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PHYSIOLOGICAL STUDIES ON JERUSALEM ARTICHOKE
2- EFFECT OF HARVESTING DATES, WRAPPING FILM AND STORAGE TEMPERATURE ON QUALITY ATTRIBUTES OF JERUSALEM ARTICHOKE (LOCAL CULTIVAR) DURING STORAGE.

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ABSTRACT

These experiments were carried out during two successive seasons 2007/2008 and 2008/2009 on Jerusalem artichoke local cultivar. Plants were grown at Katatba Menofya Governorate under sandy soil and drip irrigation system. Planting date was 15th of April and tubers were harvested at 15th of November and 15th of December in the two seasons, to study the yield, physical, chemical changes happened in tubers during harvesting date to determine the proper stage of harvesting. Effect of wrapping film and storage temperatures (0 °C, 5 °C and 10 °C) were examined to improve the storability of tubers.

Results indicated that Jerusalem artichoke tubers of Local cultivar harvested on 15th of November was the proper stage of harvesting which showed the higher tuber weight / plant, total yield, marketable yield, dry matter and inulin percentage. However, tubers harvested on 15th December was higher in total sugars percent when compared with those were harvested at15th November.

For the wrapping film, the non perforated polypropylene bags (nppb) treatment was the most effective in reducing weight loss. Weight loss was greater in the unwrapped tubers. Wrapping tubers in perforated polypropylene bags gave the lowest decay incidence and maintained dry matter and inulin content during storage.

Examining of storage temperature, tubers stored at 0 °C showed the lowest loss in weight and decay percentage and holds more dry matter and inulin content comparing with those stored at 5 or 10 °C. Tubers stored at 10 °C gave the highest loss in weight and decay percentage.

Jerusalem artichoke tubers, Local cultivar, harvested on 15th of November and wrapped with ppb and stored at 0 °C resulted in an important improvement in market quality through reduce decay percentage and hold more dry matter and Inulin content and gave tubers with good appearance for 5 months of storage at 0 °C.

INTRODUCTION

Jerusalem artichoke (*Helianthus tuberosus* L.). Is an alternative plant useful in many ways. It is interesting because of high sugar content, total carbohydrate (primarily inulin) and dry matter. Jerusalem artichoke is a good source of fructose, useful in food industry and for pharmaceuticals (Ben Chekroun *et al.*, 1994).The productivity and quality of Jerusalem artichoke tubers depends upon many factors, such as climate , the harvesting maturity, wrapping film ,storage temperature , and the storage time after harvest (De Leenheer and Hoebress ,1994; Coussement, 1999).

Several studies were done to determine the physical and chemical changes in Jerusalem artichoke tubers during different harvesting dates. Pinpong (1997) found that the optimum harvesting date of Jerusalem artichoke in Tialand was between 18 and 20 week after planting. Weight of fresh tuber, increased rapidly over 12 – 18 weeks. Saengthongpinit and Sajjaanantakul (2005) found that the dry matter and Inulin of Jerusalem artichoke tubers increased with maturity from 16 – 18 then decreased in the 20 week. Total sugars of tubers increased with advanced maturity. They also found that after 20 weeks, loss of weight and firmness, and reduction in specific gravity, Inulin, total sugars, and carbohydrates of tubers occurred rapidly.

Storage temperature is the most important factor for regulations the rate of associated physical and chemical processes happened in the tubers. Evidence has been presented on Jerusalem artichoke tubers by Molder *et al*. (1993) who found that higher storage temperature increased weight loss, decay and encouraged breakdown of total sugars and Inulin during storage, Tindan (1986) revealed that at higher temperature the tubers are rapidly shrivel and are more likely to decay than if kept at low temperature. Also Afek and Kays (2004) and Danilcenko *et al*., (2008) found that Jerusalem artichoke tubers can be stored for 6 – 12 months at 0 to 2 °C and 90 – 95 % RH.

The use of selective film for prolonging the storability of tubers was studied. Packed Jerusalem artichoke tubers in polyethylene bags reduced weight loss and delayed tuber senescence compared with unpackaged during storage (Stepanests *et al*., 1992; El- Sharkawy, 1998; Danilcenko *et al*.,2008).

The first part of this study showed that the Local cultivar produced higher yield of tubers with better quality (dry matter, inulin and total sugars) compared to c.v Fusaeu. Therefore the objective of the present work was to study the yield and quality of tubers during the harvesting dates to determine the proper stage of harvesting, effect of wrapping film and storage temperature were examined to improve the storability of Jerusalem artichoke Local cultivar tubers.

