Effect of some pre-harvest treatments on the quality characteristics of semi - dry date fruits (Saidy cultivar) during storage

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ABSTRACT

This research was carried out for two successive seasons (2022 and 2023) in a private orchard located at Assiut Governorate, Egypt, to evaluate the effectiveness of propolis extract and sodium thiosulfate in maintaining the quality attributes of Saidy date palm fruits during storage. The date palms were 17 years old, grown in a sandy soil, spaced at 8 * 8 meters apart, and irrigated by the drip system. At the end of August, five pre-harvest treatments of date bunches were sprayed as follows: two concentrations of propolis (3% and 5%) and two concentrations of sodium thiosulfate (0.5% and 1%), in addition to the control treatment (spraying with water). Date bunches were stored at ambient conditions (21 ± 7°C and 60 – 70% RH) for 75 days, and the fruit quality was evaluated every 15 days. The results demonstrated that all quality analyses showed that all applied treatments outperformed the control. Sodium thiosulfate at 1% and propolis extract at 5% were more effective than various treatments Saidy date fruits last longer by lowering the number of fungi, slowing down physiological and weight loss as well as decay. It is delaying changes in total soluble solids, total acidity, as well as total sugars during 75 days of storage at room temperature (21 ± 7°C and 60 – 70% RH) in both seasons.

Keywords: Saidy cultivar- Propolis- Sodium thiosulfate- Storability.

INTRODUCTION

Date palm (*Phoenix dactylifera* L.) is one of the most important fruits in dry and semi-arid areas (Chao and Krueger, 2007). Dates are an excellent source of quickly available energy because of their high carbohydrate content and abundance in specific nutrients (El-Shibli and Korelainen, 2009). Furthermore, they contain a substantial source of polyphenols, such as proanthocyanidins, flavonoid glycosides, hydroxycinnamates, and phenolic acids (Hong et al., 2006), essential minerals and vitamins (Chaira et al., 2009), as well as protein, dietary fiber, and fat (Mrabet et al., 2012). Manickavasagan et al. (2014) classify the maturity stages of dates into Khalal, Rutab, and Tamr based on their physiological development. According to their fruit moisture content, date palm cultivars can be classified into three main types: soft, semi-dry, and dry (Selim et al., 1970). Dates are marketed in according to market demands and for longer periods than the typical season, in order to achieve a good return, it might be necessary to preserve them (Hafez et al., 2012). In accordance with Ramadan et al. (2016), "Saidy" is the most significant semi-dry cultivar grown in Egypt and consumed at the fully mature stage of maturity. The cosmopolitan distribution of fungi both outdoors and indoors, particularly in environments with high moisture availability (more than 60%), contributes significantly to their contamination of date palm (Abass, 2013). Fungal contamination causes an increase in date turbidity, a modification in pH and cell decay (Hameed and Abass, 2006). *Aspergillus sp.*, *Penicillium sp.*, and *Alternaria* sp. are common contaminants of the fungal genera that affect date palm (Abass et al., 2007 and Al-Mayahi et al., 2010). These are cosmopolitan saprophytic fungi with a wide range of hydrolytic and

oxidative enzyme activity that enables them to grow in several food sources and decay them in good moisture (Schuster et al., 2002). Researchers have found and isolated all these fungi from plant debris, soil, humans, air, and walls, explaining their high contamination of date palms in preparation rooms, incubation rooms, and both indoor and outdoor laboratory air (Odutayo et al., 2007).

Numerous authors have reported the benefits of pre-harvest treatments in preserving fruit quality and extending storage period (Rahman et al., 2018, Abu-Shama et al., 2020, Ahmed et al., 2021 and Kumarihami et al., 2021). Dates stored at high temperatures and high humidity are vulnerable to insect infestation and microbiological damage, which result in significant losses. The primary fumigant for treating products that have been kept but are still accessible is methyl bromide (Azelmat et al. 2006). The Montreal protocol has designated it as an ozone-depleting compound (UNEP, 1992) because of its detrimental effects on the environment and human health. The limited usage of this substance emphasizes how urgently an alternative treatment is needed. Nowadays, there are a lot of additional efficient date preservation techniques. The other preservation techniques are too costly and would require careful thought.

