11.0 c**	**11.2 b**	**11.4 a**	**11.4 a**		**12.0 b**	**11.7 c**	**12.0 b**	**12.0 b**	**13.4 a**	

3.7. Titratable acidity percentage

The titratable acidity percentage showed a moderate reduction during the storage period. After the 7th day of storage, all treatments showed (Tables 13 and 14) a significant decrease when compared with harvest day that was clear on treated treatment before harvest when compared with treated after harvest. Treated fruits after harvest had no significant differences between chitosan and propolis in two concentrations where the control had the highest decrease in acidity followed by fruits treated with acetic acid 5% and fruits treated with ethanol 6%. The low value of total acidity in the control group, relative to coating treatments, suggested that the coating late ripening provided a semi-permeable film around the fruits.

Titratable acidity evaluation of the organic acid content of the fruit can decrease during postharvest storage on account of using organic acids as a substrate for respiratory metabolism. (**Perdones *et al.*, 2014**). **(El-Ramady *et al.*, 2015)** cleared that increasing the exhaustion of organic acids by the respiratory operation and transformation to simple sugars in the postharvest treatments caused decreasing in acidity at the end of the storage time. These results agree with the detection by (**Santos *et al.*, 2015**) in avocado linear dropping in acidity caused by coating in propolis also (**Ataíde *et al.*, 2017**) in Juazeiro fruit.

Table (13). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on acid percentage season 2021

Acid (%) Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	means
Chitosan 1%	2.30	2.09	2.55	1.76	1.33	**2.00 a**	2.76	2.45	2.15	1.61	1.31	**2.05 a**
Chitosan 2%	2.30	2.20	1.68	1.40	1.48	**1.81 a**	2.76	1.96	1.57	1.29	1.03	**1.72 c**
Propalis 1%	2.30	2.84	1.96	1.51	1.42	**2.00 a**	2.76	2.27	1.82	1.47	1.18	**1.90 b**
Propalis 2%	2.30	2.55	2.02	1.71	1.59	**2.03 a**	2.76	2.35	2.00	1.56	1.23	**1.98 ab**
Acetic acid 5%	2.30	2.92	2.61	1.43	1.28	**2.10 a**	2.76	2.42	2.12	1.62	1.37	**2.06 a**
Ethanol 6%	2.30	3.33	3.24	2.65	1.82	**2.66 a**	2.76	1.78	1.53	1.19	1.27	**1.70 c**
Control	2.30	3.18	2.67	2.35	1.53	**2.40 a**	2.76	2.52	2.13	1.63	1.22	**2.05 a**
Means	**2.30 a**	**2.68 a**	**2.39 a**	**1.83 a**	**1.49 a**		**2.76 a**	**2.25 b**	**1.90 c**	**1.48 d**	**1.23 e**	

Table (14). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on acid percentage season 2022

Acid (%) Season 2022												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	means	H	7	14	21	28	means
Chitosan 1%	1.45	2.51	1.88	1.83	1.39	**1.81 a**	2.51	2.55	2.28	1.90	1.52	**2.15 a**
Chitosan 2%	1.45	2.81	2.35	1.80	1.73	**2.03 a**	2.51	2.52	2.30	1.91	1.48	**2.14 a**
Propalis 1%	1.45	2.28	1.68	1.43	1.24	**1.61 a**	2.51	2.09	1.73	1.39	1.07	**1.76 c**
Propalis 2%	1.45	2.24	1.40	1.48	1.28	**1.57 a**	2.51	2.40	2.12	1.66	1.36	**2.01 b**
Acetic acid 5%	1.45	2.33	1.76	1.55	1.45	**2.71 a**	2.51	2.39	1.99	1.64	1.19	**1.94 b**
Ethanol 6%	1.45	2.94	1.91	1.68	1.27	**1.85 a**	2.51	2.45	2.50	2.10	1.47	**2.21 a**
Control	1.45	2.98	2.06	1.61	1.42	**1.90 a**	2.51	2..64	2.22	1.77	1.22	**2.07 ab**
Means	**1.45 a**	**2.61 a**	**1.86 a**	**1.62 a**	**1.39 a**		**2.51 a**	**2.43 a**	**2.16 b**	**1.77 c**	**1.33 d**	

3.8. Ascorbic acid content

The major vitamin found in citrus fruit is ascorbic acid which is a water-soluble substance and acts as a natural, free radical scavenger, which can effectively reduce reactive oxygen species (ROS) (**Zou *et al.*, 2016**). Tables (15 and 16**)** found that there was no significant difference between treatments on the initial day. Nevertheless, in the second sampling time, Chitosan (1% and 2%) and Propolis (1% and 2%) showed the highest ascorbic acid content when application spraying or dipping. Throughout the storage period, rising ascorbic acid was found in propolis at 2% compared to the first day of storage. Finally, a significant decline was observed in the other treatments (Ethanol 6%, acetic acid 5%, and control), while there was no significant difference between them on the end day of storage. The reduction of ascorbic acid could concern the infestation of fruit by microbes and fruit flies due to the

destruction of enzymes for vitamin C production by both microbes and insect larvae activities (**Ting and Attaway, 1971).**