MATERIALS AND METHODS

The experiment was carried out during two successive seasons 2007/2008 and 2008/2009 on Jerusalem artichoke Local cultivar. This cultivar is commonly cultivated in Egypt. Plants were grown at El-Katatba, Menofya Governorate under sandy soil and drip irrigation system.

Tubers were planted on 15 th of April for the two seasons. Agricultural practices took place whenever it was necessary according to the recommendations of Ministry of Agriculture.

Harvesting date:

Jerusalem artichoke tubers were harvested for different maturity stages on 15th of November and 15th of December in the two seasons. At harvest, nine plants from each harvesting date were taken at random to estimate the

total yield and marketable yield as well as dry matter, inulin and total sugar percentage of tubers.

Storage experiment:

Jerusalem artichoke tubers were harvested on 15 November, then transported immediately to the laboratory of postharvest center, Horticulture Research Institute. Tubers were sorted out and all the defected tubers were discarded, then packed in perforated and non perforated polypropylene bags (15µm) in addition to unpacked tubers (control). Eighteen replicates were prepared for each wrapping film and control; each replicate weighed approximately 250 gm, and placed in carton boxes (30*20*10cm).

All treatments were stored at various temperature degrees (0, 5 and 10°C) and RH 90- 95 %. Complete randomized design was adopted. Three replicates from each wrapping film and temperature degree were taken at random and examined every month for the following properties: weight loss, decay, general appearance, dry matter, Inuline (analyzed according to Winton and Winton,1958), total sugars (analyzed .according to Nelson, 1974; Somogyi, 1952).

All obtained data were statistically analyzed according to the method described by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

Results presented in Table (1) revealed that harvesting date of Jerusalem artichoke had a significant effect on tuber yield and marketable yield per fadden at the first season and dry matter and inulin percentage during the two seasons. However, total and marketable yield per Fadden, dry matter and inulin percentage were higher in tubers harvested at 15 November compared with those harvested at 15 December. However, total sugars percentage was higher in tubers harvested at 15 December during the two seasons compared with those harvested at 15 November. While, total sugars content was increase with maturity stage. These results were agreement with those obtained by Saengthongpinit and Sajjaanntakul (2005) who found that total sugars content in Jerusalem artichoke tubers increased rapidly up to 9-fold in the late of maturity compared to those at early stages.

From the same table it was observed that decreasing in inulin content and increase total sugars were seen in tubers harvested in 15 December compared with those harvested at 15 November, which had higher inulin and lower contents of sugars. These results caused by the depolymeristation of fruetan by fructan exohydrolase (FEH), (Edelman and Jefford, 1968), and also could be attributed to the increase in free fructose could indicate increased the activity of Inulinase as the tuber grown older which resulted in lower content of inulin (Limami and Fiala,1993).

Also, the data in Table (1) revealed that the increasing in dry matter content in tubers were associated with increasing yield harvested at 15

November. These results agree with those obtained by (Soja *et al.*, (1990). However, the late of maturity data show that dry matter was low, so the total yield was lower. These results were in agreement with those obtained by Saengthongpinit and sajjaanntakul (2005). Who found that the dry matter which estimate tubers yield, was lower at the late maturity tubers.

Table (1): Effect of harvesting date on dry matter, inulin, total and total,marketable yield of balady cultivar in 2007 and 2008 seasons.

Harvesting date	Total yield (ton/ fed)	Marketable yield (ton / fed)	Dry matter %	Inulin (%) (D.W)	Total sugars% (F.W)
	2007 season				
15 November	23.49	17.78	22.98	10.09	8.02
15 December	18.31	13.25	21.61	9.21	8.34
LSD at 0.05 % level	2.58	1.17	0.22	0.21	0.08
	2008 season				
15 November	18.64	15.70	24.68	9.29	8.59
15 December	17.09	15.76	23.18	8.25	8.86
LSD at 0.05 % level	NS	NS	0.19	0.13	0.10

From the previous results it could be concluded that Jerusalem artichoke tubers cv. local harvested at 15 November seems to be the optimum harvest time which obtained high total yield and marketable yield / Fadden and gave tubers with good quality (higher dry matter and inuline percentage).

Storage experiment:

Weight loss:

Data in Table (2) showed that the period of storage had a significant effect on the percentage of weight loss, the loss in weight was increased as the storage period elapsed in the two seasons. The decrease in fresh weight of Jerusalem artichoke tubers might be attributed to the loss in moisture through transpiration and loss in dry matter content through respiration (Wills *et al.*, 1981). These results agree with those obtained by El_ Sharkawy *et al*. (2003).

