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Impact of Packaging on Keeping Quality and Postharvest Losses of Husk Tomato (*Physalis pubescens* L.) Fruits Stored at Room Conditions

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ABSTRACT

The experiment was carried out during the two seasons of 2017 and 2018 in the Faculty of Agriculture, Ain Shams University, to study the effect of packing treatments on the storage ability of husk tomato. The packaging of treatments were non-perforated, 2 and 4% perforated polyethylene bags or punnets and foam dishes. The obtained results indicated that weight loss, decay, total losses, and total sugars were increased with extending the storage period up to 10 days whereas the vitamin C and firmness were decreased. The perforated packages were the most effective in reducing decay. The 4% perforated polyethylene punnuts was the best.

***Keywords*:** Fruit packaging, husk tomato, postharvest.

Introduction

The ground cherry (*Physalis pruinosa*, sometimes identified as *P. pubescens*), also called husk tomato, husk cherry or strawberry tomato, is still a novelty to many gardeners. Yet, surprisingly, it has been grown for generations and is quite possibly the easiest vegetable to grow in the entire nightshade family (*Solanaceae)*, a group that includes such popular plants as tomatoes, peppers, potatoes and eggplants. The genus *Physalis*, contains about 463 species but 100 species its fruit has an orange yellow skin, 1.25-2.50 cm diameter and 4-10 g of weight. There is growing interest in the fruits of the husk tomato (*Physalis pubescens L.*) due to its high nutritional value, it contained on dry matter basis, 11% protein, 18% fat, 13% ash, 5% total dietary fiber and about 31 kcals/100 g and b-carotene (Bock *et al.,* 1995; Olivares-Tenorio *et al.,* 2016). The fruit is a berry, with smooth, waxy, orange –yellowish. The part of the physalis that can be used is composed of 6% husk and 94%berry. They are protected by papery husks with minute seeds in a juicy pulp which is sweet and tangy resembling Chinese lanterns. Food availability and accessibility cannot only be increased by efficient production (Tilman *et al*., 2011; Benke and Tomkins, 2017), but also by reducing losses during the production and postharvest operations (McNamara and Tata, 2015). It is a waste of resources to produce food and not have it reach the consumer at a quality fit for consumption (Bourne, 2014). Reduction of food losses benefits farmers, consumers, and the environment.

To our knowledge, no available data about the best backing material for keeping the quality of husk tomato fruit during handling and the storage under ambient conditions. Consequently, the present study aimed to investigate the effect of polyethylene bags, commercial polyethylene punnets and commercial foam dishes on keeping quality and postharvest losses during marketing at room temperature.

Materials and Methods

Plant material

Mature fruits of cv 'Balady' husk tomato were obtained from an orchard located at South Tahreir, Northwest of the Delta of Egypt during 2017 and 2018 seasons. The plants were grown in sand soil (spaced at 1.5 X 0.9 m) with drip irrigation system. Light orange mature fruits were harvested in the 1st week of February in both seasons and immediately transported to the postharvest laboratory of the

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Faculty of Agriculture Ain Shams University. The fruits were uniform in size, color, and the absence of the mechanical injuries and external defects.

Treatments

Fruits were packaged in three types of packing materials, i.e. polyethylene bags, commercial polyethylene punnets and commercial foam dishes tightly covered with shrinkable polyethylene as shown in Table 1.

Table 1: The examined packing treatments

Packing Material	Treatment
Polyethylene bags	Non-perforated polyethylene bags (P.B.)
	Polyethylene bags with 2% perforation (P.B. 2%)
	Polyethylene bags with 4% perforation (P.B. 2%)
Polyethylene punnets	Non-perforated polyethylene pun nets (P.P.)
	Polyethylene punnets with 2% perforation (P.P. 2%)
	Polyethylene punnets with 2% perforation (P.P. 4%)
Foam dishes	Covered with shrinkable polyethylene (F.D,)

Each treatment was replicated six times and each replicate consisted of two bags each contained 300 g. Three replicates per each treatment were devoted to weight loss and decay measurements while the other replicates were devoted to the other measurements. The bags were put in one layer in carton boxes and kept at room conditions (16 ± 2^{o} C and a relative humidity of 70 ± 3%) and examined every two days.

