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Effect of Pre-Treatments on the Quality of Dried Persimmon (*Diospyros kaki*) Fruit Sheets

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ABSTRACT

The present study proposed to produce dried persimmon (*Diospyros kaki*) fruit sheets in order to determine whether it could be used as a substitute for fresh fruits. Chemical and physical properties of whole fresh persimmon fruits and pulps were investigated. The antioxidant activity, total tannin and crude fiber of whole persimmon fruit were higher than that of the pulp. Meanwhile, total cartenoids, ascorbic acid and the contents of K, Ca, Mn and P were higher in pulp than in whole fruit. Both whole persimmon fruits and pulp were washed, crushed, purred and pre–treated with steaming, followed by immersion in 0.3% sodium metabisulfite and 0.2% citric acid solutions for 30 min prior to drying as a sheet form. Rehydration of dry sheets was completed in 5 min with moisture content of about 14%. The highest values of total soluble solids content and colour index were observed for persimmon pulp pre–treated with 0.3% sodium metabisulfite. Also, both samples that were treated with sodium metabisulfite had a good rehydration ratio and received the highest average scores for the sensory evaluations (colour, taste, texture and odour).

Key words: persimmon, DPPH, ESR free radical, drying, vitamin C, minerals, crude fiber.

INTRODUCTION

Persimmon (*Diospyros kaki*) is a good source of natural antioxidants, vitamins, and dietary fiber which are probably involved in the reduction of degenerative human diseases (Steinmetz & Potter 1996), due to their antioxidative and free radical scavenging properties (Boileau *et al*., 1999).

Although persimmon peel is generally regarded as waste, Gorinstein *et al*. (1994) reported that the concentrations of carotenoids and polyphenols are higher in the peel than in the pulp and also persimmon peel if supplemented to a diet it would show hypochlesterolemic and antioxidative effects in rats.

There are over 400 species of persimmon that vary widely in shape and colour, although they are broadly classified into two major groups: the non-astringent and astringent varieties. The astringency is due to the high soluble tannin content of the fruit, which diminishes during the natural ripening process (Telis *et al*., 2000).

According to Marder & Shoemaker (1995), the relatively high temperatures commonly applied during convection drying lead to tannin degradation, whereas sugars present in the fruit exude to the surface where they crystallize. The result is a sweet, tasteful and non astringent dried product. So-young Kim *et al*. (2006) concluded that heat treatment like drying increases the total phenolic concentration and the antioxidative and antigenotoxic activities of the ethanol and water extracts of persimmon peel.

The persimmon is mainly eaten fresh but can be frozen, canned or dried and can be stored for up to 6 months in modified or controlled atmospheres. During dehydration of whole fruits, the skin acts as a semi permeable membrane that controls the water transfer rate from the fruit to external medium, (Telis *et al*., 2000).

The aim of the present study was to reveal the highly nutritional value of persimmon fruits and the effect of different pre-treatments on both the whole fruits and pulp to introduce a commercially feasible technology of dried persimmon sheets.

MATERIALS AND METHODS

Materials:

Persimmon (*Diospyros kaki*) fruits were obtained from the Horticultural Research Institute, Agric. Research Center, Giza - Egypt.

Preparation of persimmon purée: Whole fresh persimmon fruits were washed, crushed and puréed with peel. Other batches of fresh fruits were peeled and the pulp puréed. Both of the two batches were divided into four lots. One lot was left without any treatment and served as control and the second was steamed under atmospheric pressure for 30 min. The third lot was immersed in 0.3 % metabisulfite solution and the fourth lot was immersed in 0.2 % citric acid solution for 30 minutes. All treated and untreated samples were placed on trays (made of 8 mesh screen) in an air ventilation oven at 65 ˚C / 6 hr, and then temperature was reduced to 50 ˚C. Dehyration was continued until the moisture content reached approximately 14 %.

Methods:

Drying and rehydration ratios: Drying ratio was determined as reported by Van-Arsdel *et al*. (1973). Rehydration ratio of dried samples was evaluated using the method of Ranganna (1979).

Analytical methods: Moisture content (vacuum oven method), total solids, total soluble solids (T.S.S), crude fiber, ash, protein and crude ether extract were determined according to the A.O.A.C (1996). The 2,6 dichloro-phenol indophenol titration method was used to estimate ascorbic acid as described by the A.O.A.C. (1996). Estimating reducing and total sugar contents was calculated as reported by Nelson (1944). Total tannins were determined by the vanillin hydrochloric spectrophotometric as described by Price & Bulter (1977). Mineral contents were carried out using atomic absorption spectrophotometry according to the A.O.A.C (1984). The method described by Wettstein (1957) was used for the determination of total carotenoids. Titratable acidity of samples was determined according to the A.O.A.C. (1996) as anhydrous malic acid. The SO_2 content was determined according to the method described by Reith & Willems (1958). Antioxidant activity of persimmon methanolic extract (4 ml) against 1 ml DPPH (1,1-diphenyl 1-2 picryl hyolrazyl) radicals was determined according to Brunet *et al*. (2005). The resultant spectra were recorded on an ESR electron spin Bruker-Alex-Sys 5000 operated at x-band frequency. The ESR spectrometer was set at the following conditions, 0.01 field modulation amplitude. The anti-radical activity (AA) was defined as:

$$AA\ \% = 100 \cdot (H_O - H_S) / HO$$

Where:

HO: Height of the second peak in the ESR spectrum of DPPH free radical of the blank.

HS: Height of the second peak in the ESR spectrum when the extract was added to DPPH.