However, it was observed that packed Jerusalem artichoke tubers in perforated polypropylene bags (ppb) or non perforated polypropylene bags (nppb) slowed the rate of weight loss comparatively to the highest ones obtained from unpacked tubers. A non perforated bag surpasses the perforated ones in minimizing tubers weight loss percentage during storage. Application of polypropylene film for storage strongly affected the rate of transpiration. Unpacked tubers showed the highest weight loss percentage. Tubers of Jerusalem artichoke have a thin and delicate skin and after harvest it became sensitive to water escape (Danilcenko *et al.*, 2008). The use of polypropylene bags might reduce respiration rate of the tuber and reduce O_2, increase CO_2 and hinder against moisture loss in the package and inhibited certain ripening processes which diminished the weight loss in tubers during storage (Molder *et al*., 1993).

Various temperature degrees showed significant differences in tuber weight loss, however, tubers stored at 0°C exhibited the least loss compared

with tubers stored at 5 or 10°C. Lower temperature reduced the rate of physiological processes(respiration and transpiration) and hence decreased the speed of this character (Danilcenko *et al .,* 2008), while, Cabezas *et al* .(2002) found that tubers kept for 30 days at temperature of 18 °C can loss above 20% of water.

Table (2): Effect of storage temperature and wrapping film on weight loss percentage of Jerusalem artichoke tubers in 2007/2008 and 2008/2009 seasons.

Temperature	Wrapping film	2007/2008 season storage period(month)						mean	2008 /2009 season storage period(month)						mean
		0	1	2	3	4	5		0	1	2	3	4	5	
0 °C	ppb	0.00	0.92	1.44	2.45	3.32	4.58	2.54	0.00	0.82	1.31	2.52	3.41	4.68	2.55
	n ppb	0.00	0.19	0.22	0.29	0.64	0.72	0.41	0.00	0.11	0.21	0.25	0.50	0.61	0.34
	Control	0.00	2.26	3.03	4.14	4.98	6.35	4.15	0.00	2.16	2.94	3.92	4.81	5.98	3.96
	Mean	0.00	1.12	1.56	2.29	2.98	3.88	2.37	0.00	1.03	1.49	2.23	2.91	3.76	2.28
5° C	ppb	0.00	1.12	1.88	2.95	4.05	5.56	3.11	0.00	0.98	2.10	3.10	3.98	5.31	3.09
	n ppb	0.00	0.25	0.34	0.50	0.81	1.12	0.60	0.00	0.18	0.31	0.55	0.78	0.94	0.55
	Control	0.00	2.76	3.94	4.98	5.62	7.62	4.98	0.00	2.62	3.41	4.64	5.36	6.98	4.60
	Mean	0.00	1.38	2.05	2.81	3.49	4.77	2.90	0.00	1.26	1.94	2.76	3.37	4.41	2.75
10° C	ppb	0.00	1.74	2.81	3.92	4.46	6.93	3.97	0.00	1.87	2.61	3.84	4.32	7.14	3.96
	n ppb	0.00	0.74	0.93	1.17	1.32	1.51	1.13	0.00	0.82	1.10	1.32	1.41	1.65	1.26
	Control	0.00	3.92	6.11	8.14	10.31	12.63	8.22	0.00	4.14	6.23	8.41	10.25	11.94	8.19
	Mean	0.00	2.13	3.28	4.41	5.36	7.02	4.44	0.00	2.28	3.31	4.52	5.33	6.91	4.47
Wrapping film	ppb	0.00	1.26	2.04	3.11	3.94	5.69	3.21	0.00	1.22	2.01	3.15	3.90	5.71	3.20
	n ppb	0.00	0.39	0.50	0.65	0.92	1.12	0.72	0.00	0.37	0.54	0.71	0.90	1.07	0.72
	Control	0.00	2.98	4.36	5.75	6.97	8.87	5.79	0.00	2.97	4.19	5.66	6.81	8.30	5.59
	Mean	0.00	1.54	2.30	3.17	3.95	5.22		0.00	1.52	2.25	3.17	3.87	5.03	
LSD at 0.05 %	Storage temperature(A)	0.42								0.40					
	Wrapping film (B)	0.74								0.69					
	Storage period (C)	0.82								0.72					
	A*B	0.62								0.75					
	A*B*C	0.94								0.81					

npp= perforated poly propylene n ppb= non perforated poly propylene control = un packed tubers

Regarding the effect of the interaction of wrapping film, storage temperature and storage period, data revealed that the highest weight loss after 5 months of storage was found with unpacked tuber stored at 10 °C however, tubers packed in non perforated polypropylene bags stored at 0 °C gave the lowest ones after the same period.

