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Effect of Some Post-Harvest Treatments on Quality Attributes of Sugar Beet during Storage under Toshka Region Conditions

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THE present study was carried out during 2017/2018 and 2018/2019 seasons at Desert Agricultural Research Station (DARS), Toshka region, Aswan Governorate. The effect of post-harvest treatments; covering with leaves and dipping in $Ca(OH)_2$ (1%), during storage periods (0, 2, 4 and 6 days) on quality characteristics of some sugar beet varieties (Oscar poly, Athospoly, Sarah, Ravel and Friancesca) under Toshka region conditions was investigated. The results showed that Post-harvest treatments had a significant effect on weight loss, sucrose, purity, losing sugars for molasses, sugar recovery and beet quality percentages. The best values of all studied traits were recorded for the roots that covered with leaves. Sucrose, purity, sugar recovery and beet quality percentages significantly decreased ($P<0.05$) while losing of weight and sugar percentages for molasses increased as a storage period increased up to 6 days. Concerning sugar beet varieties, Athospoly sugar beet variety was showed superiority over the other varieties in sucrose (60.37 and 69.82 %) and sugar recovery (52.35 and 59.23%). Ravel variety was recorded the best values for purity (92.81 and 92.70%) and beet quality (86.49 and 85.94%), while Friancesca variety was recorded the lowest values for weight loss percentage (14.21 and 14.09%).

Keywords: Sugar beet verities, Post-harvest treatments, Weight loss, Sucrose, Purity, Losing sugars for molasses, Sugar recovery and beet quality percentages .

Introduction

Sugar beet (*Beta vulgaris* L.) is an important crop for sugar production in Egypt. It produces about 62.1% of the domestic sugar production (SCC, 2020). Thus, the sugar beet varieties are considered as the corner stone or one of the essential wings for production to minimize the gap between the sugar production and consuming. Many investigators pointed out the important role of varieties in respect to their influence on yield and quality (Al-Jbawi et al., 2015; Al-Zubi1, 2016; Hoffmann & Schnepel 2016; Ahmed et al., 2017; Abd El-Rahman et al., 2019; Sorour et al., 2020). Prolonging postharvest period of beet roots led to reduction of sucrose and purity as well as increasing of the weight loss percentage (Al-Zubi, 2016). Also, delaying the sugar beet delivery to factory decreases sucrose content, sugar recovery and beet quality percentage. On other side, sucrose loss percentage in wastes increased with increasing the period between the harvest times and processing from zero time (at harvest) to nine days (Abd Alraoof et al., 2020). This loss is mainly due to ongoing respiration, but changes in cell wall composition and pathogen infestation also contribute. However, some varieties can cope better during storage. Also, changes in sugar beet roots during storage resulting in the characterization of varieties genotypes (Madritsch et al., 2020). Many studies

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have been performed to investigate effects of delaying delivery on sugar beet properties (Tsialtas & Maslaris, 2013; Al-Jbawi et al., 2015; El-Syiad, 2016, Hoffmann & Schnepel, 2016; Madritsch et al., 2020). Due to delaying the sugar beet delivery to factory, the chemical and technological parameters between varieties was significantly varied in sucrose, purity, sugar recovery and root quality percentage (El-Safy et al., 2020). Also, many studies have been carried out to investigate effect of post-harvest treatments in weight losses and quality parameters for sugar beet (Gomaa, 2013; El- Shahaby et al.,2014; El-Syiad et al.,2016; Hoffmann, 2018; Abd Alraoof et al., 2020; Mioduszewska et al., 2020). There are many factors affecting sugar beet quality, among these factors is the post-harvest treatments to protect harvested sugar beet roots during storage. Therefore, the aim of this study was to investigate effects of covering with leaves and dipping in Ca $(OH)_2$ treatments on quality attributes of sugar beet roots (grown in new reclaimed land) after harvest and before processing.

Materials and Methods

Materials

Sugar beet varieties, namely; Oscar poly, Athospoly, Sarah, Ravel and Francesca, were obtained from the Sugar Crops Research. Institute (SCRI), Giza Governorate, Egypt. At harvest, 195 days from sowing, 180 roots were collected at random for each variety. These roots were divided into separate three pile under the direct sun light (60 roots of each pill) to determine the changes in the root weight and the changes in the root quality characteristics as follows:

1.The first pile without treatment.
2.The second pile was covered with green leaves of beet sugar.
3.The third pile was dipping in 1% calcium hydroxide solution (El-Nasr Company, Egypt) for 10 min.

All piles were stored for 0, 2, 4 and 6 days from 17th -23th April in both seasons under direct sun light in open air after treatment at Toshka region conditions.

Methods

The present study was carried out at the farm of Desert Agricultural Research Station (DARS), Toshka (latitude of 22^{o}.49^{-} N, longitude of 28^{o} .58^{-} E and an elevation of 188 m above sea level) Aswan Governorate, Egypt, during 2017/2018 and 2018/2019 seasons, at age 195 days from sowing because at that age (195 d), these varieties recorded the highest sucrose content based on results of previous study (Sorour et al., 2020) to study the effect of post-harvest treatments and storage periods on quality characteristics of some sugar beet varieties. The study included sixty treatments represent the combination of three post-harvest treatments (without treatment, covering with leaves, dipping in $Ca(OH)_2$ 1% and storage periods (0, 2, 4, 6 days). The plant samples were weighted and then were sent to the laboratory of quality analyses at Fayoum Sugar Company to determine the quality characteristics.

