

## Effect of Jojoba Oil Emulsion on Prolonging Storage Periods of Costata Persimmon Fruits

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**Abstract:** This experiment was carried out during two successive seasons (2008-2009) and (2009-2010) on Costata persimmon fruits (*Disopyros kaki*, L) harvested at mature stage. Experimental fruits were divided into five similar groups; each of three boxes and each box about 2 kg. Fruits of each group were emulsified in one of the following jojoba oil emulsion concentrations: 0, 25, 50, 75 and 100%. Treated fruits were stored at 13±1°C and 90% RH. Weight loss percentage, decayed fruits, changes in fruit weight loss, fruit firmness, flesh SSC, total sugars, acid and vitamin C were evaluated at 7 days intervals. Jojoba oil emulsifying reduced weight loss, decay fruit percentage. This beneficial effect was connected to oil emulsion concentrations; the high oil concentration recorded the lower weight loss and discarded fruit percentage. Jojoba oil treatments increased both fruit flesh firmness and acid content, since fruits treated with 100% concentration showed higher flesh firmness and flesh acid values than the lower tested oil concentrations. Fruits received oil at 75% concentration showed the lower total sugar content than those of the control. SSC of fruit was not much affected by all jojoba oil concentrations. All treatments improved shelf live compared with the control. The percentage of natural infection was increased with increasing storage period. In this concern, jojoba oil emulsion at 100% was the effective preserving natural compound.

**Key words:** Cold storage, jojoba oil emulsion, persimmon, shelf life

### INTRODUCTION

The demand for persimmon as a favorite and popular fruit for fresh consumption as well as for canning and drying industry, it could be promising export commodity to the foreign markets.

The fruit has a high tannin content which makes the immature fruit astringent. Persimmons must be completely ripened before consumption. When ripe, this fruit comprises thick pulpy jelly encased in a waxy thin skinned shell.

Storage is essential for extending the marketing period of fruits, regulating their supply to the market and for transportation to long distance. The marketing period could be extended by pre-cooling, storage under low temperature and some pre-storage treatments. There is a dispute need to study, how the marketing period could be extended and how to reduce the loss of fruits and supply persimmon fruit frequently and over long period of time?

The recent experiments were conducted to study the effect of jojoba oil to extend marketing life of some fruits. Several attempts were conducted to prolong the marketing season of persimmon fruits. Among these attempts-

besides cold storage are the use of jojoba oil as emulsifiable natural product.

Jojoba oil (pronounced "ho-HO-bah") is the liquid wax produced in the seed of the jojoba (*Simmondsia chinensis*) plant. Unrefined jojoba oil appears as a clear golden liquid at room temperature with a slightly fatty odor. Refined jojoba oil is colorless and odorless. The melting point of jojoba oil is approximately 10°C.

#### Benefits of jojoba oil:

- Provides all day moisturization - jojoba oil does not evaporate like water based moisturizers can
- Very stable-jojoba oil does not become rancid or lose antioxidants even after long periods of storage
- Spreads well and absorbs well

Abd El-Moniem *et al.* (2008) studied the effect of different coating materials and concluded that coating Washington navel orange fruits with jojoba oil and orange oil were the best in reducing decay and wet loss with increasing fruits storage life. Hoa *et al.* (2002) treated mango fruits with different coating treatments and found that, all coating treatments reduced the respiratory rate

and loss of firmness; also the changes in the acid content were delayed in all coated mangoes.

Mehaisen (2005b.) found that olive oil coating treatment on pear, significantly increased fruit firmness and decreased weight loss, but had no effect on total soluble solid and titratable acidity compared with uncoated fruits.

Persimmon fruits are subjected to infections during shipment and storage, and these results in a considerable loss. Fungal infections have a pronounced effect on the metabolism of different chemical compounds of the fruits. It is great importance to study the pathogens affecting persimmon fruits as powers suffer great losses, and how to minimize or control the decay of persimmon that would be a great value to growers, retailers and consumers.

## MATERIALS AND METHODS

This investigation was carried out during two successive seasons (2008-2009) and (2009-2010) on mature Costata persimmon fruits, to study the effect of emulsifying fruits with jojoba oil on different fruit properties under storage consistories.