Measurements

Physical measurements

Fruit weight loss was recorded as follows: weight loss = [(w0-w1)/w0] ×100 (where w0 is the initial weight and w1 is the weight measured at the sampling date). The decay incidence was determined by calculating the number of decayed fruits at the sampling date and expressed as a percentage of initial fruit number (Sultan, 2014). Fruit firmness was measured in three fruits per bag (i.e, six fruit per replicate and 18 per treatment) using a pressure tester (Digital force-Gouge Model FGV-0.5A to FGV-100A. Shimpo instruments) with a probe 5 mm in diameter, a penetration depth of 4 mm. Total losses were recorded by calculating both weight loss plus the decay percentages

Chemical measurements

After firmness measurements, fruit flesh was homogenized in the fruit juicer with 50 mL double distillated water and filtered for chemical analysis according to the methods of A.O.A.C. (2000). The total soluble solids (TSS) were determined by digital refractometer (ATAGO, mod. N-1E, Japan). The total acidity (TA) was determined by titration with NaOH 0.1 N and expressed as citric acid. Ascorbic acid (L-AA) was determined by titration with 2, 6-dichlorophenol indophenol dye. Total sugars were determined on fruit dry weight basis according to the method of Yemm and Wills (1954).

Statistical analysis

Data were statistically analyzed in a complete randomized design with three replicates. Obtained data were subjected to the analysis of variance procedure and means were compared by L.S.D. method at 5% level of significant according to Snedecor and Cochran, (1982).

Results

Weight loss

Data presented in Table (2) showed that the weight loss percentage was increased gradually by increasing the storage period up to 10 days where it recorded the highest value if compared with the other storage periods in 2017 and 2018 seasons. As for the response of weight loss percentage of husk tomato fruits to the different packaging treatments, in general, using 4% perforated punnets, followed in decreasing order by 4% perforated bags showed the highest value of weight loss. non-perforated punnets recorded the lowest values of weight loss in the two seasons. The interaction within storage

period and different packaging treatments showed that the highest weight loss was recorded after10 days with 4% perforated punnets treatment in the two seasons. Whereas, storage for 2 days recorded the lowest value with non-perforated bags in the two seasons.

Table 2: Effect of packaging treatments on weight loss percent of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

	2017							2018						
Treatments (A)	**Storage period (days) (B)**													
	0	**2**	**4**	**6**	**8**	**10**	**Mean**	**0**	**2**	**4**	**6**	**8**	**10**	**Mean**
P.B.	0.0	0.80	1.51	2.21	2.80	3.31	1.78	0.0	0.70	1.68	2.34	2.87	3.556	1.89
P.B. 2%	0.0	3.12	5.33	6.89	9.25	12.87	6.25	0.0	5.01	5.63	7.41	9.51	13.64	6.57
P.B. 4%	0.0	4.83	7.81	10.27	13.13	17.03	8.85	0.0	5.01	8.34	10.61	12.95	18.15	9.18
P.P.	0.0	0.92	1.72	2.49	3.65	4.87	2.28	0.0	0.89	1.91	2.82	3.66	5.34	2.41
P.P. 2%	0.0	3.40	5.61	7.18	9.97	12.56	6.45	0.0	5.49	6.67	7.72	10.40	13.27	6.91
P.P. 4%	0.0	5.33	8.74	11.12	15.15	19.75	10.02	0.0	5.49	9.02	11.21	14.86	20.82	10.23
F.D.	0.0	2.42	5.51	7.65	9.15	10.51	5.87	0.0	2.42	6.02	7.41	9.22	11.10	6.03
Mean	0.0	2.98	5.18	6.83	9.02	11.56		0.00	3.03	5.61	7.08	9.06	12.27	
LSD 5%	A= 0.12		B= 0.11		A x B= 0.29			A= 0.21		B= 0.19		A x B= 0.29		
P.B= perforated polyethylene					P.P= Polyethylene punnets			F.D= Foam dishes						

Decay

The lowest decay percent was registered with storage for 2 days, but the highest value was observed after 10 days of storage regardless the packaging treatments (Table 3). Using non-perforated bags resulted in the highest decay percent of husk tomato fruits. Whereas, with using packaging with 4% perforation (punnets or bags) the decay percent was the lowest, compared to the other tested treatments in the two seasons.