Weight loss percentage (W.L %)

The samples of beet roots were weighted at the same harvest time and after 2, 4 and 6 days from harvested date for both seasons.

Determination of sucrose percentage

Sucrose percentage was estimated in fresh samples of sugar beet root using "Saccharometer" according to the method described by AOAC (2005).

Determination of moisture content

Moisture content was estimated by dried in electric oven at 105ºC until constant weight was recorded according to the method recommended in AOAC 1990),

Determination of purity percentage

Purity percentage was calculated according to the following equation, described by Devillers (1988): Purity % = 99.36- [14.27 (Na + K + α-amino N)/ sucrose%].

Root impurities in terms of α-amino N, Na and K percentages (meq/100 g beet) according to AOAC (2012).

Determination of beet quality and sugar recovery percentage

Beet quality and sugar recovery percentage were determined according to Silin & Silina (1977) and Sapronova et al. (1979) using the following equations:

Sugar recovery % = (pol-0.29) – 0.343 (k + Na) – α amino N (0.0939).

Beet quality = (sugar recovery/ pol) X 100.

Where:

Pol = Sucrose%, K = Potassium, Na = Sodium, α-N = Alpha-amino nitrogen,

Determination of sucrose lost to molasses percentage (SLM %)

It was calculated as described by Devillers (1988) using the following equation: SLM% = [0.14(Na + K) + 0.25 (α-amino N) + 0.5].

Statistical analysis

The collected data were statistically analyzed according to Snedecor and Cochran (1981). Treatment means were compared using LSD at 5% level of probability. Also, simple correlation coefficients and linear regression were computed among studied traits according to Steel and Torrie (1980).

Results and Discussion

Effect of post-harvest treatments on weight loss

Results in Table 1 showed that post-harvest treatments had a significant effect on weight loss % in two seasons. The roots of sugar beet covering with leaves had the lowest W.L% (12.84 and 10.81%) compared to the roots without treated had the highest weight loss (22.96 and 18.69%) in 1st and 2nd seasons, respectively. These results could be attributed to the increase of water loss because of respiration process and the beet leaves are secondary waste. Similar observations were mentioned by Klotz & Lafta (2009), Gomaa (2013) and Mioduszewska et al. (2020), they reported that highest values of W.L% recorded for 1% Ca $(OH)_2$ compared with other samples and control at the end of storage periods. During storage, a gradual increase was observed in W.L% ($p<0.05$) as roots processing delayed for 2 to 6 days from harvest times. W. L% gradually increased to reach its highest value after 6 days, the increase on W. L% of all treated from 15.45 to 31.70% and from 10.58 to 29.76% during storage in the 1st and 2nd seasons respectively. These results are in harmony with those reported by Al-Abdallah et al. (2010). They reported that roots weight significantly dropped by increasing post-harvest period. Results found that sugar beet varieties significantly varied in W. L% in the two seasons. Sarah variety gave the highest values of W. L% (20.72 and 16.79 %) while Francesca variety gave the lowest values (14.21 and 14.09 %) in the 1st and 2nd seasons respectively. These results may be due to the differences in water evaporation among studied varieties at the different post-harvest period. These results are in similar with that reported by Al-Zubi (2016) who noted that varieties varied significantly in root weight loss. It could be noted that all possible interactions between the studied factors were significant, except between storage periods and varieties in the 1st season as well as the second order interaction in the two seasons. Also, varieties contained a higher number of parenchyma cells and cambial rings as well as a thinner periderm prior to storage showed a better storability behavior. In addition, the downregulation of genes involved in roots ripening-related softening processes seemed to be a potential precondition for good storability as well as the upregulation of a specific, obviously more efficient pathogen defense system (Madritsch et al., 2020).

Effect of post-harvest treatments on the sucrose percentage

As shown in Table 2, post-harvest treatments had a significant effect on sucrose % in both seasons. The roots covered with leaves recorded the highest value of sucrose % (60.25 and 66.60%), while the roots without treated recorded the lowest value (53.27 and 60.52 %) in 1st and 2nd seasons, respectively. Abou Shady (1994), Gomaa (2013) and Alraoof et al. (2020) showed that sucrose content decreased during storage under all post-harvest treatments used. After harvesting, sucrose % decreased as storage period increased in both seasons. Sucrose % gradually decreased to reach minimum value after 6 days from harvest date; the decrease in the sucrose % of all treated samples was 74.01 to 45.04% and 77.70 to 51.70% (on dry weight basis) during storage in both seasons, respectively. These results may be due to the higher rate of sucrose inversion and due to increasing activity of degrading enzymes and higher rate of respiration with increasing storage period after harvest. These results are in accordance with those obtained by Asadi (2007), Hoffmann & Schnepel (2016) and Madritsch et al. (2020), and they found that sucrose % of beet roots stored under open air decreased from 75.96% to 38.90% (on dry weight basis). In addition, increasing post-harvest period enzyme activity increased, sucrose % decreased. The results indicated that tested sugar beet varieties significantly varied in sucrose % in both seasons. Arthospoly variety surpassed the other varieties

in sucrose (60.37 and 69.82%), while the lowest values (54.41 and 60.03% DM) were recorded by Sarah variety in the 1st and 2nd seasons respectively. Such effect give evidence to the genetic variation among the used varieties in their efficiently of sugar synthesis and translocation of assimilates to storage organs. This confirms the findings of Mousa (1990), Sarwar et al. (2008) and Ahmed et al. (2017), they found that sugar beet varieties varied significantly in sucrose percentage. Sucrose% was significantly affected by the all possible interactions between the three studied factors except between post-harvest treatments and varieties in second season. Generally, the highest values of sucrose % were obtained from Ravel and Arhospoly varieties after harvesting immediately, with all post-harvest treatments in 1st and 2nd seasons respectively.