Decay:

Data in Table (3) clear that decay percentage of Jerusalem artichoke tubers increased with prolongation of storage period. This finding may be attributed to that the biological activity in tuber became low at the later period of storage and this in turn led to fungal and bacterial infection. These results are in a harmony with those obtained by El- Sharkawy *et al.* (2003).

Table (3): Effect of storage temperature and wrapping film on decay percentage of Jerusalem artichoke tubers in 2007/2008 and 2008/2009 seasons.

Temperature	Wrapping film	2007/2008 season storage period(month)						mean	2008 /2009 season storage period(month)						mean
		0	1	2	3	4	5		0	1	2	3	4	5	
0 °C	ppb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	n ppb	0.00	0.00	0.00	0.00	10.12	13.42	4.71	0.00	0.00	0.00	0.00	14.22	20.31	6.91
	Control	0.00	0.00	0.00	0.00	12.15	15.22	5.47	0.00	0.00	0.00	0.00	13.45	23.14	7.32
	Mean	0.00	0.00	0.00	0.00	7.42	9.55	3.39	0.00	0.00	0.00	0.00	9.22	14.48	4.74
5° C	ppb	0.00	0.00	0.00	0.00	0.00	19.22	3.84	0.00	0.00	0.00	0.00	0.00	23.18	4.64
	n ppb	0.00	0.00	0.00	8.48	15.27	23.19	9.39	0.00	0.00	0.00	5.17	13.14	28.45	9.35
	Control	0.00	0.00	0.00	9.29	19.28	27.46	11.21	0.00	0.00	0.00	10.14	16.22	30.14	11.30
	Mean	0.00	0.00	0.00	5.92	11.52	23.29	8.15	0.00	0.00	0.00	5.10	9.79	27.26	8.43
10° C	ppb	0.00	0.00	0.00	0.00	12.67	25.28	7.59	0.00	0.00	0.00	0.00	10.24	22.16	6.48
	n ppb	0.00	0.00	0.00	11.35	20.24	35.24	13.37	0.00	0.00	0.00	12.92	17.23	30.84	12.20
	Control	0.00	0.00	0.00	13.11	25.27	38.24	15.32	0.00	0.00	0.00	15.14	23.18	35.14	14.69
	Mean	0.00	0.00	0.00	8.15	19.39	32.92	12.09	0.00	0.00	0.00	9.35	16.88	29.38	11.12
Wrapping film	ppb	0.00	0.00	0.00	0.00	4.22	14.83	3.81	0.00	0.00	0.00	0.00	3.41	15.11	3.71
	n ppb	0.00	0.00	0.00	6.61	15.21	23.95	9.15	0.00	0.00	0.00	6.03	14.86	26.53	9.49
	Control	0.00	0.00	0.00	7.47	18.90	26.97	10.67	0.00	0.00	0.00	8.43	17.62	29.47	11.10
	Mean	0.00	0.00	0.00	4.69	12.78	21.92		0.00	0.00	0.00	4.82	11.96	23.71	
LSD at 0.05 %level	Storage temperature(A)	2.41								2.64					
	Wrapping film (B)	1.12								1.06					
	Storage period (C)	3.21								2.94					
	A*B	2.65								2.50					
	A*B*C	2.74								2.68					

npp= perforated poly propylene n ppb= non perforated poly propylene control = un packed tubers

It is clear from the data that Jerusalem artichoke tubers packed in perforated polypropylene bags (ppb) was the most effective ones in minimizing decay percentage during whole periods of storage. On the contrary, the highest ones were obtained when using non perforated polypropylene bags (nppb) and unpacked tubers. The higher percentage of decay in nppb may be due to that the relative humidity in the non perforated bags is close to saturation. Therefore, water condensation on the surface of both films and produce. The most deleterious effect of inpack condensation is enhancement of growth pathogens, resulting in produce decay. In addition, a combination of high humidity and low O_2 is favorable for the development of human pathogens (Hintlian and Hothkiss 1986). The low decay incidence in perforated film could be attributed to the continuous ventilation, less moisture condensation, suppression of off flavor development (Abd El Rahmen, 2001). These results are in a harmony with those reported by (Danilcenko *et al* ., 2008), who mentioned that the ability to store Jerusalem artichoke tubers in polyethylene bags for period of up to one year is a significant improvement over conventional storage where spoilage commences between 5 and 11 weeks.