Table 3: Effect of packaging treatments on decay percent of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

	2017							2018						
Treatments (A)	**Storage period (days) (B)**													
	0	**2**	**4**	**6**	**8**	**10**	**Mean**	**0**	**2**	**4**	**6**	**8**	**10**	**Mean**
P.B.	0.0	1.21	6.11	16.22	26.59	41.49	15.27	0.00	1.40	6.59	16.45	27.08	42.27	15.63
P.B. 2%	0.0	0.0	1.41	9.91	16.32	25.27	8.82	0.00	0.02	1.90	9.73	16.77	24.89	8.88
P.B. 4%	0.0	0.0	0.80	6.00	11.04	17.11	5.82	0.00	0.03	0.95	5.77	11.00	17.50	5.88
P.P.	0.0	0.81	4.91	13.79	22.87	34.48	12.81	0.00	0.90	5.06	13.78	23.01	38.48	13.54
P.P. 2%	0.0	0.0	1.07	8.02	14.27	20.83	7.36	0.00	0.00	1.13	8.04	14.22	21.07	7.41
P.P. 4%	0.0	0.0	0.54	5.04	8.98	13.18	4.62	0.00	0.02	0.85	5.15	8.10	12.62	4.46
F.D.	0.0	0.0	2.09	11.25	18.30	27.98	9.93	0.00	0.04	2.30	11.61	17.99	27.88	9.97
Mean	0.0	0.29	2.42	10.03	16.91	25.77		0.00	0.34	2.68	10.08	16.88	26.39	
LSD 5%	A= 0.51		B= 0.55		A x B= 1.35			A= 0.33		B= 0.30		A x B= 0.81		
P.B= perforated polyethylene					P.P= Polyethylene punnets			F.D= Foam dishes						

The interaction between storage period and packaging treatments indicated that using non – perforated polyethylene bags followed in decreasing order by non-perforated punnuts caused the highest percent of decay after 10 days compared to other treatments.

Total losses

Data illustrated in Table (4) indicate that the percentage of losses was increased by extending the storage period up to 10 days.

Regarding the effect of different packaging treatments, the obtained results indicated that the perforated punnuts recorded the lowest values in total losses without significant different between 2 and 4 % perforated punnuts treatment. While the highest were by using the non-perforated packages

The interaction treatments between the two studied factors, showed that the total losses were the highest in both seasons after storage for 10 days with the non-perforated polyethylene bags.

Firmness

Concerning the effect of different storage period, data presented in Table (5) showed that the firmness percent of fruits was decreased gradually and constantly with increasing storage period up to 10 days.

As to packaging treatments, the statistical analyses of the obtained data showed that the highest firmness was observed with the non – perforated packing treatments without significant difference between them. Whereas the lowest value was with 4% perforated packing treatments in both seasons with no significant difference between them.

The interaction between storage periods and packaging treatments showed that the highest firmness percent was detected with non-perforated polyethylene packages and foam dish treatments but the lowest values were noticed, in general, with the perforated polyethylene packages, in both seasons.

Table 4: Effect of packaging treatments on total losses percent of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

Treatments (A)	2017 Storage period (days) (B)							2018 Storage period (days) (B)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	0.00	2.02	7.63	18.43	29.40	44.80	17.05	0.00	2.29	8.28	18.79	29.95	45.83	17.52
P.B. 2%	0.00	6.75	6.75	16.80	25.57	38.16	15.09	0.00	3.27	7.53	17.15	26.27	38.52	15.46
P.B. 4%	0.00	4.83	8.61	16.27	24.17	34.14	15.07	0.00	5.04	9.29	16.38	23.95	35.65	15.05
P.P.	0.00	1.73	6.63	16.29	26.52	39.36	13.82	0.00	1.61	6.97	16.59	26.66	43.82	15.94
P.P. 2%	0.00	6.68	6.68	15.20	24.25	33.39	14.67	0.00	3.42	7.79	15.76	24.62	34.34	14.32
P.P. 4%	0.00	5.33	9.27	16.16	24.13	32.92	14.64	0.00	5.51	9.87	16.36	22.96	33.44	14.69
F.D.	0.00	2.42	7.60	18.90	27.45	38.49	15.81	0.00	2.46	8.32	19.02	27.21	38.98	16.00
Mean	0.00	3.27	7.59	16.86	25.93	37.32		0.00	3.37	8.29	17.15	25.95	38.65	
LSD 5%	A= 0.55		B= 0.51		A x B= 1.34			A= 0.39		B= 0.36		A x B= 0.96		