Effect of post-harvest treatments on the purity percentage

Data presented in Table 3 revealed that post-harvest treatments had a significant effect on purity % in both seasons. Sugar beet roots covered with leaves had the highest purity% (93.04 and 92.60%), while the roots without treated recorded the lowest one, (91.34 and 91.03%) in 1st and 2nd seasons, respectively. These results are in agreement with those obtained by Gomaa (2013) and Abd Alraoof et al. (2020), they found that purity % of roots were significantly decrease with post-harvest treatments. Also, the purity % was significantly and gradually decreased with the increase in the storage period in both seasons. This finding was probably due to the high increase of sucrose inversion as a result of the high activity of invertase enzyme. These results are in accordance with those obtained by Gomaa (2013), Al-Jbawi et al. (2015) and Al-Zubi (2016) they noted that purity % trait was affected significantly by storage duration. Sugar beet varieties significantly varied in purity % in both seasons. Ravel variety surpassed the other varieties in purity (92.81 and 92.70 %) while Oscar poly variety contained the lowest values (91.34 and 90.85%) in the 1st and 2nd seasons, respectively. These results may be due to the genetic differences among varieties. These results are in the same line with those reported by Al-Jbawi et al. (2015), Ahmed et al. (2017) and Abd El-Rahman et al. (2019), they reported that significant differences regarding purity between sugar beet varieties. Data also showed that purity % was significantly affected by all possible interactions between the three studied factors except between post- harvest treatments and varieties. Generally, the highest values of purity % were obtained from Ravel variety after harvesting immediately, with all post-harvest treatments in both seasons.

Effect of post-harvest treatments on the sugar loss to molasses percentage

The sugar loss to molasses percentage was significantly affected by the examined post-harvest treatments (Table 4). The lowest values (1.78 and 1.94%) were recorded when roots covered with leaves, whereas the roots kept without covering recorded the maximum sugar loss to molasses (2.07 and 2.21%) in the two seasons, respectively. These findings are probably due to the increase of water loss as a result of respiration process of beet roots. Similar results were obtained by Asadi (2007), Hoffmann (2018) and Abd El-Rahman et al. (2019), they found that treated roots post-harvest treatment had significant effect on sugar loss in molasses. It could be noted that the effect of storage period after harvest on sugar loss to molasses % was significant in the two seasons. Sugar loss to molasses % gradually increased to reach maximum value after 6 days from harvest date. The increase in the sugar loss to molasses % of all treated samples was 1.37 to 2.39% and 1.61 to 2.48% during storage in the 1st and 2nd seasons, respectively. These results were accordance with those reported by El-Syiad (2016), who noticed that the losses of sucrose in wastes were increased due to prolongation of storage periods until 9 days during the two working seasons to 4.60 % and 4.12% of beet respectively. Additionally, the examined varieties significantly varied in sugar loss to molasses % in both seasons. Ravel variety recorded the lowest sugar loss to molasses %, while Oscar poly variety recorded the highest one. These results are in line with those reported by Hoffmann & Schnepel (2016) and Ahmed et al. (2017), they found that sugar beet varieties varied significantly in sugar loss to molasses percentage. Also, data showed that all possible interactions between the studied factors were significant except the second order interaction, in the 1st season. Generally, the lowest values of sugar loss to molasses % (1.06 and 1.45%) were obtained from Ravel variety when processed immediately (in the same harvest time) with all post- harvest treatment.

TABLE 1. Effect of post-harvest treatments after age 195 days on W.L % of sugar beet varieties during the processing delay periods during two seasons.

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	**0.00**
	2	18.46	22.64	26.92	13.63	15.86	**19.50**	12.53	12.25	19.76	17.44	13.21	**15.04**
	4	27.61	34.61	34.64	39.97	28.81	**33.13**	23.23	26.04	25.81	30.65	19.94	**25.13**
	6	40.28	38.31	45.32	42.92	29.27	**39.22**	36.42	31.04	36.92	35.07	33.54	**34.60**
	Mean	**21.59**	**23.89**	**26.72**	**24.13**	**18.49**	**22.96**	**18.04**	**17.33**	**20.62**	**20.79**	**16.67**	**18.69**
Cover with leaves	0	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	**0.00**
	2	12.21	14.57	8.10	8.39	6.96	**10.05**	5.11	4.70	5.14	5.48	7.32	**5.55**
	4	19.17	25.15	18.73	16.64	10.81	**18.10**	13.37	18.79	13.28	14.97	11.67	**14.42**
	6	28.78	28.03	23.34	20.33	15.67	**23.23**	22.01	20.49	32.28	21.62	19.96	**23.27**
	Mean	**15.04**	**16.94**	**12.54**	**11.34**	**8.36**	**12.84**	**10.12**	**11.00**	**12.68**	**10.52**	**9.74**	**10.81**
Ca (OH)2	0	0.00	0.00	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	0.00	0.00	**0.00**
	2	14.99	19.14	18.59	16.48	14.79	**16.80**	10.10	11.83	12.09	12.18	9.60	**11.16**
	4	25.54	29.28	33.90	28.41	21.32	**27.69**	27.67	21.04	20.07	22.00	23.02	**22.76**
	6	32.71	30.47	39.11	33.88	27.06	**32.65**	29.28	29.90	36.10	30.87	30.81	**31.39**
	Mean	**18.31**	**19.72**	**22.90**	**19.69**	**15.79**	**19.28**	**16.76**	**15.69**	**17.07**	**16.26**	**15.86**	**16.33**
S. period x Varieties	0	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	2	**15.22**	**18.78**	**17.87**	**12.83**	**12.54**	**15.45**	**9.25**	**9.60**	**12.33**	**11.70**	**10.04**	**10.58**
	4	**24.11**	**29.68**	**29.09**	**28.34**	**20.31**	**26.31**	**21.42**	**21.96**	**19.72**	**22.54**	**18.21**	**20.77**
	6	**33.92**	**32.27**	**35.93**	**32.38**	**24.00**	**31.70**	**29.24**	**27.14**	**35.10**	**29.19**	**28.10**	**29.76**
Mean		**18.31**	**20.18**	**20.72**	**18.39**	**14.21**	**18.36**	**14.98**	**14.67**	**16.79**	**15.86**	**14.09**	**15.28**
LSD at .05 level for:													
Post-harvest treatment (A)							**5.955**						**3.172**
Storage periods (B)							**3.289**						**2.424**
Sugar beet varieties (C)							**4.518**						**1.692**
A x B							**5.698**						**4.198**
A x C							**7.828**						**2.929**
B x C							**N.S**						**3.383**
A x B x C							**N.S**						**N.S**