Harvested fruits were directly transferred to the laboratory at the Agricultural Development System (ADS) project, Faculty of Agriculture, Cairo University.

Defective fruits including wounded and other disorders were excluded, the rest considered as sound fruits were washed with tap water and air dried. Jojoba oil emulsions were prepared by mixing oil with tween 80 in water, Ju *et al.* (2000).

Experimental fruits were divided into five similar groups. Each group was subjected to one of the following treatments:-

- Jojoba oil at 100%
- Jojoba oil at 75% (75 mL jojoba + 25 mL water+tween 80)
- Jojoba oil at 50% (50 mL jojoba + 50 mL water+tween 80)
- Jojoba oil at 25% (25 mL jojoba + 75 mL water + tween 80)
- Control (water only)

Each treatment was replicated three times and each replicate was about 2 kg weight putted as one layer in a carton box. Experimental boxes were stored at 13±1°C and 90% relative humidity for 28 days.

Changes in some physical and chemical fruit properties were determined at seven days intervals.

### Physical properties:

- **Fruit weight loss percentage:** Each box was individually weighted before cold storage to get the initial weight, and then weighted after each period of

cold storage. Fruit weight was recorded and then percentage of weight loss was calculated according to the following equation:

$$\text{Fruit weight loss \%} = \frac{W_i - W_s}{W_i} \times 100$$

where,

$W_i$  = Initial fruit weight before cold storage

$W_s$  = Fruit weight at the end of sampling period

- **Decay percentage:** The decayed fruits as percentage were calculated according to the following equation: Total number of decayed fruits/Initial number of stored fruits × 100.
- **Fruit firmness:** A very thin batch of skin was removed on the two opposite sides of each fruit and flesh firmness was determined by using a hand manages T pressure tester and the average fruit flesh firmness of two sides was measured in lb/inch<sup>2</sup>.

### Chemical properties:

- **Soluble Solids Content (SSC %):** A refractometer was used to determine the soluble solids content in fruit flesh according to AOAC (1990).
- **Titratable acidity %:** It was determined according to the method described in AOAC (1990). Results were expressed as gm citric in 100 gm fruit flesh.
- **Ascorbic acid content (vitamin C):** It was determined according to AOAC (1990). It was calculated as milligram vitamin C per 100 ml of fresh weight.
- **Total sugars %:** Was determined by using the methods of AOAC (1990) and the concentration were calculated as gm glucose per 100 g fresh flesh weight.
- **Isolation and identification of the causal organism:** Samples of infected persimmon fruits representing from the cultivar Costata was collected from Behara and Kaluobia governorates, and used for isolation trials according to El-Naggar (1983) and identified according to Barnett and Hunter (1987).
- **Pathogenicity test:** Healthy persimmon fruits at maturity stage were used, since percentage of diameter and weight of infected rotted tissues were recorded after 10 days at 20±1°C.
- **Linear growth:** Equal amounts of agar media were autoclaved and poured in Petri dishes, then left to solidify. Two cross diameters were drawn on the bottom of the dishes to meet at the center. A single disc (5 mm in diameter) of fungal growth of cultures grown on potato dextrose media for eight days was placed in the center of each dish. A set of five dishes were used for each particular treatment and incubated at 25°C. Two perpendicular diameters were measured daily where the average represents the linear growth (mm.).

- **Amount of growth:** Twenty ml of liquid media placed in conical flask (100 mL) were sterilized, and inoculated with fungal growth discs. Flasks were incubated at 25°C, then flasks contents were filtered after 15 days on weighed filter paper, washed with distilled water and dried at 70°C using vacuum oven, weighed, finally the mycelial weight was calculated. Five replicates were used for each particular treatment.
- **Storage experiment:** Persimmon fruits were collected at maturity stage; where each treatment contained 20 fruits.  
The relative percentage of fruit rot fungi, percentage of decay and the development of fungus *Penicillium* and *Botrytis* were determined. Fruits were washed, dried and then put in carton boxes (52 × 27 × 13 cm). The samples were taken after 0, 7, 14, 21 and 28 days of storage under cold conditions (4±1°C) and 85-90 R.H. also after 7, 14 days as shelf life periods. The fruits were divided into five groups, the first four groups were sprayed with jojoba oil emulsion at 100, 75, 50 and 25%, and the fifth group was sprayed with water only as a control. Three boxes were served for each treatment.