Honeybees naturally produce propolis, also known as bee glue, from various plant exudates (Candir et al., 2009). Many biological activities, including antibacterial, antiviral, and antifungal properties, have led to its use in pharmacological applications (Valente et al., 2011). In addition, it contains complex chemical compounds that include 10% volatile oils, 30% waxes, and 60% resinous compounds, balsams, as well as pollen grains, which are abundant in vital elements including calcium, zinc, iron, magnesium, and nickel (El-Deeb, 2017). The effectiveness of propolis application in maintaining fruit quality during storage has been demonstrated in recent studies (Badawy, 2016, Passos et al., 2016, Kahramanoglu et al., 2018, Abd Elwahab et al., 2019 and Abd Elgawad, 2021).

Sulfur dioxide (SO_2) is a common postharvest fumigant that effectively reduces polyphenol oxidase (PPO) activity (Sivakumar and Korsten, 2006). Sulfur dioxide derivatives, including potassium metabisulfite, sodium bisulfite, and sodium thiosulfate, are inorganic salts that serve as an alternative to SO_2 fumigation, releasing SO_2 gradually (Sivakumar et al., 2010). Researchers (Vijayanand et al., 2000, Liang et al., 2012, Kamel et al., 2015 and Shawky et al., 2020) showed that the fruit storage period can be exhibited by using these compounds to control postharvest diseases like decay. The aim of this study is to evaluate the effectiveness of propolis extract and sodium thiosulfate in maintaining the quality attributes of Saidy Date fruits during storage.

MATERIALS AND METHODS

Fruit material:

This research was carried out for two successive seasons (2022 and 2023) in a private orchard located at Assiut Governorate, Egypt to evaluate the effectiveness of propolis extract and sodium thiosulfate in maintaining quality attributes of Saidy date fruits during storage. The date palms were 17 years old, grown in a sandy soil, spaced at 8 x 8 meters apart and irrigated by a drip system. Fifteen date palms with uniform vigor and in good physical condition, free of insect damage and diseases were selected. The involved date palms received the standard horticulture practices.

Preparation of pre-harvest applications:

Propolis extract

Propolis samples used in this work were collected from the apiary of the Faculty of Agriculture, Assiut University, by scraping the walls and frames of the hives. Propolis

extracts prepared as follows: 900 milliliters of 70% ethanol were mixed with 100 grams of propolis that had been frozen to -18 degrees Celsius, chopped into small pieces, and ground in a cold mortar. The mixture was then progressively heated in a water bath at 70 degrees Celsius for 24 hours. The extract was filtered and kept in a refrigerator unit use (Boeru and Derevici, 1978). In order to produce the 3% and 5% propolis extracts, the 10% propolis solution was diluted with 70% ethanol in the appropriate amounts.

Sodium Thiosulfate:

Sodium Thiosulfate (STS) was purchased from Sigma-Aldrich Company. By dissolving 1.58 g of STS in 100 ml of water, a 0.1 M STS stock solution was obtained. The stock solution was kept out of the light until the STS was ready (Sudaria et al., 2017).

Pre-harvest applications:

At the end of August, five pre-harvest treatments of date bunches were sprayed as follows:

1) Tap water (control)
2) Propolis at 3%
3) Propolis at 5%
4) Sodium thiosulfate at 0.5%
5) Sodium thiosulfate at 1%

Post-harvest measurements:

After the fruits get in the tamr stage (the last week of September), they tend to have dark-brown and semi-dry or dry appearance according to Chao and Krueger (2007).

At the end of September, six bunches were hand-picked at the Tamr stage, or full maturity. Each bunch was treated as a duplicate. After being cut from the palm trees-head, the bunches were carefully selected and sliced into strands.

After being wrapped in plastic bags, the stands were quickly transported to post-harvest processing lab of the Faculty of Science at Assuit University in Egypt. Upon arrival at the lab, the fruits were physically separated from the strands, and only the ones that were uniformly sized and free of mechanical damage were selected. All treatments were placed in plastic boxes and stored at ambient conditions (21 ± 7°C and 60 - 70 % RH) for 75 days. Samples were taken at 0, 15, 30, 45, 60 and 75 days after storage.