TABLE 2. Effect of post-harvest treatments after age 195 days on the sucrose percentage (on DWB)* of sugar beet varieties during the processing delay periods during two seasons.

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	69.90	77.58	71.10	82.26	69.18	**74.01**	72.84	85.21	73.79	81.12	75.52	**77.70**
	2	59.14	54.94	49.71	52.85	54.32	**54.19**	65.13	72.81	61.95	57.98	58.46	**63.27**
	4	50.85	46.69	45.13	41.04	42.25	**45.19**	57.58	62.28	53.66	46.46	56.55	**55.31**
	6	41.37	42.01	39.28	36.06	39.76	**39.70**	45.63	52.99	41.90	42.06	46.36	**45.79**
	Mean	**55.32**	**55.30**	**51.31**	**53.06**	**51.38**	**53.27**	**60.30**	**68.32**	**57.83**	**56.90**	**59.22**	**60.52**
Cover with leaves	0	69.90	77.58	71.10	82.26	69.18	**74.01**	72.84	85.21	73.79	81.12	75.52	**77.70**
	2	60.71	68.98	58.46	59.03	57.34	**60.90**	67.69	76.16	63.41	67.18	72.76	**69.44**
	4	58.20	60.71	53.12	54.25	54.79	**56.21**	60.87	64.62	60.24	62.98	65.09	**62.76**
	6	49.80	51.51	46.25	53.67	48.07	**49.86**	54.14	60.72	49.88	59.80	57.87	**56.48**
	Mean	**59.65**	**64.70**	**57.24**	**62.30**	**57.35**	**60.25**	**63.89**	**71.68**	**61.83**	**67.77**	**67.81**	**66.60**
Ca (OH)2	0	69.90	77.58	71.10	82.26	69.18	**74.01**	72.84	85.21	73.79	81.12	75.52	**77.70**
	2	63.16	62.77	54.87	56.05	55.66	**58.50**	67.58	75.90	62.05	66.49	71.22	**68.65**
	4	57.29	53.81	49.07	48.30	50.35	**51.77**	62.06	63.55	59.34	58.44	60.15	**60.71**
	6	43.34	50.30	43.75	45.40	45.03	**45.57**	53.40	53.18	46.55	57.12	53.85	**52.82**
	Mean	**58.42**	**61.12**	**54.70**	**58.00**	**55.06**	**57.46**	**63.97**	**69.46**	**60.43**	**65.79**	**65.19**	**64.97**
S. period x Varieties	0	**69.90**	**77.58**	**71.10**	**82.26**	**69.18**	**74.01**	**72.84**	**85.21**	**73.79**	**81.12**	**75.52**	**77.70**
	2	**61.00**	**62.23**	**54.35**	**55.98**	**55.77**	**57.87**	**66.80**	**74.96**	**62.47**	**63.88**	**67.48**	**67.12**
	4	**55.45**	**53.74**	**49.11**	**47.86**	**49.13**	**51.06**	**60.17**	**63.48**	**57.75**	**55.96**	**60.60**	**59.59**
	6	**44.84**	**47.94**	**43.09**	**45.04**	**44.29**	**45.04**	**51.06**	**55.63**	**46.11**	**52.99**	**52.69**	**51.70**
Mean		**57.80**	**60.37**	**54.41**	**57.79**	**54.59**	**56.99**	**62.72**	**69.82**	**60.03**	**63.49**	**64.07**	**64.03**
LSD at .05 level for:													
Post-harvest treatment (A)							**0.973**						**1.927**
Storage periods (B)							**1.518**						**2.032**
Sugar beet varieties (C)							**2.278**						**2.332**
A x B							**2.629**						**3.520**
A x C							**3.946**						**N.S**
B x C							**4.557**						**4.664**
A x B x C							**7.893**						**8.078**

TABLE 3. Effect of post-harvest treatments after age 195 days on the purity percentage of sugar beet varieties during the processing delay periods during two seasons.