#### Statistical analysis:

- Data were statistically analyzed using MSTAT-C software (MSTAT, Michigan University East Lansing). Analysis of variance (ANOVA) and Duncan multiple significant difference was performed to determine any significant difference among various treatments.  $p < 0.05$  was selected as decision for significant differences according to (Sendecor and Cochran, 1982).
- Every sampling data was analyzed individually, means with different letters within each column are significant (S) at 0.05% level and means without letters are not significant (N.S.).
- The mean values obtained were subjected to statistical analysis according to Thomas and Hills (1972), and L.S.D. was obtained whenever "F" values were significant at 0.05% level.

### RESULTS AND DISCUSSION

**Weight loss %:** Data in Table 1 showed that, jojoba treatments in general reduced weight loss percentage during the storage period compared with the control. However, the differences between jojoba treatments and the control were beginning after 7 days of the storage, since 100% jojoba treatment was the superior in reducing weight loss % in both studied seasons. In this respect, jojoba at 100% recorded 2.91 and 3.26 as the main during 28 days of the storage, which significantly affected shelf life/day, while the untreated fruits (control) recorded 3.62

and 3.81 in the first and second seasons, respectively. These results were agreed with Abd El-Moniem *et al.* (2008) on mango, since they found that jojoba treatments reduced weight loss percentage of mango fruits comparing with the control. Similar results were obtained by Mehaisen (2005a) when coated guava fruits with olive oil, also Panhwar (2005) when used edible oil as coating for mango fruits.

**Firmness:** Data in Table 2 cleared that flesh firmness was gradually decreased with control treatment beginning at the day 7, while jojoba treatments saved flesh firmness for a long period at the storage compared with the control especially when the fruits treated with the higher three concentrations of jojoba, which positively affected shelf life/day. This was true in both studied seasons.

The obtained results are agreed with those of Ismail (1997) who found that coating Le Conte pear with simpler fresh significantly increased firmness. Similar results were obtained by Mehaisen (2005a) who reported that guava fruits coated with olive oil were firmer than uncoated ones. Based on these parameters (weight loss) and firmness of persimmon fruits coated with jojoba oil seemed to have in general long life span in cold storage compared with the control.

#### Chemical properties:

- **Soluble Solids Content (SSC):** Results in Table 3 indicated that SSC was gradually increased with the control treatments during the storage period, while jojoba treatments showed stability in SSC during the storage period which cencequality affect the fruit shelf life/day However, no significant differences were detected among jojoba treatments in the two seasons of the study.  
These results are agreed with those obtained by Mehaisen (2005b), Abd El-Moniem *et al.* (2006) and Abd El-Migeed and Fotouh (2007) on guava, orange and mango fruits.
- **Titrateable acidity:** In Table 4 results showed that acidity percentage was gradually decreased according to the storage period, this was true among all treatments including that of the control. On the other hand, the control treatment showed a high reduction values than jojoba treatments during the storage period, this reduction was significant only in the first season beginning from the day 7. On the other side, a constant trend was detected among jojoba treatments. The obtained data are in line with those obtained by Abd El-Moniem *et al.* (2006) and Abd El-Migeed and Fotouh (2007) on orange and mango fruits.
- **Ascorbic acid content (V.C.):** Generally, V.C content was reduced among the storage period with all treatments. However, V.C. as shown in Table 5

Table 1: Effect of jojoba oil treatments on weight loss (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH) **Season (2008-2009)**