Quality attributes:

Physical and chemical attributes of date fruits were assessed during storage as following:

- Fruit weight loss (%) was determined using the following formula [(starting fruit weight - examination fruit weight date) / (starting fruit weight)] × 100.
- Fruit decay (%): Both pathological and physiological disorders (microbial decay, and Insect infestation) on fruits were considered as decayed fruits.
  Decayed fruit percentage was determined as follow [(weight of decayed fruits at examination date) / (Total weight of fruits)] ×100.
- A total soluble solid (%) was recorded using a hand refractometer.
- Total titratable acidity (%) was determined (A.O.A.C., 2005).
- Total sugars (%) were determined (A.O.A.C., 2005).

Fungal analysis:

The microbiological analysis was conducted for fungal and bacterial counts using dilution plate method. For fungal analysis; ten grams of dates were transferred into 90 ml sterilized distilled water, stirred for 10 min. One ml of the solution transferred into Petri dish and covered with potato dextrose agar medium, then the plates were incubated at 30 ±1ºC for 6 days with three replicates and the developed fungi were counted as colony forming units (CFU) per 10 grams of dates (Mansour et al., 2018 and 2019 and Mahmoud et al., 2021).

Experimental design and statistical analysis:

Two factors were included in the factorial experiment: six storage periods and

five pre-harvest treatments were set up in a fully randomized design with three replications. The current data was statistically analyzed in accordance with Snedecor and Cochran (1980). L.S.D. values at the 5% level were used to compare averages (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

- Weight loss (%):

Data presented in **Table (1)** demonstrated that the percentage of fruit weight loss gradually increased with the prolongation of the storage period for all treatments of Saidy date fruits in both seasons. The application of propolis extract and sodium thiosulfate before harvest in all concentrations significantly reduced the increase in fruit weight loss compared to the control group during storage in both seasons. The higher concentration of both propolis extract and sodium thiosulfate had significantly greater impact on reducing fruit weight loss than the lower concentration. When considering the interaction between pre-harvest treatments and storage periods, data indicated that applying sodium thiosulfate at 1% and propolis extract at 5% resulted in the lowest percentage of fruit weight loss, while the control group significantly achieved the highest percentage after 75 days of storage under ambient conditions in both seasons. According to Wolucka et al. (2005), Barman et al. (2011) and Razzaq et al. (2014), storage progress leads to an increase in the physiological loss of weight which lead to an increase in fruit transpiration rate, cellular breakdown, and a delay in fruit quality decline. The positive effect of propolis in reducing weight loss is due to its role in acting as a semipermeable film that can extend fruit life after harvest by lowering respiration, oxidative reaction, and moisture loss rates (Petriccione et al., 2015).

Table (1). Effect of pre-harvest spraying with propolis and sodium thiosulfate on weight loss (%) of Saidy date fruits during storage in 2022 and 2023 seasons.

Date (D) / Treatment (T)	Storage period (day)						
	0	15	30	45	60	75	Means (T)
Season, 2022							
Water (Control)	0.00	0.62	0.85	1.25	2.49	3.37	**1.43**
Propolis at 3%	0.00	0.10	0.90	1.01	1.56	1.69	**0.88**
Propolis at 5%	0.00	0.30	0.45	0.66	0.92	1.18	**0.59**
Sodium thiosulfate at 0.5%	0.00	0.12	0.25	1.11	1.17	1.43	**0.68**
Sodium thiosulfate at 1%	0.00	0.15	0.36	0.66	0.75	0.92	**0.47**
Means (D)	**0.00**	**0.26**	**0.56**	**0.94**	**1.38**	**1.72**	
LSD at 5%	**T = 0.24**		**D = 0.26**		**T X D = 0.58**		
Season, 2023							
Water (Control)	0.00	0.72	0.98	1.41	1.76	2.61	**1.25**
Propolis at 3%	0.00	0.20	0.58	1.43	1.58	1.70	**0.92**
Propolis at 5%	0.00	0.26	0.36	0.91	1.23	1.55	**0.72**
Sodium thiosulfate at 0.5%	0.00	0.35	0.55	1.03	1.53	1.81	**0.88**
Sodium thiosulfate at 1%	0.00	0.10	0.24	0.90	1.41	1.5	**0.69**
Means (D)	**0.00**	**0.33**	**0.54**	**1.14**	**1.5**	**1.83**	
LSD at 5%	**T = 0.18**		**D = 0.20**		**T X D = 0.44**		