P.B= perforated polyethylene P.P= Polyethylene punnets F.D= Foam dishes

Table 5: Effect of packaging treatments on firmness (Lib/inch) of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

Treatments (A)	2017 Storage period (days) (B)							2018 Storage period (days) (B)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	23.70	23.60	23.41	23.17	22.89	22.43	23.20	24.6	24.2	23.7	23.5	22.7	22.7	23.61
P.B. 2%	23.7	23.55	22.81	22.22	21.98	21.75	22.67	24.6	22.7	23.1	22.3	22.0	21.9	22.81
P.B. 4%	23.7	23.40	22.90	22.00	21.63	21.35	22.50	24.6	23.4	22.3	22.4	21.7	21.3	22.67
P.P.	23.7	23.60	23.53	23.37	22.75	22.10	23.17	24.6	23.4	24.8	23.7	22.7	22.3	23.64
P.P. 2%	23.7	23.65	23.11	22.37	21.98	21.73	22.76	24.6	23.4	23.1	23.2	22.0	21.7	23.05
P.P. 4%	23.7	23.31	22.60	21.98	21.54	21.27	22.40	24.6	23.2	22.2	21.9	21.6	21.8	22.58
F.D.	23.7	23.70	23.41	22.97	22.56	22.25	23.10	24.6	23.0	23.6	19.8	22.5	22.4	22.72
Mean	23.70	23.55	23.11	22.58	22.19	21.84		24.6	23.3	23.3	22.4	22.2	22.0	
LSD 5%	A= 0.64		B= 0.59		A x B= 1.56			A= 0.67		B= 0.62		A x B= 1.65		

P.B= perforated polyethylene P.P= Polyethylene punnets F.D= Foam dishes

TSS

The result in Table (6) showed that there were slight and gradual increases in total soluble solids by prolonging the storage up to 10 days. These results were completely similar in both experiments of 2017 and 2018.

Table 6: Effect of packaging treatments on percent of total soluble solids concentration in husk tomato fruits during storage at room temperature in 2017 and 2018 seasons**.**

Treatments (A)	2017 Storage period (days) (B)							2018 Storage period (days) (B)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	13.8	13.9	13.9	14.2	14.5	14.6	14.17	14.7	13.8	14.0	14.6	14.9	15.2	14.59
P.B. 2%	13.8	13.9	13.9	14.4	14.6	14.9	14.28	14.7	14.0	14.3	14.9	15.0	15.6	14.80
P.B. 4%	13.8	13.9	14.1	14.8	14.9	14.4	14.34	14.7	13.9	14.5	15.0	15.3	15.0	14.77
P.P.	13.8	13.9	14.1	14.3	14.5	14.6	14.23	14.7	13.8	14.1	14.7	14.9	15.3	14.63
P.P. 2%	13.8	13.9	14.0	14.3	14.5	14.8	14.24	14.7	13.8	14.0	14.8	15.0	15.5	14.66
P.P. 4%	13.8	13.9	14.2	14.9	15.3	15.8	14.68	14.7	13.9	14.3	15.0	15.7	16.4	15.06
F.D.	13.8	13.9	14.0	14.4	15.7	15.1	14.50	14.7	13.8	14.0	14.7	16.2	15.9	14.92
Mean	13.8	13.9	14.0	14.4	14.8	14.9		14.7	13.9	14.2	14.8	15.3	15.6	
LSD 5%	A= 0.18		B= 0.17		A x B= 0.45			A= 0.20		B= 0.19		A x B= 0.50		

P.B= perforated polyethylene P.P= Polyethylene punnets F.D= Foam dishes

It clear is from the results in Tables (6) that the highest TSS values were recorded in fruits packed in 4% perforated punnets, followed in decreasing order, by those packed in foam dishes, in both seasons.

The interaction treatments within different storage periods and husk tomato fruit packaging treatments had a significant effect on the TSS, the highest values in both seasons were 15.82 and 16.46 % , respectively, by using 4% perforated punnuts after 10 days .

Total titratable acidity

The storage period of 0 and10 days showed the highest values of total acidity compared to the other periods, in both seasons as shown in Table 7.