Treatments	Cold storage/day					Main	Shelf life/day		
	0	7	14	21	28		7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	0.00k	1.47j	2.72fg	4.70e	5.64c	2.91c	7.96	10.35	9.16b
75% Jojoba oil	0.00k	1.32j	2.58g	4.4 ie	6.67b	3.00bc	7.33	10.25	8.79b
50% Jojoba oil	0.00k	1.28j	2.23hi	5.40cd	6.47b	3.08b	8.42	11.11	9.76a
25% Jojoba oil	0.00k	1.33j	2.48gh	5.21d	6.35b	3.08b	8.77	10.86	9.81a
Cont.	0.00k	1.98j	2.96f	5.58c	7.60a	3.62a	-	-	-
Main	0.00e	1.48d	2.59c	5.06b	6.75a	8.12b	10.64a	-	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	0.00i	1.52k	2.55ij	5.60f	6.63c	3.26c	9.15	11.49	10.32b
75% Jojoba oi	10.00i	1.51k	2.81h	i5.66e	f6.45c	3.29c	10.09	11.24	11.22a
50% Jojoba oil	0.00i	1.50k	2.90h	5.60f	6.72c	3.34c	9.29	11.25	10.27b
25% Jojoba oil	0.00i	1.70k	3.51g	5.92de	7.11b	3.65b	9.23	11.70	10.47b
Cont.	0.00i	2.34j	3.01h	6.00d	7.71a	3.81a	-	-	-
Main	0.00i	1.71d	2.9 c	5.76b	6.92a	-	9.44b	11.70a	-

Means having different letters within each column are significant at 0.05% level

Table 2: Effect of jojoba oil treatments on firmness (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Main	Shelf life/day		
	0	7	14	21	28		7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	18.23a	16.84b	15.57c	8.17ef	7.60ef	13.28ab	4.53	0.43	2.48
75% Jojoba oil	18.47a	16.90b	16.17bc	8.53e	7.77ef	13.61a	5.03	0.70	2.87
50% Jojoba oil	18.47a	15.93bc	15.10c	10.53d	7.70ef	13.55a	5.23	0.43	2.83
25% Jojoba oil	18.03a	15.93bc	15.53c	7.77ef	7.20f	12.89b	5.10	0.40	2.75
Cont.	18.53a	8.60c	8.60e	5.07g	4.43g	10.38c	-	-	-
Main	18.35a	16.17b	14.19c	8.01d	6.98e	-	4.98a	0.49b	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	18.00a	16.20b	15.60bc	6.90ef	6.40ef	12.62a	5.47b	0.33d	2.90a
75% Jojoba oil	18.00a	16.00bc	15.50bc	7.30e	6.50ef	12.66a	5.24ab	0.26d	2.75a
50% Jojoba oil	18.00a	16.00bc	15.60bc	7.40e	6.50ef	12.70a	5.02b	0.36d	2.78a
25% Jojoba oil	18.00a	16.20b	15.00c	7.10e	6.00f	12.46a	4.27c	0.36d	2.31b
Cont.	18.00a	15.10c	9.00d	4.50g	2.30h	9.78b	-	-	-
Main	18.00a	15.90b	14.14c	6.64d	5.54e	-	5.00a	0.33b	-

Means having different letters within each column are significant at 0.05% level

Table 3: Effect of jojoba oil treatments on SSC% of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Main	Shelf life/day		
	0	7	14	21	28		7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	15.53	17.13	18.33	19.07	19.43	17.90b	20.33	20.83	20.58
75% Jojoba oil	15.60	16.83	18.17	18.67	19.17	17.69b	20.00	20.80	20.40
50% Jojoba oil	15.53	17.40	18.20	19.00	19.67	17.96b	20.40	21.00	20.70
25% Jojoba oil	15.50	17.17	18.00	19.17	19.67	17.90b	20.23	20.83	20.53
Cont.	15.50	17.67	19.00	20.10	20.80	18.61a	-	-	-
Main	15.53a	17.24d	19.20b	19.20b	19.75a	-	20.24b	20.87a	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	14.50	6.10	17.40	18.50	19.00	17.10b	19.59d	19.61d	19.60c
75% Jojoba oil	14.50	16.30	17.50	18.50	19.20	17.20b	19.80cd	20.39ab	20.09b
50% Jojoba oil	14.50	16.50	17.70	18.90	19.50	17.42ab	20.17bc	20.63a	20.40a
25% Jojoba oil	14.50	16.50	17.70	19.00	19.50	17.44ab	19.92cd	19.00e	19.46b
Cont.	14.50	16.80	18.00	19.00	19.50	17.56a	-	-	-
Main	14.50e	16.44d	17.66c	18.78b	19.34a	-	19.87a	19.91b	-