The results are similar to those found by Badawy (2016) in their study of orange fruits. Passos et al. (2016) studied bananas, Kahramanoglu et al. (2018) studied

pomegranates, and Abd Elwahab et al. (2019) studied date palms. They all found that applying propolis extract greatly decreased the increase in the percentage of weight loss during storage in comparison to the control treatment. Moreover, Kamel et al. (2015) found that fruit weight loss was reduced by propolis extracts and sodium metabisulfite as compared to control during storage.

- Decay (%):

Table (2) demonstrates that as the storage period extended, the percentage of fruit decay significantly increased for all treatments of Saidy date fruits in both seasons. Pre-harvest applications of propolis extract and sodium thiosulfate, at all concentrations, significantly reduced the increase in the fruit decay percentage compared to the control during the storage period in both seasons. The high concentration of both propolis extract and sodium thiosulfate was significantly more effective in reducing fruit decay than the lower concentration. In terms of the interaction between pre-harvest treatments and storage periods, the application of sodium thiosulfate at 1% and propolis extract at 5% resulted in the lowest fruit decay percentage. On the other hand, the highest percentage of this one was significantly attained by control after 75 days of storage under ambient conditions in both seasons.

Decay of fruits is due to physiological changes, diseases, insect infestation, and aging processes (Prusky and Keen, 1993). Propolis's ability to reduce decay percentage is attributed to its numerous biological activities, including antibacterial, antiviral, antifungal, and pharmacological properties (Salomao et al., 2004). These results align with the findings of Badawy (2016) and Kahramanoglu et al. (2018), who reported that applying propolis extract significantly reducing the increase in the decay percentage during storage compared to the control. Also, Kamel et al. (2015) found that the rate of decay decreased when they were treated with propolis extracts and sodium metabisulfite compared to when they were stored without these treatments.

Table (2). Effect of pre-harvest spraying with propolis and sodium thiosulfate on decay % of Saidy date fruits during storage in 2022 and 2023 seasons.

Date (D)	Storage period (day)						
Treatment (T)	0	15	30	45	60	75	**Means (T)**
Season, 2022							
Water (Control)	0.00	5.56	32.97	39.56	44.00	64.36	**31.08**
Propolis at 3%	0.00	0.00	4.40	21.66	24.51	40.00	**15.10**
Propolis at 5%	0.00	0.00	6.03	8.57	14.69	27.97	**9.55**
Sodium thiosulfate at 0.5%	0.00	0.00	0.00	12.72	17.31	36.19	**11.04**
Sodium thiosulfate at 1%	0.00	0.00	0.00	0.00	14.36	29.93	**7.38**
Means (D)	**0.00**	**1.11**	**8.68**	**16.50**	**22.97**	**39.69**	
LSD at 5%	**T = 2.37**		**D = 2.58**		**TXD = 5.81**		
Season, 2023							
Water (Control)	0.00	10.00	30.10	37.62	41.60	58.33	**29.61**
Propolis at 3%	0.00	0.00	4.17	21.43	23.08	41.67	**15.06**
Propolis at 5%	0.00	0.00	4.55	7.00	8.00	38.33	**9.65**
Sodium thiosulfate at 0.5%	0.00	0.00	7.00	10.38	18.38	30.38	**11.02**
Sodium thiosulfate at 1%	0.00	0.00	0.00	0.00	9.09	32.91	**7.00**
Means (D)	**0.00**	**2.00**	**9.16**	**15.29**	**20.03**	**40.32**	
LSD at 5%	**T = 2.83**		**D = 3.08**		**TXD = 6.93**		

- Total soluble solids (TSS %):

Table (3) shows that the amounts of TSS gradually increase during storage period for all treatments of Saidy date fruits throughout both seasons. Furthermore, pre-harvest applications of propolis extract and sodium thiosulfate, at all concentrations, significantly reduced the increase in the TSS percentage compared to the control treatment during storage period in both seasons. The higher concentration of both propolis extract and sodium thiosulfate more effective in reducing the increase in TSS than the lower one. In addition data of the interaction between pre-harvest treatments and storage periods, the application of sodium thiosulfate at 1% and propolis extract at 5% had the lowest percentage of TSS, while the control treatment significantly achieved the highest percentage after 75 days of storage under ambient conditions in both seasons.