Regarding the effect of packaging treatments on the total acidity, the obtained results revealed that the total acidity in fruit tissues of husk tomato recorded the highest values with packaging in non-perforated polyethylene bags while the lowest values were noticed in foam dish packing, in both seasons.

Concerning, the effect of interactions between storage period and packaging, data indicated that the highest values were recorded after 10 days with non- perforated treatments. While the lowest values were observed in foam dishes after 4 days of storage, in both seasons

Table 7: Effect of packaging treatments on total acidity percent contents of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

Treatments (A)	2017 Storage period (days) (B)							2018 Storage period (days) (B)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	0.85	0.71	0.68	0.76	0.80	0.87	0.78	0.86	0.81	0.70	0.75	0.81	0.89	0.80
P.B. 2%	0.85	0.67	0.66	0.72	0.75	0.81	0.75	0.86	0.76	0.65	0.73	0.77	0.84	0.77
P.B. 4%	0.85	0.63	0.62	0.71	0.73	0.80	0.73	0.86	0.66	0.52	0.75	0.74	0.83	0.73
P.P.	0.85	0.65	0.70	0.79	0.82	0.88	0.78	0.86	0.63	0.51	0.77	0.83	0.90	0.75
P.P. 2%	0.85	0.71	0.69	0.74	0.79	0.86	0.78	0.86	0.69	0.57	0.80	0.80	0.89	0.77
P.P. 4%	0.85	0.66	0.63	0.75	0.78	0.84	0.75	0.86	0.64	0.52	0.70	0.79	0.87	0.73
F.D.	0.85	0.65	0.59	0.64	0.71	0.79	0.71	0.86	0.63	0.53	0.70	0.72	0.81	0.71
Mean	0.85	0.67	0.65	0.73	0.77	0.83		0.86	0.69	0.57	0.74	0.78	0.86	
LSD 5%	A= 0.06		B= 0.05		A x B= 0.15			A= 0.05		B= 0.05		A x B= 0.13		

P.B= perforated polyethylene P.P= Polyethylene pun nets F.D= Foam dishes

Vitamin C

Table (8) show that vitamin C content was gradually decreased by prolonging storage period up to 10 days in the two seasons.

Regarding the effect of packaging treatments, the obtained results indicated that fruits packed in non-perforated polyethylene bags had the highest vitamin C content whereas those packed in 4 % perforated polyethylene punnets or bags contained the lowest values in both seasons.

The interaction between the two studied factors indicated that the values of vitamin C of husk tomato fruits were the lowest with storage period up to 10 days, in both seasons, when fruits were packed in 4 % perforated packages.

Table 8: Effect of packaging treatments on Vitamin C contents (mg/100gm fresh weight) of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

Treatments (A)	2017 Storage period (days) (B)							2018 Storage period (days) (B)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	16.2	16.1	16.0	14.9	14.0	13.0	15.10	16.6	16.1	16.0	15.1	13.9	13.3	15.23
P.B. 2%	16.2	16.0	15.6	13.9	13.0	12.6	14.59	16.6	16.2	16.1	13.8	13.0	12.7	14.77
P.B. 4%	16.2	15.9	15.0	13.6	12.9	12.3	14.34	16.6	16.1	15.6	13.7	12.7	12.3	14.56
P.P.	16.2	16.0	15.8	14.5	13.6	13.0	14.87	16.6	15.8	16.0	14.7	13.7	12.8	14.97
P.P. 2%	16.2	15.9	15.7	14.4	13.6	12.7	14.79	16.6	16.1	15.7	14.5	13.8	13.0	14.98
P.P. 4%	16.2	15.8	14.9	13.9	12.6	11.7	14.22	16.6	16.0	15.4	13.9	12.3	11.7	14.37
F.D.	16.2	16.1	15.9	14.8	13.7	12.6	14.93	16.6	15.7	15.1	14.9	13.8	12.7	14.85
Mean	16.2	16.0	15.6	14.3	13.3	12.6		16.6	16.0	15.7	14.4	13.3	12.6	
LSD 5%	A= 0.21		B= 0.19		A x B= 0.51			A= 0.30		B= 0.27		A x B= 0.73		

P.B= perforated polyethylene P.P= Polyethylene punnets F.D= Foam dishes

Total sugars

Data recorded in Table (9) showed that the total sugar percent increased gradually by increasing the storage period up to10 days, regardless of the packing treatments during both seasons.