Coated fruit in Chitosan due to increasing ascorbic acid, that is may be caused by reducing oxygen and inhibition of respiration (**Jiang *et al.*, 2012**). In line with the present study's results, the higher level of ascorbic acid by usage Chitosan on orange by (**Antonio *et al.*, 2023**) and application CH nanoparticles on pomegranate aril (**Amiri *et al.*, 2021**) so also (**Zeb *et al.*, 2020)** on apple who determination that Chitosan casing minimize oxygen diffusion, slowing down the respiration rate, which in the end retard the deteriorative oxidation reaction of ascorbic acid of fruit. Meanwhile (**Putra *et al.*, 2018**) using porpolis in Tangerine and on orange (**Ibtesam, 2016**).

Table (15). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on ascorbic acid content season 2021

V.C mg/kg Season 2021												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Means	H	7	14	21	28	Means
Chitosan 1%	31.2	31.2	32.0	31.4	28.1	**31.1 e**	45.0	45.0	44.4	43.4	41.5	**43.8 a**
Chitosan 2%	37.0	37.0	37.0	36.2	34.5	**36.3 d**	45.0	41.2	40.9	40.0	38.3	**41.1 a**
Propalis 1%	41.8	41.7	41.3	39.5	37.4	**40.3 b**	45.0	38.3	38.0	36.9	35.0	**38.6 a**
Propalis 2%	50.5	50.7	50.2	49.2	47.1	**49.5 a**	45.0	44.5	43.7	42.3	41.0	**43.3 a**
Acetic acid 5%	50.5	50.4	50.2	49.3	47.5	**49.6 a**	45.0	44.4	43.0	41.2	38.9	**42.5 a**
Ethanol 6%	36.8	36.6	36.1	35.0	32.5	**35.4 d**	45.0	44.0	42.7	40.9	37.5	**42.0 a**
Control	40.1	40.0	40.2	37.6	33.1	**38.2 c**	45.0	44.7	43.0	39.5	36.5	**41.7 a**
Means	**41.1 a**	**41.1 a**	**41.0 a**	**39.7 b**	**37.1 c**		**45.0 a**	**43.1 a**	**42.2 a**	**40.6 a**	**38.3 a**	

Table (16). The effect of chitosan and proplis in different concentrations on pre-harvest and postharvest for Baladi Orange on ascorbic acid content season 2022

V.C mg/kg Season 2022												
	Spray						Dipping					
Treatments	Period in days											
	H	7	14	21	28	Mean	H	7	14	21	28	Mean
Chitosan 1%	40.1	40.0	42.1	40.9	38.7	**40.3 cd**	42.5	41.6	41.3	39.5	36.4	**40.3 a**
Chitosan 2%	44.9	44.9	45.2	43.7	41.4	**44.0 b**	42.5	33.7	33.8	32.0	29.0	**34.2 d**
Propalis 1%	47.0	47.0	46.1	44.4	42.7	**45.4 ab**	42.5	35.5	35.6	34.3	32.5	**36.1 c**
Propalis 2%	39.6	39.5	40.2	39.3	36.2	**38.9 d**	42.5	41.1	40.9	39.0	36.6	**40.2 a**
Acetic acid 5%	43.1	43.1	43.3	39.3	36.3	**41.0 c**	42.5	38.5	37.7	35.7	.33.1	**37.5 bc**
Ethanol 6%	38.7	38.5	38.7	35.6	31.9	**36.6 e**	42.5	41.7	40.1	37.8	34.5	**39.3 a**
Control	48.9	48.1	48.0	45.2	41.8	**46.4 a**	42.5	41.1	39.6	36.8	33.4	**38.7 ab**
Means	**43.2 a**	**43.0 a**	**43.3 a**	**41.2 b**	**38.5 c**		**42.5 a**	**39.2 b**	**38.4 b**	**36.4 c**	**33.6 d**	

4. Conclusion

Both Propolis and Chitosan gave good results in preserving the quality of Baladi Orange fruits during storage in room conditions, and the effect was due to the Propalis itself and not the solvent (ethanol alcohol). Likewise, the impact of using Chitosan solution was due to the chitosan and not the solvent (acetic acid). Due to their volatility, both acetic acid and alcohol gave results close to Treating the fruits after harvest and maintaining the quality of the fruits more than treating them preharvest reduced the effect of the corticosteroid infection, propolis was included in the prevention program. When the price of chitosan is equal to that of propolis, using propolis is better than chitosan

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