Table (3). Effect of pre-harvest spraying with propolis and sodium thiosulfate on TSS % of Saidy date fruits during storage in 2022and 2023 seasons.

Date (D)	Storage period (day)						
Treatment (T)	0	15	30	45	60	75	**Means (T)**
Season, 2022							
Water (Control)	81.19	82.59	82.92	83.03	83.33	84.05	**82.85**
Propolis at 3%	81.12	81.28	81.58	81.59	82.17	83.08	**81.80**
Propolis at 5%	80.50	81.08	81.43	81.66	82.04	82.24	**81.49**
Sodium thiosulfate at 0.5%	81.04	81.66	81.79	81.91	82.16	82.74	**81.88**
Sodium thiosulfate at 1%	80.66	80.85	81.21	81.27	82.03	82.16	**81.36**
Means (D)	**80.90**	**81.49**	**81.78**	**81.89**	**82.35**	**82.85**	
LSD at 5%	**T = 0.19**		**D = 0.21**		**TXD = 0.47**		
Season, 2023							
Water (Control)	81.87	81.98	82.49	82.73	82.95	83.77	**82.63**
Propolis at 3%	81.04	81.78	82.27	82.33	82.71	82.91	**82.17**
Propolis at 5%	80.54	81.19	81.26	81.36	81.46	81.66	**81.25**
Sodium thiosulfate at 0.5%	81.21	81.31	81.34	81.45	81.53	81.92	**81.46**
Sodium thiosulfate at 1%	80.16	80.95	81.14	81.20	81.32	81.51	**81.05**
Means (D)	**80.96**	**81.44**	**81.70**	**81.81**	**81.99**	**82.36**	
LSD at 5%	**T = 0.13**		**D = 0.14**		**TXD = 0.32**		

The increase in fruit TSS as the storage period progresses could be attributed to an increase in the dry matter percentage from respiration and metabolic activity, as well as moisture loss from transpiration (Nandaniya et al., 2017). The delay in the rise of TSS content for the propolis-coated fruits may be due to modifications to the fruit's internal atmosphere, such as a decrease O_2 levels and increase CO_2 levels, which lowers metabolic activity and respiration rate (Hong et al., 2012). These results are harmony with the findings of Badawy (2016) and Passos et al. (2016), who found that applying propolis extract significantly reduced the increase in TSS percentage during storage period compared to the control. Also, Kamel et al. (2015) found that the TSS percentage decreased when they were treated with propolis extracts and sodium metabisulfite compared to control treatment during storage.

- Total acidity (%):

Table (4) demonstrates that extending the storage period led to a significant gradual decrease in the total acidity percentage for all treatments of Saidy date fruits in both seasons. Pre-harvest applications of propolis extract and sodium thiosulfate at all concentrations

significantly slowed down the decline in the total acidity percentage compared to the control during the storage period in both seasons. The higher concentration of both propolis extract and sodium thiosulfate was significantly more effective in reducing the decrease in total acidity than the lower one. In terms of the interaction between pre-harvest treatments and storage periods, the application of sodium thiosulfate at 1% and propolis extract at 5% achieved the highest percentage of total acidity. On the other hand, the lowest percentage of this one was significantly attained by control after 75 days of storage under ambient conditions in both seasons.

There may be a reason why the fruit's total acidity level decline. This is due enzymes may be turning acids into salts and sugars and using organic acids in the respiration process with the increase storage period. A reduction in respiration rates and metabolic activities, which prevents the loss of organic acids during cold storage, could explain the higher acidity in fruits treated with propolis (Hernandez-Munoz et al., 2008). The obtained results agree with the findings of Badawy (2016) and Passos et al. (2016), who reported a significant decrease in fruit acidity during storage due to propolis extract application. Furthermore, Kamel et al. (2015) discovered that the use of propolis extracts and sodium metabisulfite significantly reduced fruit acidity loss during storage compared to the control.