Means having different letters within each column are significant at 0.05% level

Table 4: Effect of jojoba oil treatments on acidity (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Shelf life/day			
	0	7	14	21	28	Main	7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	0.41a	0.36b	0.31c	0.20ef	0.20ef	0.30a	0.15	0.09	0.12
75% Jojoba oil	0.41	0.34b	0.30cd	0.22e	0.20ef	0.29a	0.15	0.10	0.13
50% Jojoba oi	0.41a	0.35b	0.29cd	0.21e	0.20ef	0.29c	0.14	0.63	0.39
25% Jojoba oil	0.41a	0.3c	0.28d	0.20ef	0.16g	0.2 b	0.12	0.63	0.38
Cont.	0.41a	0.31c	0.22e	0.18fg	0.14h	0.25c	-	-	-
Main	0.41a	0.33b	0.28c	0.20d	0.18e	-	0.14b	0.37a	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	0.30	0.22	0.20	0.15	0.13	0.20a	0.12bc	0.10e	0.11b
75% Jojoba oil	0.30	0.25	0.20	0.13	0.12	0.20a	0.11d	0.10de	0.11b
50% Jojoba oil	0.30	0.25	0.20	0.16	0.14	0.21a	0.13a	0.12c	0.13a
25% Jojoba oil	0.30	0.25	0.20	0.16	0.15	0.21a	0.13ab	0.12bc	0.13a
Cont.	0.30	0.20	0.15	0.13	0.12	0.18b	-	-	-
Main	0.30a	0.23b	0.19c	0.15d	0.13e	-	0.12a	0.11b	-

Means having different letters within each column are significant at 0.05% level

Table 5: Effect of jojoba oil treatments on V.C. (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Shelf life/day			
	0	7	14	21	28	Main	7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	8.17a	7.07cdef	5.22ij	4.28kl	4.07k	15.76b	3.47	2.17	2.82
75% Jojoba oil	7.84abc	7.20bcde	6.20gh	5.17ij	4.30k	16.14	a3.43	2.10	2.77
50% Jojoba oil	7.96ab	7.28bcd	6.60defg	5.61hi	4.50jk	16.39a	3.60	2.40	3.00
25% Jojoba oil	8.14a	7.60bcd	6.31fgh	5.18ij	3.90lm	6.23a	3.27	2.23	2.75
Cont.	8.28a	7.90ab	6.40efgh	4.78jk	3.17m	6.11a	-	-	-
Main	8.08a	7.41ab	6.15c	5.00d	3.99e	-	3.44a	2.23b	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	8.11a	8.00a	5.20cd	4.00fg	3.51gh	5.76a	2.53	1.87	2.20b
75% Jojoba oil	8.10a	7.80ab	5.31cd	4.50def	3.61gh	5.86a	2.48	2.00	2.24b
50% Jojoba oil	8.10a	7.80ab	5.50c	4.88cde	4.00fg	6.06a	3.69	2.95	3.32a
25% Jojoba oil	8.10a	7.77ab	5.60c	4.81cdef	4.21efg	6.10a	3.42	3.08	3.25a
Cont.	8.10a	7.00b	4.22efg	3.10h	2.00i	4.88b	-	-	-
Main	8.10a	7.67b	5.17c	4.26d	3.47e	-	3.03a	2.47b	-

Means having different letters within each column are significant at 0.05% level

Table 6: Effect of jojoba oil treatments on total sugars (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Shelf life/day			
	0	7	14	21	28	Main	7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	12.50	15.23	16.13	17.10	17.50	15.69b	18.57c	18.97b	18.77
75% Jojoba oil	12.50	14.50	16.00	16.50	17.37	15.37c	18.17d	18.97b	18.57
50% Jojoba oil	12.57	15.33	16.11	17.60	17.60	15.72b	18.27cd	19.17ab	18.72
25% Jojoba oil	12.27	15.23	16.17	17.60	17.601	5.71b	18.10d	19.37a	18.73
Cont.	12.50	15.33	17.00	18.67	18.67	16.28a	-	-	-
Main	12.49e	15.13d	16.28c	17.75a	17.75a	-	18.28b	19.12a	-
<b>Season (2009-2010)</b>									
100% Jojoba oil	11.50i	13.20h	14.50g	15.60ef	17.00d	14.36c	17.52f	17.98e	17.75d
75% Jojoba oil	11.50i	13.60h	14.50g	16.00e	17.30cd	14.58c	17.90e	19.02bc	18.46c
50% Jojoba oil	11.50i	14.50g	15.50ef	16.00e	17.50bcd	15.00b	18.50d	19.20b	18.85b
25% Jojoba oil	11.50i	14.50g	15.00fg	17.80abc	18.10ab	15.38a	18.94c	19.58a	19.26a
Cont.	11.50i	14.50g	15.00fg	17.50abc	18.30a	15.36a	-	-	-
Main	11.50e	14.06d	14.90c	16.58b	17.64a	-	18.22b	18.95a	-