Concerning the effect of packaging treatments, the highest percent of total sugars was obtained with packing in non-perforated polyethylene punnets. These findings were true for the two carried seasons.

Regarding the interaction of storage period and packaging treatments, the data in Table (9) showed that the non-perforated polyethylene punnuts packaging application gave the highest total sugar percent after 10 days in both seasons.

Table 9: Effect of packaging treatments on total sugars percent of husk tomato fruits during storage at room temperature in 2017 and 2018 seasons.

Treatments (A)	2017							2018						
	Storage period (days) (B)													
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
P.B.	10.7	10.9	11.4	11.3	11.7	12.1	11.40	11.12	10.59	11.87	11.55	12.09	12.76	11.66
P.B. 2%	10.7	10.9	11.4	11.4	11.5	11.7	11.31	11.12	10.99	11.60	11.60	11.92	12.31	11.59
P.B. 4%	10.7	10.8	11.3	11.3	11.6	11.8	11.30	11.12	11.73	11.27	11.53	11.77	12.38	11.63
P.P.	10.7	11.4	12.0	12.0	12.2	12.4	11.84	11.12	12.15	12.42	12.33	12.76	12.92	12.28
P.P. 2%	10.7	11.0	11.5	11.5	11.7	11.9	11.43	11.12	11.50	11.48	11.70	12.12	12.48	11.73
P.P. 4%	10.7	11.0	11.3	11.4	11.7	11.9	11.40	11.12	11.43	11.19	11.61	12.13	12.50	11.66
F.D.	10.7	11.3	11.4	11.4	11.9	12.2	11.53	11.12	11.56	11.22	11.57	12.30	12.81	11.76
Mean	10.7	11.0	11.5	11.5	11.8	12.0		11.12	11.42	11.58	11.70	12.16	12.59	
LSD 5%	A= 0.38		B= 0.35		A x B= 0.93			A= 0.33		B= 0.30		A x B= 0.81		
P.B= perforated polyethylene				P.P= Polyethylene punnets				F.D= Foam dishes						

Discussion

The obtained results indicated that prolonging the storage period increased weight loss, decay, total losses, TSS, total acidity and total sugars but decreased firmness and vitamin C. This might due to increasing water loss, respiration and enzyme activities by extending the storage period. Similar observations also noted on other vegetable crops (maksimovic *et al*., 2014; Shobham *et al*., 2017 ; Al-Habsia *et al*., 2019; Bose *et al*., 2019).

Kader (2002) explained that water loss is the main cause of fruit deterioration, because it leads to a direct reduction in weight and quality and shortens shelf life due to acceleration of ripening and senescence. The increase in TSS during the ripening process is attributed to the hydrolysis of starch and polysaccharides of the cell wall that give rise to soluble sugars (Balaguera-López1 *et al*., 2016).

There are relatively few reports available in the literature on the degradation kinetics of vitamin C in fruits and vegetables (Ariahu *et al*., 2011). Yet the reaction order, rate constant, and activation energy are essential for predicting food quality loss during storage, as well as thermal processing (Nisha *et al*., 2005).

Generally, packaging had effect on firmness; there was softening of fruits as the storage time progressed which could be due to texture modification through degradation of polysaccharides such as pectins, cellulose and hemicellulose that take place during ripening (Azene and Workneh, 2014).

Concerning the influence of packaging treatments, using the perforated polyethylene punnuts, followed in decreasing order, by perforated polyethylene bages increased weight loss but decreased the decay percent and total sugars, compared to other treatments. The most effective treatment in reducing the decay and increasing the total sugar percentages was 4% perforated polyethylene punnuts, after 10 days of storage. This may be due to that the non- perforated punnuts or bages retained moisture which cause increasing the growth of microorganism and fungus. In general, our results agree with those of Zudaire *et al.* (2017 & 2019).

Conclusion

In this experiment, weight loss, decay, total losses, and total sugars were increased with prolonging the storage period up to 10 days whereas the vitamin C and firmness were decreased. However, the perforated packages were the most effective in reducing decay. The 4% perforated polyethylene punnuts was the best.

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