Table (4). Effect of pre-harvest spraying with propolis and sodium thiosulfate on acidity % of Saidy date fruits during storage in 2022 and 2023 seasons.

Date (D)	Storage period (day)						
Treatment (T)	0	15	30	45	60	75	**Means (T)**
Season, 2022							
Water (Control)	0.21	0.19	0.18	0.18	0.17	0.17	**0.18**
Propolis at 3%	0.21	0.20	0.19	0.19	0.18	0.18	**0.19**
Propolis at 5%	0.22	0.21	0.20	0.18	0.19	0.19	**0.20**
Sodium thiosulfate at 0.5%	0.22	0.20	0.20	0.19	0.19	0.18	**0.20**
Sodium thiosulfate at 1%	0.23	0.21	0.21	0.19	0.19	0.18	**0.20**
Means (D)	**0.22**	**0.20**	**0.20**	**0.19**	**0.19**	**0.18**	
LSD at 5%	**T = 0.03**		**D = 0.04**		**TXD = 0.08**		
Season, 2023							
Water (Control)	0.21	0.21	0.20	0.19	0.18	0.17	**0.19**
Propolis at 3%	0.21	0.21	0.20	0.19	0.18	0.18	**0.20**
Propolis at 5%	0.20	0.21	0.20	0.19	0.19	0.19	**0.20**
Sodium thiosulfate at 0.5%	0.22	0.21	0.21	0.19	0.19	0.18	**0.20**
Sodium thiosulfate at 1%	0.23	0.22	0.21	0.20	0.20	0.20	**0.21**
Means (D)	**0.21**	**0.21**	**0.20**	**0.19**	**0.19**	**0.18**	
LSD at 5%	**T = 0.02**		**D = 0.03**		**TXD = 0.06**		

- Total sugars (%):

The data in **Table (5)** showed that the percentage of total sugars gradually increased with the prolong storage time for all treatments of Saidy date fruits during both seasons. Furthermore, pre-harvest applications of propolis extract and sodium thiosulfate, at all concentrations, significantly reduced the increase in the total sugar percentage compared to the control during the storage period in both seasons. The higher concentrations of both propolis extract and sodium thiosulfate were significantly more effective in reducing the

increase in total sugars than the lower ones. In addition of the interaction between pre-harvest treatments and storage periods, the application of sodium thiosulfate at 1% and propolis extract at 5% yielded the lowest percentage of total sugars, while the control treatment significantly achieved the highest percentage after 75 days of storage under ambient conditions in both seasons.

It's possible that the high respiration rate caused more starch and polysaccharides to be turned into sugars by enzymes, which led to an increase in total sugars during storage (Karemera and Habimana, 2014). Propolis treatment could suppress the respiration rate and slow down the synthesis of metabolites, resulting in lower total sugars (Das et al., 2013). These results are in line with those obtained by Abd Elwahab et al. (2019) on date palm; they mentioned that application with propolis extract significantly reduced the increase in the total sugar percentage compared to control during storage.

Table (5). Effect of pre-harvest spraying with propolis and sodium thiosulfate on total sugars % of Saidy date fruits during storage in 2022 and 2023 seasons.

Date (D)	Storage period (day)						
Treatment (T)	0	15	30	45	60	75	**Means (T)**
2022, season							
Water (Control)	78.58	79.77	80.75	81.75	82.06	83.34	**81.04**
Propolis at 3%	77.92	78.07	79.75	80.75	81.57	81.96	**80.00**
Propolis at 5%	77.64	78.40	79.00	79.40	80.32	80.86	**79.27**
Sodium thiosulfate at 0.5%	77.74	78.07	79.50	80.40	80.69	81.63	**79.67**
Sodium thiosulfate at 1%	77.36	77.59	78.75	79.50	80.35	80.98	**79.09**
Means (D)	**77.85**	**78.38**	**79.55**	**80.36**	**81.00**	**81.75**	
LSD at 5%	**T = 0.11**		**D = 0.12**		**TXD = 0.27**		
2023, season							
Water (Control)	77.82	78.07	80.23	80.63	81.71	86.55	**80.83**
Propolis at 3%	77.11	77.50	78.00	79.86	80.83	82.25	**79.26**
Propolis at 5%	77.18	77.50	78.86	79.52	80.11	80.98	**79.02**
Sodium thiosulfate at 0.5%	77.36	78.08	78.50	79.41	80.51	81.53	**79.23**
Sodium thiosulfate at 1%	77.14	77.75	78.75	79.73	79.90	80.21	**78.91**
Means (D)	**77.32**	**77.78**	**78.87**	**79.83**	**80.61**	**82.30**	
LSD at 5%	**T = 0.07**		**D = 0.08**		**TXD = 0.17**		