Concerning storage temperature, data showed that the less the temperature of storage, the less the percentage of decayed tubers. This may be explained by Saengthongpinit and Sajjaanantakul.(2005) on Jerusalem artichoke tubers, when they pointed that decay percentage was minimized in stored tubers under low temperature conditions than the higher ones. However, the decay tubers started to be observed at 3 months at 5 and 10 °C, and at 4 months at 0 °C. Molder *et al*., (1993) noticed that Jerusalem artichoke tubers, which stored at 2 and 5 °C exhibited decay after 12 and 6 months from storage, respectively.

Concerning the interaction among storage temperature, wrapping film and storage period, data presented in Table(3) indicated that no decay was observed in Jerusalem artichoke tubers packed in ppb and stored at 0 °C during five months of storage, However, the highest decay percentage was observed in unpacked tubers stored at 10 °C.

General appearance:

Data in Table (4) show that general appearance (GA) of Jerusalem artichoke tubers was decreased with the prolongation of storage period. The decrease of GA during storage period might be due to shriveling, change in color and decay. Similar results were reported by El-Sharkawy *et al*. (2003).

However, Jerusalem artichoke tubers packed in perforated polypropylene bags gave the highest value of GA, while those packed in non perforated ones or unpacked resulted in the lowest rates.

From the same data it is obvious that the general appearance of tubers was significantly affected by different storage temperature. The highest values of GA comparatively resulted from tubers stored at 0 °C or 5 °C and the lowest ones come from storing at 10 °C. These results are matched will with those obtained by Molder *et al*. (1993) who found that Jerusalem artichoke tubers retained better quality when stored at 2 or 5 °C. These results might be attributed to that lower temperature, led to a depression in the vital physiological and biochemical reactions in the tubers which in turn minimize the shriveling and decay (Danilcenko *et al* ., 2008).The interaction among storage temperature, wrapping film and storage period was significant. Jerusalem artichoke tubers packed in perforated polypropylene bags and then stored at 0 °C did not exhibit any changes in their appearance till 4 months and gave tubers with good appearance after 5 months of storage. Meanwhile, tubers packed in non perforated ones rated excellent appearance after 3 months at 0 °C. On the other hand, tubers appearance stored at 10 °C rated good appearance after 1month and dropped to poor appearance at 3 months.

Table (4): Effect of storage temperature and wrapping film on general appearance (score) of Jerusalem artichoke tubers in 2007/2008 and 2008/2009 seasons.

Temperature	Wrapping film	2007/2008 season storage period(month)						mean	2008 /2009 season storage period(month)						mean
		0	1	2	3	4	5		0	1	2	3	4	5	
0 °C	ppb	9.00	9.00	9.00	9.00	8.33	7.67	8.67	9.00	9.00	9.00	9.00	7.67	7.00	8.45
	n ppb	9.00	9.00	9.00	8.33	5.67	3.67	7.45	9.00	9.00	9.00	7.67	5.67	3.67	7.34
	Control	9.00	9.00	8.33	5.67	4.33	3.00	6.56	9.00	9.00	9.00	7.67	5.00	3.00	7.11
	Mean	9.00	9.00	8.78	7.67	6.11	4.78	7.56	9.00	9.00	9.00	8.11	6.11	4.56	7.63
5° C	ppb	9.00	9.00	9.00	7.67	7.67	5.67	8.00	9.00	9.00	9.00	7.67	7.00	5.00	7.78
	n ppb	9.00	9.00	8.33	5.67	5.00	3.00	6.67	9.00	9.00	8.33	6.33	5.67	3.00	6.89
	Control	9.00	9.00	6.33	4.33	3.67	3.00	5.89	9.00	9.00	8.33	5.67	5.00	3.00	6.67
	Mean	9.00	9.00	7.89	5.89	5.45	3.89	6.85	9.00	9.00	8.55	6.56	5.89	3.67	7.11
10° C	ppb	9.00	9.00	9.00	7.00	5.67	5.00	7.45	9.00	9.00	9.00	7.67	5.67	4.33	7.45
	n ppb	9.00	9.00	8.33	5.67	4.33	3.00	6.56	9.00	9.00	8.33	5.00	3.67	3.00	6.33
	Control	9.00	9.00	5.00	3.67	3.67	3.00	5.56	9.00	9.00	7.00	5.00	3.67	3.00	6.11
	Mean	9.00	9.00	7.44	5.45	4.56	3.67	6.52	9.00	9.00	8.11	5.89	4.34	3.44	6.63
Wrapping film	ppb	9.00	9.00	9.00	7.89	7.22	6.11	8.04	9.00	9.00	9.00	8.11	6.78	5.44	7.89
	n ppb	9.00	9.00	8.55	6.56	5.00	3.22	6.89	9.00	9.00	8.55	6.33	5.00	3.22	6.85
	Control	9.00	9.00	6.55	4.56	3.89	3.00	6.00	9.00	9.00	8.11	6.11	4.56	3.00	6.63
	Mean	9.00	9.00	8.04	6.33	5.37	4.11		9.00	9.00	8.55	6.85	5.45	3.89	
LSD at 0.05 %level	Storage temperature(A)	0.30								0.43					
	Wrapping film (B)	0.43								0.54					
	Storage period (C)	0.71								0.68					
	A*B	0.84								0.60					
	A*B*C	0.86								0.74					