Means having different letters within each column are significant at 0.05% level

was affected by jojoba treatments. In this respect, the lower concentrations were more effective than the highest one. The untreated fruits showed the lower significant

values especially in the second season. On the other hand, jojoba at 50% seems to be more effective in increasing shelf life/day comparing with the other treatments.

Table 7: Effect of jojoba oil treatments on discarded fruit (%) of Costata persimmon fruits under cold storage and shelf life periods (13±1°C and 90% RH)

Treatments	Cold storage/day					Main	Shelf life/day		
	0	7	14	21	28		7	14	Main
<b>Season (2008-2009)</b>									
100% Jojoba oil	0.00h	0.00h	0.00h	5.17g	14.60e	3.95c	33.03	51.53	42.28
75% Jojoba oil	0.00h	0.00h	0.00h	5.90g	16.00d	4.38b	35.37	49.80	42.58
50% Jojoba oil	0.00h	0.00h	0.00h	5.63g	16.83c	4.49b	38.80	53.73	46.27
25% Jojoba oil	0.00h	0.00h	0.00h	5.60g	17.00c	4.52b	39.53	51.70	45.62
Cont.		0.00h	0.00h	7.40f	18.50b	32.47a	11.67a	-	--
Main		0.00d	0.00d	1.48c	8.16b	19.38a	-	36.68b	51.69a-
<b>Season (2009-2010)</b>									
100% Jojoba oil	0.00k	0.00k	6.00i	20.90h	35.30e	12.44d	36.14e	49.92c	43.03b
75% Jojoba oil	0.00k	0.00k	5.50j	25.30f	40.20d	14.20b	41.47d	53.64b	47.56a
50% Jojoba oi	10.00k	0.00k	5.10j	25.30f	41.00c	14.28b	40.36d	54.12b	47.24a
25% Jojoba oil	0.00k	0.00k	6.10i	22.00g	41.30c	13.88c	39.34d5	7.78a	48.56a
Cont.		0.00k	0.00k	20.50h	42.10b	55.60a	23.64a	-	--
Main		0.00d	0.00d	8.64c	27.12b	42.68a	-3	9.33b	53.87a-

Means having different letters within each column are significant at 0.05% level

Table 8: Frequency of isolated fungi causing rot to persimmon fruits

Isolates fungal group	Record	
	No of fruits	Isolation (%)
<i>Penicillium</i> sp.	20	48.3
<i>Botrytis</i> sp.	20	32.7
<i>Rhizopus</i> sp.	20	10.0
<i>Alternaria</i> sp.	20	9.0
Total	80	100.0

Table 9: Percentage of rotted persimmon fruits inoculated with isolated fungi by different techniques under shelf life conditions (room temperature) (20±1°C) after 10 days

Isolates fungi	Rotted fruits	
	Spraying technique	Wounding technique
<i>Penicillium</i> sp.	90.0	100.0
<i>Botrytis</i> sp.	80.0	100.0
<i>Rhizopus</i> sp.	12.5	100.0
<i>Alternaria</i> sp.	7.5	75.0
Un-inoculated	2.5	25.00

Table 10: Diameter and percentage of rotted weight tissue of persimmon fruits inoculated with isolated fungi under shelf life conditions (20±1°C) after 10 days

Isolates fungi	Diameter of rotted tissues (mm.)	Infected * weight of rotted tissues (%)
<i>Penicillium</i> sp.	56.8	73.2
<i>Botrytis</i> sp.	54.5	60.0
<i>Rhizopus</i> sp.	24.1	26.0
<i>Alternaria</i> sp.	22.5	24.0
Un-inoculated	2.5	7.5

\*Infected weight of rotted tissues = Weight of rotted tissues/total weight of the fruits%

These results are in accordance with those obtained by Mehaisen (2005a) who stated that "ascorbic acid decreased in guava fruits with extended storage".