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	94.25	95.72	95.13	97.09	95.65	**95.57**	93.02	94.17	94.71	95.11	94.79	**94.36**
	2	90.70	91.92	91.43	91.99	92.50	**91.71**	91.15	91.84	91.62	91.94	92.54	**91.82**
	4	88.87	90.43	88.90	90.32	90.91	**89.89**	88.73	90.78	88.69	90.60	91.70	**90.10**
	6	87.84	89.14	86.74	88.71	88.62	**88.21**	86.52	89.12	86.72	88.81	87.99	**87.83**
	Mean	**90.41**	**91.80**	**90.55**	**92.03**	**91.92**	**91.34**	**89.85**	**91.48**	**90.44**	**91.61**	**91.75**	**91.03**
Cover with leaves	0	94.25	95.72	95.13	97.09	95.65	**95.57**	93.02	94.17	94.71	95.11	94.79	**94.36**
	2	93.25	94.24	93.59	93.43	94.17	**93.74**	92.57	92.94	92.81	93.52	93.50	**93.07**
	4	92.07	92.88	91.97	92.00	93.08	**92.40**	91.11	91.78	91.63	92.91	92.78	**92.04**
	6	90.76	90.60	89.33	91.25	90.37	**90.46**	90.20	90.91	90.29	92.26	90.93	**90.92**
	Mean	**92.58**	**93.36**	**92.51**	**93.45**	**93.32**	**93.04**	**91.72**	**92.45**	**92.36**	**93.45**	**93.00**	**92.60**
Ca (OH)2	0	94.25	95.72	95.13	97.09	95.65	**95.57**	93.02	94.17	94.71	95.11	94.79	**94.36**
	2	91.42	93.42	92.70	92.81	93.25	**92.72**	91.42	91.91	92.14	93.19	93.37	**92.40**
	4	90.00	92.06	90.71	91.69	92.60	**91.41**	90.26	91.00	89.95	92.51	92.28	**91.20**
	6	88.45	89.93	88.58	90.27	89.72	**89.39**	89.25	89.32	87.64	91.34	89.77	**89.46**
	Mean	**91.03**	**92.78**	**91.78**	**92.97**	**92.81**	**92.27**	**90.99**	**91.60**	**91.11**	**93.04**	**92.55**	**91.86**
S. period x Varieties	0	**94.25**	**95.72**	**95.13**	**97.09**	**95.65**	**95.57**	**93.02**	**94.17**	**94.71**	**95.11**	**94.79**	**94.36**
	2	**91.79**	**93.20**	**92.57**	**92.74**	**93.30**	**92.72**	**91.71**	**92.23**	**92.19**	**92.88**	**93.14**	**92.43**
	4	**90.31**	**91.79**	**90.53**	**91.33**	**92.20**	**91.23**	**90.03**	**91.19**	**90.09**	**92.01**	**92.25**	**91.11**
	6	**89.02**	**89.89**	**88.22**	**90.08**	**89.57**	**89.35**	**88.66**	**89.78**	**88.22**	**90.80**	**89.56**	**89.40**
Mean		**91.34**	**92.65**	**91.61**	**92.81**	**92.68**	**92.22**	**90.85**	**91.84**	**91.30**	**92.70**	**92.43**	**91.83**
LSD at .05 level for:													
Post-harvest treatment (A)							**0.275**						**0.255**
Storage periods (B)							**0.175**						**0.460**
Sugar beet varieties (C)							**0.294**						**0.378**
A x B							**0.303**						**2.641**
A x C							**N.S**						**N.S**
B x C							**0.588**						**0.759**
A x B x C							**1.020**						**1.317**

TABLE 4. Effect of post-harvest treatments after age 195 days on the sugar loss to molasses% of sugar beet varieties during the processing delay periods during two seasons.