npp= perforated poly propylene n ppb= non perforated poly propylene control = un packed tubers

General appearance score: 9 = excellent, 7 = good, 5 = fair, 3 = poor, and 1 = unusable.

Dry matter:

Data in Table (5) showed that dry matter content was significantly affected by the period of storage in both seasons. Dry matter increased until 90 days of storage and then it decreased with increasing storage period, i.e. at150 days. The increase in the first period might owe much to the higher rate of moisture loss through transpiration than the rate of dry matter loss through respiration. The reduction in dry matter during the last period of storage might be attributed to the higher rate of sugar loss through respiration than the water loss through transpiration (Wills *et al*., 1981). Ben Chekroun *et al*. (1997) showed that the dry matter of Jerusalem artichoke tubers maintained for the first 7 weeks of cold storage beyond this period, a decrease trend takes place until the end of the storage.

However, there were clear evidences from the data that Jerusalem artichoke tubers packed in ppb hold more dry matter content than nppb or the unpacked tubers. Danilcenko *et al*., (2008) found also that the higher dry matter content was found in tubers packed in polyethylene bags.

Concerning storage temperature, data revealed that tubers stored at lower temperature (0 and 5°C) hold more dry matter content than those kept at higher temperature (10 °C). These results might be attributed to that lower temperature led to a depression in the vital physiological and biochemical reaction in the tubers which in turn minimize the exhaust of dry matter (Saengthongpinit and Sajjaanantakul 2005).

The interaction among storage temperature, wrapping film and storage period was significant. The lowest value of dry matter content was noted in unpacked tubers stored at 10 °C after 5 months of storage, while the highest one was found in tubers packed in perforated polypropylene bags stored at 0 °C during the same period.

Table (5): Effect of storage temperature and wrapping film on dry matter content (% F.W) of Jerusalem artichoke tubers in 2007/2008 and 2008/2009 seasons.

Temperature	Wrapping film	2007/2008 season storage period(month)						mean	2008 /2009 season storage period(month)						mean
		0	1	2	3	4	5		0	1	2	3	4	5	
0 °C	ppb	22.98	23.31	23.42	23.55	23.40	23.21	23.31	24.68	24.89	24.95	25.06	24.80	24.67	24.84
	n ppb	22.98	23.20	23.32	23.50	23.10	22.61	23.12	24.68	24.79	24.80	24.87	24.50	23.90	24.59
	Control	22.98	23.35	23.55	23.10	22.80	22.28	23.01	24.68	24.90	25.05	24.51	24.03	23.71	24.48
	Mean	22.98	23.29	23.43	23.38	23.10	22.70	23.15	24.68	24.86	24.93	24.81	24.44	24.09	24.64
5° C	ppb	22.98	23.34	23.45	23.61	23.20	22.62	23.20	24.68	24.92	24.98	25.12	24.61	24.00	24.72
	n ppb	22.98	23.26	23.37	23.51	22.70	22.11	22.99	24.68	24.82	24.87	24.93	24.31	23.61	24.54
	Control	22.98	23.42	23.64	22.90	22.40	21.81	22.86	24.68	24.99	25.13	24.62	23.83	23.11	24.39
	Mean	22.98	23.34	23.49	23.34	22.77	22.18	23.02	24.68	24.91	24.99	24.89	24.25	23.57	24.55
10° C	ppb	22.98	23.35	23.54	23.61	22.90	22.10	23.08	24.68	24.98	25.10	25.19	24.32	23.51	24.63
	n ppb	22.98	23.32	23.45	23.65	22.30	21.70	22.90	24.68	24.90	24.96	25.09	24.11	23.13	24.48
	Control	22.98	23.49	23.72	22.74	22.01	21.41	22.73	24.68	25.11	25.19	24.38	23.52	22.50	24.23
	Mean	22.98	23.39	23.57	23.33	22.40	21.74	22.90	24.68	25.00	25.08	24.89	23.98	23.05	24.45
Wrapping film	ppb	22.98	23.33	23.47	23.59	23.17	22.64	23.20	24.68	24.93	25.01	25.12	24.58	24.06	24.73
	n ppb	22.98	23.26	23.38	23.55	22.70	22.14	23.00	24.68	24.84	24.88	24.96	24.31	23.55	24.54
	Control	22.98	23.42	23.64	22.91	22.40	21.83	22.86	24.68	25.00	25.12	24.50	23.79	23.11	24.37
	Mean	22.98	23.34	23.50	23.35	22.76	22.21		24.68	24.92	25.00	24.86	24.23	23.57	
LSD at 0.05 %	Storage temperature(A)	0.11								0.08					
	Wrapping film (B)	0.13								0.10					
	Storage period (C)	0.14								0.15					
	A*B	0.10								0.09					
	A*B*C	0.16								0.15					