- **Total sugars%:** Results in Table 6 showed that total sugars were increased gradually according with the increase of storage period. However, it seems that sugar content was increased with decreasing jojoba concentration. The shelf life was lengthened as the

concentration decreased. In this respect, it seems that jojoba oil is benefit natural product to conserve persimmon fruits during cold storage. Joseph and Aworh (1991) and Buk *et al.* (1997) concluded that, fruit will reach high levels of sugar, ascorbic acid, soluble solids and their lowest level of acidity as they ripened. The present results provided supporting evidence that coating persimmon fruits with jojoba oil helped to delay ripening preserve fruit quality.

- **Discarded fruits %:** It is clear from Table 7 that jojoba treatments had a positive effect on reducing the discarded fruits %. On the other side, the untreated fruits (control) recorded the highest significant percentage of discarded fruits beginning from the day 14. However, 100% jojoba treatment was more effective in reducing the discarded fruits percentage and gave the lowest value during the storage period. On the other hand, shelf life was affected significantly in the second season only. It was prolonged as the concentration reduced. These results confirmed with the findings by Hoa *et al.* (2002) and Tefera *et al.* (2007) who found that the biologically active natural products have the potential to replace synthetic fungicides.

**Isolation and identification of fungi causing fruit rot of persimmon:** Data in Table 8 showed that four genera of fungus were isolated from rotted persimmon fruits. Fungi were purified and identified as: *Penicillium digetatum*, *Botrytis cinerea*, *Rhizopus nigricans* and *Alternaria solani*. *Penicillium* was the most frequently isolated fungus followed by *Botrytis*, *Rhizopus* and *Alternaria* was the lowest frequently.

These fungi have been reported as persimmon fruits rotting pathogens by Barnett and Hunter (1987), Gaweesh Salwa (1980), El-Naggar (1983) and Abd El-Migeed and Fotouh (2007).

Table 11: Effect of different treatments of jojoba oil emulsion on rate (mm.) and amount of growth (mg.) of persimmon fruits rot fungi after 14 days

Fruits rot fungi								
Treatments	Penicillium		Botrytis		Rhizopus		Alternaria	
	Rate* (mm.)	Amount ** (mg.)	Rate (mm.)	Amount (mg.)	Rate (mm.)	Amount (mg.)	Rate (mm.)	Amount (mg.)
100%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75%	0.0	0.0	0.0	0.0	0.0	0.0	51.0	174.3
50%	31.5	249.6	25.0	198.1	35.0	277.4	70.0	309.0
25%	53.0	420.0	42.0	332.8	57.5	355.7	70.0	408.0
Control	80.0	498.8	75.0	507.6	80.0	520.0	78.0	560.0

\* Rate: Rate of growth (mm.); \*\* Amount: Amount of growth (mg.); L.S. D.: 5%; Fungi: 2.67; Treatments: 7.06

Table 12: Effect of different treatments of jojoba oil emulsion on natural infection (%) of persimmon fruits under cold storage and shelf life periods

Storage periods														
Treatments	Cold storage/day										Shelf life storage day			
	0		7		14		21		28		7		14	
	P.*	B.**	P.	B.	P.	B.	P.	B.	P.	B.	P.	B.	P.B.	
100%	0.0	0.0	0.0	0.0	2.0	3.2	7.5	8.3	11.0	12.5	3.2	5.5	9.3	10.0
75%	0.0	0.0	0.0	0.0	3.5	5.5	9.3	12.5	13.5	17.0	7.5	10.0	12.0	12.0
50%	0.0	0.0	0.0	0.0	7.5	10.0	12.5	14.0	15.1	18.3	10.0	13.0	15.0	20.0
25%	0.0	0.0	0.0	0.0	10.0	15.0	15.0	17.0	17.6	19.2	15.0	19.3	18.1	28.2
Control	0.0	0.0	2.5	10.0	16.5	18.5	19.2	21.0	22.0	26.0	22.5	26.0	27.0	35.0