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	1.59	1.38	1.47	1.06	1.36	**1.37**	1.85	1.70	1.54	1.45	1.51	**1.61**
	2	2.21	1.99	2.09	2.02	1.87	**2.04**	2.17	2.19	2.19	2.01	1.94	**2.10**
	4	2.49	2.15	2.61	2.17	2.10	**2.30**	2.69	2.40	2.78	2.12	2.13	**2.42**
	6	2.64	2.39	2.96	2.39	2.48	**2.57**	2.95	2.63	3.01	2.37	2.63	**2.72**
	Mean	**2.24**	**1.98**	**2.28**	**1.91**	**1.95**	**2.07**	**2.42**	**2.23**	**2.38**	**1.99**	**2.05**	**2.21**
Cover with leaves	0	1.59	1.38	1.47	1.06	1.36	**1.37**	1.85	1.70	1.54	1.45	1.51	**1.61**
	2	1.67	1.64	1.67	1.76	1.58	**1.66**	1.90	1.96	1.84	1.85	1.81	**1.87**
	4	1.93	1.81	1.99	1.96	1.80	**1.90**	2.13	2.09	2.09	1.93	1.98	**2.04**
	6	2.12	2.13	2.40	2.10	2.16	**2.18**	2.25	2.25	2.31	2.06	2.33	**2.24**
	Mean	**1.83**	**1.74**	**1.88**	**1.72**	**1.73**	**1.78**	**2.03**	**2.00**	**1.94**	**1.82**	**1.91**	**1.94**
Ca (OH)2	0	1.59	1.38	1.47	1.06	1.36	**1.37**	1.85	1.70	1.54	1.45	1.51	**1.61**
	2	2.08	1.74	1.93	1.88	1.75	**1.88**	2.18	2.20	2.13	1.91	1.90	**2.06**
	4	2.34	1.96	2.29	2.06	1.87	**2.10**	2.41	2.24	2.55	1.96	2.04	**2.24**
	6	2.59	2.27	2.53	2.31	2.36	**2.41**	2.59	2.37	2.80	2.23	2.46	**2.49**
	Mean	**2.15**	**1.84**	**2.05**	**1.83**	**1.83**	**1.94**	**2.26**	**2.13**	**2.25**	**1.89**	**1.98**	**2.10**
S. period x Varieties	0	**1.59**	**1.38**	**1.47**	**1.06**	**1.36**	**1.37**	**1.85**	**1.70**	**1.54**	**1.45**	**1.51**	**1.61**
	2	**1.99**	**1.79**	**1.90**	**1.88**	**1.73**	**1.86**	**2.08**	**2.12**	**2.05**	**1.92**	**1.89**	**2.01**
	4	**2.25**	**1.98**	**2.29**	**2.06**	**1.92**	**2.10**	**2.41**	**2.24**	**2.47**	**2.00**	**2.05**	**2.24**
	6	**2.45**	**2.26**	**2.63**	**2.27**	**2.33**	**2.39**	**2.60**	**2.41**	**2.70**	**2.22**	**2.47**	**2.48**
Mean		**2.08**	**1.85**	**2.07**	**1.82**	**1.84**	**1.93**	**2.24**	**2.12**	**2.19**	**1.90**	**1.98**	**2.09**
LSD at .05 level for:													
Post-harvest treatment (A)							**0.043**						**0.039**
Storage periods (B)							**0.029**						**0.056**
Sugar beet varieties (C)							**0.044**						**0.058**
A x B							**0.053**						**0.101**
A x C							**0.075**						**0.103**
B x C							**0.089**						**0.120**
A x B x C							**N.S**						**0.207**

Effect of post-harvest treatments on the sugar recovery percentage

As shown in Table 5, post-harvest treatments had a significant effect on sugar recovery percentage in both seasons. Under the conditions of coverage, leaves had the highest mean values of sucrose recovery (52.69 and 57.34%), while roots without treatments had the lowest mean values of sucrose recovery % (45.19 and 50.63) (based on dry weight).in 1st and 2nd seasons, respectively. These findings are in line with those reported by Kenter & Hoffmann (2009) and Hassan et al. (2011) they reported that this deterioration or losses rates in recovery sugar might be due to the decrease in moisture % of beet roots and sucrose consumption during respiration process of roots.

Delaying day's delivery had a significant effect on sugar recovery percentage in the two seasons. Sugar recovery gradually decreased to reach its lowest value after 6 days, the decrease on the sucrose recovery % of treated samples from 67.83 to 36.05 %, and from 68.88 to 41.51 % (on dry weight basis) during storage periods in the 1st and 2nd seasons, respectively. These findings are in agreement with Tsialtas & Maslaris (2013) and Abd Alraoof et al. (2020) they reported that the sucrose recovery of roots decreased markedly with increasing of storage periods from time of harvest until 9 days.

The tested sugar beet varieties significantly varied in sugar recovery % in both seasons. The maximum sucrose recovery (52.35 and 59.23%) was noticed in Arthospoly and the minimum (46.57 and 50.73%) in Sarah variety when stored samples at all different treatments in the 1st and 2nd seasons. The obtained results are in line with those of Zalat (1993) and Sarwar et al. (2008), they stated that there were significant differences in sucrose recovery percentage among the studied cultivars. It could be noted that all the different interactions between the studied factors were significant except between post-harvest treatments and varieties in the 2ndn season.

Generally, the best sugar recovery (77.58%) was noticed in Ravel variety in the 1st season and (75.30%) for Arhospoly variety in the 2nd season when processed immediately (in the same harvest time) with all post-harvest treatment in both seasons, respectively.

Effect of post-harvest treatments on the beet quality percentage

Data in Table 6 showed that post-harvest treatments had a significant effect on quality percentage in both seasons. The roots covered with leaves recorded the highest value of quality (86.90 and 85.81%) compared with those without treated, which recorded the lowest value of quality (83.54 and 82.80%) in both seasons, respectively. This finding was probably due to the reduction in sucrose % of sugar beet roots. Moreover, high and rapid deterioration in quality of sugar beet roots may be due to the high increase of sucrose inversion as a result of the high activity of invertase enzyme. These findings are agreement with those reported by Gomaa (2009) and Gomaa (2013) and El- Shahaby et al. (2014) and El-Syiad et al. (2016).

Also, data cleared that the delaying days of beet sugar delivery to the sugar factory had a significant effect on beet quality percentage at all studied treatments in the two growing seasons. Beet quality% gradually decreased to reach its minimum value after 6 days from harvest date, the decrease on the quality percentage of most treated samples from 91.51 to 79.82% and from 88.62 to 79.93% during storage in the 1st and 2nd seasons respectively. These results are in harmony with those reported by Abou-Shady (1994) and Ferweez & El-Dengawy (2006), when they reported that the quality of beet roots decreased during increasing storage periods. Also, the sugar beet varieties significantly varied in quality % in the two seasons. Ravel variety had the highest values of quality (86.49 and 85.94 %), while the lowest values (83.09 and 82.01 %) were recorded by Oscar poly variety in the 1st and 2nd seasons respectively.