Fungal analysis:

The obtained data clear the high efficiency of all treatments in controlling the fungal presence comparing with the control sample as cleared in **figure (1).** The highest antifungal activity obtained using sodium thiosulfate (1%) giving 5.7, 16.3, 17, 20.7, 27.7 & 33.3 after 0, 15, 30, 45, 60, and 75 days in comparing with for the control samples 25.3, 34.3, 48, 71.7, 85, 92.7 after 0, 15, 30, 45, 60, and 75 day, respectively. Followed by propolis (5%) treatment which gives 7.3, 17.7, 18.3, 21, 34.7, 38.7 after 0, 15, 30, 45, 60, and 75 day. However, sodium thiosulfate (0.5%) and propolis (3%) (8.0, 20.0, 22.3, 30.0, 37.0 & 38.7) and (9.3, 20.7, 25.3, 29.3, 42.0 & 44.0) after 15, 30, 45, 60 and 75 days, respectively.

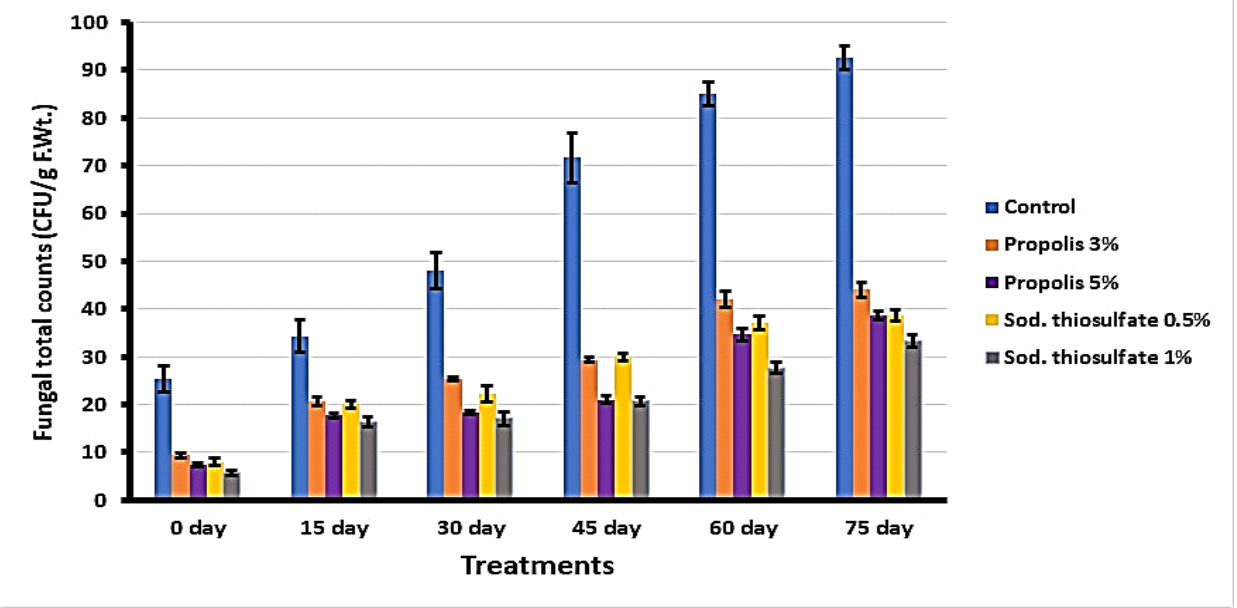

Figure (1). Effect of pre-harvest spraying with propolis and sodium thiosulfate on fungal total counts (CFU per g fresh dates) of date fruits during storage in 2022 and 2023 seasons.