\* P.: *Penicillium digetatum*; cold storage periods: 4±1°C; \*\* B.: *Botrytis cinerea*; shelf life storage period: 20±1°C; L.S. D.: at5%; Fungi: 1.78; Treatments: 1.01; Periods of storage: 2.56

**Pathogenicity test:** Isolated fungi were inoculated into wounded and unwounded persimmon fruits at maturity stage, each of spraying and wounding techniques. Two fungi *Penicillium* and *Botrytis* were capable to invade healthy (unwounded) fruits inducing rots at 90, 80%, respectively. Under spraying technique as shown in Table 9 wounding technique showed that two fungi had 100% infection.

The severity of the damage caused to persimmon fruit varies considerably among different isolated fungi. Diameter of rotted tissues was *Penicillium* (56.8), *Botrytis* (54.5), *Rhizopus* (24.1) and *Alternaria* (22.5). The damage severity, in which the ratio of weight of infected tissues to total weight of fruit could be based as a reliable index was great for *Penicillium* (73.2) and *Botrytis* (60.0).

The difference in the severity of rot damage caused to fruit among fungi might be attributed to the difference in substances which secreted by fungi and the capacity of pectin and cellulose hydrolysis.

**Effect of different fungi on diameter and percentage of rotted weight tissues of persimmon fruits:** Isolated fungi were differed in their activity concerning rotted persimmon tissues in both diameter and percentage of rotted tissues parameters as tabulated in Table 10. Data shows that *Penicillium* rotted tissues followed by *Botrytis*, were the highest isolated fungi, while *Rhizopus* and *Alternaria* were the lowest.

The effect of preserving jojoba on the rate and amount of growth indicated that, jojoba at 100 and 75% was the effective compound for *Penicillium* and *Botrytis* while 50 and 25% had the lowest effect on different fungi, El-Naggar (1983) and Abd El-Moniem *et al.* (2006).

**Effect of different of jojoba oil emulsion treatments on linear and amount of growth of persimmon fruit rot fungi:** Results presented in Table 11 show that different treatments of jojoba oil emulsion affected the linear growth of two fungi fungal growth which was inhibited completely at higher concentrations of jojoba oil treatments than the least concentration. The same trend of jojoba oil effect on the fungal rate of growth was found in fungal amount of growth.

It could be concluded from the table of rate and amount of growth, that the 100 and 75% of jojoba oil emulsion were the effective, while 50 and 25% treatments was least effective.

**Effect of jojoba oil emulsion treatments on natural infection (%) of persimmon fruits under cold storage and shelf life periods:** The data presented in Table 12 indicate that the percentage of natural infection was increased with increasing storage period under cold and shelf life conditions. *Penicillium* has a higher percentage than *Botrytis*. This trend is true at the different treatments of jojoba oil emulsion, where the highest parentage of infection were found by least treatments of jojoba oil.

After 21 days of storage under cold or shelf life *Penicillium* reached the infection to 100%, while *Botrytis* rot fungi on all the fruits reached the infection to 100% after 28 days of storage.

Jjoba oil emulsion (100%) was the more effective on reducing natural infection (%) of persimmon fruits under cold storage and shelf life. These results are agreed with Bhadra and Sens (1999), El-Mohamedy *et al.* (2002) and Ziguo and Erice (2001).

### CONCLUSION

It could be concluded that all jjoba oil concentrations improved shelf life compared with the control. In this respect, Jjoba oil emulsifying reduced weight loss, decay fruit percentage. This beneficial effect was connected to oil emulsion concentrations; the high oil concentration recorded the lower weight loss and discarded fruit percentage. Jjoba oil treatments increased both fruit flesh firmness and acid content, since fruits treated with 100% concentration showed higher flesh firmness and flesh acid values than the lower tested oil concentrations. Fruits received oil at 75% concentration showed the lower total sugar content than those of the control. SSC of fruit was not much affected by all jjoba oil concentrations. All treatments improved shelf live compared with the control.

The percentage of natural infection was increased with increasing storage period. In this concern, jjoba oil emulsion at 100% was the effective preserving natural compound.

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