The variation among evaluated varieties in quality of sugar beet roots could be attributed to their genetic structure. These results are in accordance with those obtained by El-Safy et al. (2020), who reported that significant differences among the varieties were recorded in quality of sugar beet %. Concerning the interaction effect, it could be noted that all the different interactions between the studied factors were significant except between post-harvest treatments and varieties in the 2nd season. Generally, the best quality (94.30 and 89.81%) was obtained from Ravel variety when processed immediately (in the same harvest time) with all post- harvest treatment in first and second seasons respectively.

TABLE 5. Effect of post-harvest treatments after age 195 days on the sugar recovery percentage of sugar beet varieties during the processing delay periods during two seasons.4%

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	62.00	71.07	64.83	77.58	63.67	**67.83**	62.57	75.30	66.12	72.84	67.56	**68.88**
	2	48.47	46.31	41.86	44.94	46.69	**45.65**	53.53	61.54	52.33	48.99	50.28	**53.33**
	4	39.71	37.91	36.06	33.57	35.08	**36.47**	45.31	51.44	42.62	37.96	47.86	**45.04**
	6	31.55	33.33	29.56	28.46	31.16	**30.81**	34.07	41.97	31.61	33.08	35.69	**35.28**
	Mean	**45.43**	**47.16**	**43.08**	**46.14**	**44.15**	**45.19**	**48.87**	**57.56**	**48.17**	**48.22**	**50.35**	**50.63**
Cover with leaves	0	62.00	71.07	64.83	77.58	63.67	**67.83**	62.57	75.30	66.12	72.84	67.56	**68.88**
	2	52.54	61.45	51.51	51.87	51.17	**53.71**	57.55	66.03	54.82	59.07	63.69	**60.23**
	4	49.62	52.55	45.20	46.12	47.93	**48.28**	50.43	54.50	50.83	54.55	56.21	**53.31**
	6	41.23	42.27	37.01	44.97	39.24	**40.94**	43.90	50.16	41.15	51.28	48.17	**46.93**
	Mean	**51.35**	**56.84**	**49.64**	**55.13**	**50.50**	**52.69**	**53.61**	**61.50**	**53.23**	**59.43**	**58.91**	**57.34**
Ca (OH)2	0	62.00	71.07	64.83	77.58	63.67	**67.83**	62.57	75.30	66.12	72.84	67.56	**68.88**
	2	52.49	54.93	47.77	48.49	48.77	**50.49**	56.15	64.15	53.11	57.95	62.37	**58.75**
	4	45.86	45.67	40.95	40.83	43.50	**43.36**	50.02	52.76	48.17	50.17	51.40	**50.50**
	6	33.47	40.56	34.40	37.23	36.34	**36.40**	42.06	42.29	35.76	47.94	43.57	**42.33**
	Mean	**48.46**	**53.06**	**46.99**	**51.03**	**48.07**	**49.52**	**52.70**	**58.62**	**50.79**	**57.22**	**56.23**	**55.11**
S. period x Varieties	0	**62.00**	**71.07**	**64.83**	**77.58**	**63.67**	**67.83**	**62.57**	**75.30**	**66.12**	**72.84**	**67.56**	**68.88**
	2	**51.17**	**54.23**	**47.05**	**48.44**	**48.87**	**49.95**	**55.74**	**63.91**	**53.42**	**55.34**	**58.78**	**57.44**
	4	**45.06**	**45.38**	**40.74**	**40.17**	**42.17**	**42.70**	**48.58**	**52.90**	**47.21**	**47.56**	**51.82**	**49.62**
	6	**35.42**	**38.72**	**33.65**	**36.88**	**35.58**	**36.05**	**40.01**	**44.81**	**36.17**	**44.10**	**42.48**	**41.51**
Mean		**48.41**	**52.35**	**46.57**	**50.77**	**47.57**	**49.13**	**51.73**	**59.23**	**50.73**	**54.96**	**55.16**	**54.36**
LSD at .05 level for:													
Post-harvest treatment (A)							**0.863**						**1.613**
Storage periods (B)							**1.426**						**1.818**
Sugar beet varieties (C)							**2.205**						**2.161**
A x B							**2.469**						**3.152**
A x C							**3.823**						**N.S**
B x C							**4.414**						**4.322**
A x B x C							**7.646**						**7.486**

TABLE 6. Effect of post-harvest treatments after age 195 days on the quality percentage of sugar beet varieties during the processing delay periods during two seasons.