npp= perforated poly propylene n ppb= non perforated poly propylene control = un packed tubers

Inulin content:

Data in Table (6) showed that inulin content in Jerusalem artichoke tubers decreased gradually during storage. This decrement could be attributed to the gradual increase of destruction inulinase .These results were in agreement with those obtained by Saengthongpinit and

Sajjaanantakul.(2005) who found that long term storage of Jerusalem artichoke tubers would inevitably affect inulin composition ,i.e. degradation to shorter chains. They found also that Jerusalem artichoke tuber tissue metabolism could continue at a slow rate, even at 2 °C storage temperature. Cold storage would therefore retard undesirable changes in the inulin characteristics during storage. On the other hand Molder *et al* .(1993) found that higher temperature encouraged breakdown of inulin and utilization of monosaccharide formed from the breakdown , presumably due to high respiration and other metabolic activities.

Table (6): Effect of storage temperature and wrapping film on inulin content (% F.W) of Jerusalem artichoke tubers in 2007/2008 and 2008/2009 seasons.

Temperature	Wrapping film	2007/2008 season storage period(month)						mean	2008 /2009 season storage period(month)						mean
		0	1	2	3	4	5		0	1	2	3	4	5	
0 °C	ppb	10.09	10.00	9.92	9.78	9.42	9.10	9.72	9.29	9.11	9.00	8.86	8.46	8.20	8.82
	n ppb	10.09	10.03	9.95	9.68	9.11	8.81	9.61	9.29	9.14	9.06	8.73	8.12	7.90	8.71
	Control	10.09	9.87	9.72	9.51	9.00	8.60	9.47	9.29	9.01	8.78	8.50	7.80	7.38	8.46
	Mean	10.09	9.97	9.86	9.66	9.18	8.84	9.60	9.29	9.09	8.95	8.70	8.13	7.83	8.66
5° C	ppb	10.09	9.88	9.73	9.42	9.06	8.82	9.50	9.29	9.00	8.90	8.75	8.43	8.00	8.73
	n ppb	10.09	9.79	9.75	9.30	8.82	8.53	9.38	9.29	9.01	8.91	8.54	8.02	7.68	8.58
	Control	10.09	9.56	9.39	9.15	8.60	8.12	9.15	9.29	8.92	8.54	8.32	7.51	7.03	8.27
	Mean	10.09	9.74	9.62	9.29	8.83	8.49	9.34	9.29	8.98	8.78	8.54	7.99	7.57	8.52
10° C	ppb	10.09	9.72	9.52	9.16	8.73	8.42	9.27	9.29	8.91	8.68	8.32	8.04	7.66	8.48
	n ppb	10.09	9.80	9.57	9.00	8.50	8.03	9.17	9.29	8.72	8.40	7.92	7.60	6.24	8.03
	Control	10.09	9.20	8.84	8.19	7.32	6.90	8.42	9 .29	8.40	8.00	7.41	7.01	6.74	7.81
	Mean	10.09	9.57	9.31	8.78	8.18	7.78	8.95	9.29	8.68	8.36	7.88	7.55	6.88	8.11
Wrapping film	ppb	10.09	9.87	9.72	9.45	9.07	8.78	9.50	9.29	9.01	8.86	8.64	8.31	7.95	8.68
	n ppb	10.09	9.87	9.76	9.33	8.81	8.46	9.39	9.29	8.96	8.79	8.40	7.91	7.27	8.44
	Control	10.09	9.54	9.32	8.95	8.31	7.87	9.01	9.29	8.78	8.44	8.08	7.44	7.05	8.18
	Mean	10.09	9.76	9.60	9.24	8.73	8.37		9.29	8.91	8.70	8.37	7.89	7.43	
LSD at 0.05 %level	Storage temperature(A)	0.19								0.13					
	Wrapping film (B)	0.10								0.15					
	Storage period (C)	0.20								0.14					
	A*B	0.21								0.15					
	A*B*C	0.22								0.17					