Sodium thiosulfate demonstrated antimicrobial activity, as stated by Paralikar and Rai (2017), who found that it inhibited the growth of *E. coli* and *S. aureus*. Turkkan and Erper (2014) studied how sodium salts, such as sodium thiosulfate, kill *Fusarium oxysporum f. sp. cepae*, which is the germ that causes onion basal rot. Also, Kim et al. (2020) said that sulfur nanoparticles made from sodium thiosulfate were effective at killing *S. aureus, E. coli, C. albicans,* and *A. flavus*. In recent years, propolis has garnered significant interest as a superfood; it contains components used in pharmaceutical, natural, and food products and has a number of advantageous biological qualities, such as antioxidant, antimicrobial, anti-inflammatory, anticancer, and antifungal qualities (Kalogeropoulos et al., 2009). The high phenols and flavonoids contents in propolis may contribute to its antifungal properties (Cottica et al., 2011). Propolis has high antifungal activity against postharvest pathogens. Urrea et al. (2023) demonstrated that propolis has antifungal properties against postharvest pathogen *Phlyctema vagabunda*. Ali et al. (2014) also inhibited *Colletotrichum gloeosporioides* by 87% using 1.5% propolis. Propolis also demonstrated its antifungal properties against *Botrytis cinereal, Rhizopus stolonifera, Penicillium italicum,* and *P. digitatum* (Yang et al., 2011 and 2016).

CONCLUSION

From the above results, it is concluded that, pre-harvest applications of sodium thiosulfate at 1% and propolis extract at 5% were more effective than other treatments in enhancing the storability via reducing the fungal counts, physiological loss in weight, decay, and delaying the changes in TSS, total acidity, and total sugars of Saidy date fruits during extended storage at ambient conditions (21 ± 0.7°C and 60 – 70% RH) for 75 days in both seasons.

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الملخص العربي

تأثير بعض معاملات ما قبل الحصاد على خصائص الجودة لثمار البلح النصف جاف (صنف الصعيدى) أثناء التخزين

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تم إجراء هذا البحث لمدة موسمين متتاليين (2022 و 2023) في مزرعة خاصة تقع في محافظة أسيوط ، مصر لتقييم فعالية مستخلص البروبوليس وثيوسلفات الصوديوم في الحفاظ على صفات جودة ثمار النخيل (صنف الصعيدى) أثناء التخزين. كان عمر أشجار النخيل 17 عامًا ، نامية في تربة رملية ، منزرعه على مسافة 8 × 8 أمتار وتُروى بنظام الرى بالتنقيط. في نهاية شهر أغسطس (قبل حصاد الثمار) ، تم رش خمس معاملات على النحو التالي: تركيزان من البروبوليس (3٪ و 5٪) وتركيزان من ثيوسلفات الصوديوم (0,5٪ و 1٪) ، بالإضافة إلى معاملة المقارنة (الرش بالماء). تم تخزين ثمار البلح تحت ظروف جو الغرفة العادى (درجة حرارة 21±7 مئوى ورطوبة نسبية 60–70٪) لمدة 75 يومًا وتم تقييم صفات الجودة للثمار كل 15 يوم. أظهرت النتائج أن جميع المعاملات أفضل النتائج مقارنة بالكنترول. كان الرش قبل الحصاد بكل من ثيوسلفات الصوديوم بنسبة 1٪ ومستخلص البروبوليس بنسبة 5٪ الأكثر فاعلية من جميع المعاملات الأخرى في تحسين القدرة التخزينية وذلك من خلال تقليل التعداد الفطري, الفقد الفسيولوجي في الوزن والتلف وتأخير التغيرات في المواد الصلبة الذائبة الكلية والحموضة الكلية والسكريات الكلية لثمار النخيل (صنف الصعيدى) خلال فترة التخزين تحت ظروف جو الغرفة العادى (درجة حرارة 21±7 مئوى ورطوبة نسبية 60–70٪) لمدة 75 يومًا في كلا الموسمين.