Post-harvest treatment	Storage periods	2017/2018 season						2018/2019 season					
		Sugar beet varieties					Mean	Sugar beet varieties					Mean
		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca		Oscarpoly	Arthospoly	Sarah	Ravel	Francesca	
Without treatment	0	88.70	91.61	90.94	94.30	92.01	**91.51**	85.89	88.37	89.57	89.81	89.44	**88.62**
	2	81.95	84.29	84.19	85.00	85.93	**84.27**	82.09	84.51	84.38	84.38	85.95	**84.26**
	4	78.06	81.19	79.90	81.75	83.03	**80.79**	78.53	82.69	79.38	81.63	84.63	**81.37**
	6	76.22	79.34	75.19	78.71	78.41	**77.57**	74.47	79.27	75.47	78.62	76.96	**76.96**
	Mean	**81.23**	**84.11**	**82.55**	**84.94**	**84.85**	**83.54**	**80.25**	**83.71**	**82.20**	**83.61**	**84.24**	**82.80**
Cover with leaves	0	88.70	91.61	90.94	94.30	92.01	**91.51**	85.89	88.37	89.57	89.81	89.44	**88.62**
	2	86.64	89.07	88.06	87.82	89.24	**88.17**	85.01	86.70	86.44	87.92	87.66	**86.75**
	4	85.20	86.60	85.10	84.99	87.44	**85.87**	82.92	84.35	84.41	86.62	86.42	**84.94**
	6	82.81	82.07	79.98	83.84	81.65	**82.07**	81.07	82.54	82.11	85.76	83.23	**82.94**
	Mean	**85.84**	**87.34**	**86.02**	**87.74**	**87.59**	**86.90**	**83.72**	**85.49**	**85.63**	**87.53**	**86.69**	**85.81**
Ca (OH)2	0	88.70	91.61	90.94	94.30	92.01	**91.51**	85.89	88.37	89.57	89.81	89.44	**88.62**
	2	82.91	87.53	87.05	86.49	87.61	**86.32**	82.99	84.54	85.49	87.17	87.65	**85.57**
	4	79.96	84.87	83.46	84.50	86.38	**83.83**	80.66	82.74	81.04	85.78	85.45	**83.13**
	6	77.22	80.60	78.63	81.92	80.70	**79.81**	78.75	79.13	76.74	83.91	80.93	**79.89**
	Mean	**82.20**	**86.15**	**85.02**	**86.80**	**86.68**	**85.37**	**82.07**	**83.70**	**83.21**	**86.67**	**85.87**	**84.30**
S. period x Varieties	0	**88.70**	**91.61**	**90.94**	**94.30**	**92.01**	**91.51**	**85.89**	**88.37**	**89.57**	**89.81**	**89.44**	**88.62**
	2	**83.83**	**86.97**	**86.43**	**86.44**	**87.60**	**86.25**	**83.36**	**85.25**	**85.44**	**86.49**	**87.09**	**85.53**
	4	**81.07**	**84.22**	**82.82**	**83.75**	**85.62**	**83.50**	**80.70**	**83.26**	**81.61**	**84.67**	**85.50**	**83.15**
	6	**78.75**	**80.67**	**77.93**	**81.49**	**80.25**	**79.82**	**78.10**	**80.31**	**78.10**	**82.77**	**80.37**	**79.93**
Mean		**83.09**	**85.87**	**84.53**	**86.49**	**86.37**	**85.27**	**82.01**	**84.30**	**83.68**	**85.94**	**85.60**	**84.31**
LSD at .05 level for:													
Post-harvest treatment (A)							**0.518**						**0.588**
Storage periods (B)							**0.437**						**0.980**
Sugar beet varieties (C)							**0.658**						**0.852**
A x B							**0.758**						**1.696**
A x C							**1.140**						**N.S**
B x C							**1.317**						**1.704**
A x B x C							**2.281**						**2.954**

Conclusions

Sugar beet considered one of the essential wings for production and minimizes the gap between production and consumption of sugar. We can conclude that the roots covered with leaves reduce the weight loss % of sugar beets more than uncovered roots. Also, as a storage period increased, up to 6 days, sucrose %, sucrose, purity, sugar recovery, and sugar beet quality decreased. In the future, it is preferable to use sugar beet leaves, which are considered waste, as an alternative to chemicals and reduce the cost of producing sugar.

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تأثير بعض معاملات ما بعد الحصاد على صفات جودة بنجر السكر أثناء التخزين تحت ظروف منطقة توشكى

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أجريت هذه الدراسة خلال موسمي حصاد ٢٠١٨ و ٢٠١٩ بمحطة بحوث الصحراء بتوشكي – محافظة أسوان ، لمعرفة تأثير معاملات ما بعد الحصاد (تغطية باوراق البنجر، الغمس في محلول هيدروكسيد الكالسيوم وعينة الكنترول) وفترات تخزين مختلفة (٠ ، ٢ ، ٤ و ٦ أيام) على خصائص الجودة لبعض أصناف بنجر السكر (أوسكار بولى، اثوسبولى ، ساره، فرانشسكا و روفائيل) تحت ظروف منطقة توشكى وتم استخدام تصميم القطع المنشقة بثلاث مكررات. أشارت النتائج إلى أن معاملات ما بعد الحصاد كان لها تأثير معنوي على صفات الجودة لكلاً من الفقد فى وزن الجذور، السكروز، النقاوة، السكر المفقود فى المولاس، ناتج السكر النظرى، جودة البنجر . هذا و قد سجلت معاملة تغطية الجذور بأوراق البنجر أفضل القيم لجميع الصفات محل الدراسة.

أوضحت النتائج أن زيادة فترة تأخير التوريد حتى ٦ أيام أدت إلى انخفاض معنوي في النسبة المئوية للسكروز والنقاوة وناتج السكر النظرى و جودة البنجر. من ناحية أخرى ، ادت الى زيادة نسبة الفاقد من وزن الجذور و السكر فى المولاس. اختلفت الأصناف الخمسة اختلافًا معنوياً في جميع الصفات محل الدراسة، كما تفوق الصنف أثوسبولي على الأصناف الأخرى في النسبة المئوية للسكروز (٦٠,٣٧ و٦٩,٨٢) وناتج السكر النظرى (٥٢,٣٥ و٥٩,٢٣). بينما سجل الصنف روفائيل أفضل قيم في النسبة المئوية للنقاوة (٩٢,٨١ و٩٢,٧٠) و جودة البنجر (٨٦,٤٩ و٨٥,٩٤)، كما سجل صنف فرانشسكا أقل القيم لنسبة الفقد فى وزن الجذور (١٤,٢١ و ١٤,٠٩).