npp= perforated poly propylene n ppb= non perforated poly propylene control = un packed tubers

Concerning wrapping film, Jerusalem artichoke tubers packed in ppb retained more inulin content compared with unpacked tubers. Control tubers showed the lowest inulin content, while tubers packed in nppb showed a slight delay in inulin degradation.

The interaction of wrapping film, storage temperature and storage period was significant after 5 months of storage. The lowest value of inulin content was observed with unpacked tubers stored at 10 °C, while the highest one was found in tubers packed in ppb stored at 0 °C , these results were in agreement with obtained by (Danilcenko *et al.*, 2008).

CONCLUSION

Jerusalem artichoke tubers, Local cultivar, harvested on 15th of November and wrapped with ppb and stored at 0 °C produced an important improvement in market quality through, reduce decay percentage and hold more dry matter and inulin content and gave tubers with good appearance for 5 months of storage at 0 °C.

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دراسات فسيولوجية على الطرطوفة
٢- تأثير موعد الحصاد والتغليف ودرجات حرارة التخزين على مواصفات الجودة لدرنات الطرطوفة (الصنف البلدى) خلال التخزين

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****قسم بحوث البطاطس والخضر خضرية التكاثر – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر**

اجريت هذه الدرراسة فى مزرعة الخطاطبة – محافظة المنوفية خلال موسمى ٢٠٠٨/٢٠٠٧ و ٢٠٠٩/٢٠٠٨ على درنات الطرطوفة الصنف المحلى. تمت الزراعة فى ١٥ ابريل وتم الحصاد فى ١٥ نوفمبر و ١٥ ديسمبر فى كلا الموسمين لدراسة المحصول الكلى والقابل للتسويق والتغير فى الصفات الطبيعية والكيماوية التى تحدث خلال مراحل النضج لتحديد انسب مرحلة للحصاد كما تم دراسة تأثير التغليف ودرجات حرارة التخزين (صفر° م , ٥° م , ١٠° م) على تحسين القدرة التخزينية لدرنات الطرطوفة.

اوضحت النتائج ان :

١. انسب موعد لحصاد درنات الطرطوفة الصنف المحلى هو ١٥ نوفمبر مقارنة بميعاد الحصاد ١٥ديسمبر حيث اعطى كمية محصول كلى وقابل للتسويق كما ارتفع محتوى الدرنات من من المادة الجافة والانيولين , بينما اعطت الدرنات التى تم حصادها فى ١٥ ديسمبر اعلى محتوى من السكريات الكلية.

٢. ادى تعبئة الدرنات فى اكياس البولى بروبلين غير المثقب اقل نسبة فقد فى الوزن بينما اعطت الكنترول (بدون تغليف) اكبر نسبة فقد فى الوزن.

٣. كما اوضحت النتائج ان تعبئة درنات الطرطوفة فى البولى بروبلين المثقب قد اعطى اقل نسبة تالف واحتفظت الدرنات بالمادة الجافة والانيولين خلال التخزين.

٤. لوحظ ان تخزين درنات الطرطوفة على درجة صفر° م قد اعطت اقل نسبة فقد فى الوزن والتالف واحتفظت بأكبر كمية من المادة الجافة والانيولين عند مقارنتها بالتخزين على درجة حرارة ٥° م , ١٠° م حيث اعطت الدرنات التى خزنت على ١٠ °م اكبر نسبة فقد فى الوزن والتالف.

٥. لذا فأن درنات الطرطوفة للصنف المحلى فى ١٥ نوفمبر ثم التعبئة فى عبوات بولى بروبلين مثقب والتخزين على درجة صفر م ادى الى تحسين الجودة التسويقية حيث قللت من التالف واحتفظت بالمادة الجافة والانيولين واعطت درنات جيدة المظهر لمدة تصل الى ٥ شهور من التخزين.

قام بتحكيم البحث

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