Sensory evaluation: Panel of trained judges were asked to evaluate the dehydrated persimmon samples for appearance, taste, colour, texture and odour using a score scale from 1-10 where 1 indicates dislike extremely and 10 like extremely (Larmond, 1970).

Statistical analysis: All data were subjected to statistical analysis according to the procedure reported by Snedecor & Cochran (1980).

RESULTS AND DISCUSSION

Chemical composition of fresh persimmon purée

The chemical composition of fresh puréed whole fruits and puréed pulp of persimmon at ripening stage was determined (Table 1). The results indicate that the whole fruits and pulp had almost the same amount of total solids and total soluble solids (26.88–27.14%) and (22.51–23.01%), respectively. It is worth to mention that, the total solids have important role in the dehydration process (Kordylas, 1991).

There were no obvious differences in total sugars as well as the reducing and non-reducing sugars of both whole fruits and pulp. Crude fiber of whole fruits was found to be a relatively higher than that of the pulp. These data are in accordance with that reported by Marlett (1992), who found that removal of peel decreases the total fiber content of persimmon fruits. Protein, crude ether extract and ash content of both samples are approximately the same, these results agree with those obtained by Herrmann (1994).

Total tannin content of whole fruits was higher than that of the pulp representing 2.90 and 1.95 %, respectively. These results are in the same range of data reported by Aksu *et al*. (1994). Moreover, Ozen *et al*. (2004) found that the fruit is characterized by its high level of tannic acid (tannins), which disappears when the fruit is become very ripe. These compounds are a group of phenolic substrates of polyphenol oxidases, containing gallic acid derivatives and glucose units linked together *via* glycosidic bonds. Also, Gorinstein *et al*. (1994) reported that the concentrations of cartenoids and polyphenols were higher in the peel than in the pulp. Tannin has antimutagenic, anticarcinogenic and antioxidant activity as stated by Gali-Hu, *et al*. (1992). Also, it was shown by Rice-Evans (1995) that tannin is OH^- radical scavenger because it is excellent nucleophiles. Total acidity (as malic acid) of whole

Table 1: Chemical composition (on dry weight basis) of whole persimmon fruits and pulp*

Chemical constituents	Whole fruits	Pulp
Total solids % (T.S.)	26.88±0.223	27.14±0.538
Total soluble solids % (T.S.S.)	22.51±1.561	23.01±1.095
Total sugars %	58.65±0.913	59.62±1.598
Reducing sugars %	30.25±1.270	31.51±1.255
Non-reducing sugars %	28.40±1.708	28.11±1.103
Crude fiber %	5.72±0.467	2.65±0.494
Protein %	2.68±0.504	2.81±1.429
Ether extract %	1.68±1.002	1.77±1.059
Ash %	2.50±0.967	2.12±0.926
Total tannins %	2.90±0.746	1.95±0.950
Total acidity % (as malic acid)	0.87±0.230	0.76±0.901
Ascorbic acid (mg/100g)	14.12±2.094	16.25±1.475
Total carotenoids (mg/100g)	1355±133.207	1830±1066.521

* Values are the means of three replicate ± SD

fruits and pulp was higher than those obtained by El-Shaikh (1986). On the other hand, Senter *et al.* (1991) and Herrmann (1994), stated that total acidity was in the range of 1.36–1.76 % on dry weight basis. These variations could be attributed to the variation in varieties and harvesting season.

Ascorbic acid content of whole fruits exhibited lower amount (14.12 mg/100g on dry weight basis), while plup had 16.25 mg/100g (on dry weight basis). These results show that persimmon fruits can be considered as an excellent source of ascorbic acid.

Total carotenoids of both persimmon samples were higher in pulp than in whole fruits, these results are in accordance with the data of Forbus *et al*. (1991).

The contents of K, Ca, Mn and P of persimmon pulp,were higher than those of the whole persimmon fruits (Table 2). These results also show that potassium was the principal element in both samples, it amounted to 2018.53 and 1855.22 (mg/100g), for pulp and whole persimmon fruit, respectively. The mineral elements of persimmon could be ranked descendigly as K, Na, Ca, P, Fe, Cu and Mn.

Generally, it could be concluded that persimmon fruit is a good source of ascorbic acid (vitamin C), carotene (pro-vitamin A), sugar, crude fiber and minerals especially potassium.(Shela *et al*., 2001).

Antioxidant activity of fresh whole persimmon fruits and pulp

The antioxidant activities of methanolic extract of whole persimmon fruits and pulp against DPPH free radical were shown in Fig. (1). The DPPH is a free radical compound and has been widely used to test the free radical- scavenging ability of various samples (Shimoji *et al*., 2002).

The antioxidant activity of whole fruits was higher than that of the pulp, they were 100 and 80 %, respectively. The outer layers of the plant such as the peel, shell and hull generally contain large amount of polyphenolic compounds to protect the inner materials. A number of phenolic acids are linked to various cell-wall components such as arabinoxylans and proteins (Harris & Hartley, 1976).

Effect of pre-drying treatments on persimmon purée constituents

The effect of different pre-drying treatments such as steaming, immersing in sodium metabisulfite solution (0.3%) and immersing in citric acid solution 0.2% on some essential constituents, such

Table 2: Mineral contents of whole persimmon fruits and pulp*

Minerals (mg/100g)	Whole fruits	Pulp
Na	521.12±31.555	265.88±39.337
K	1855.22±34.076	2018.53±159.445
Ca	108.21±0.445	133.41±0.730
Fe	5.85±1.197	3.92±0.484
Cu	2.71±0.626	2.59±0.385
Mn	1.28±0.511	1.63±0.320
P	101.08±0.391	105.91±0.342

* Values are the means of three replicate ± SD

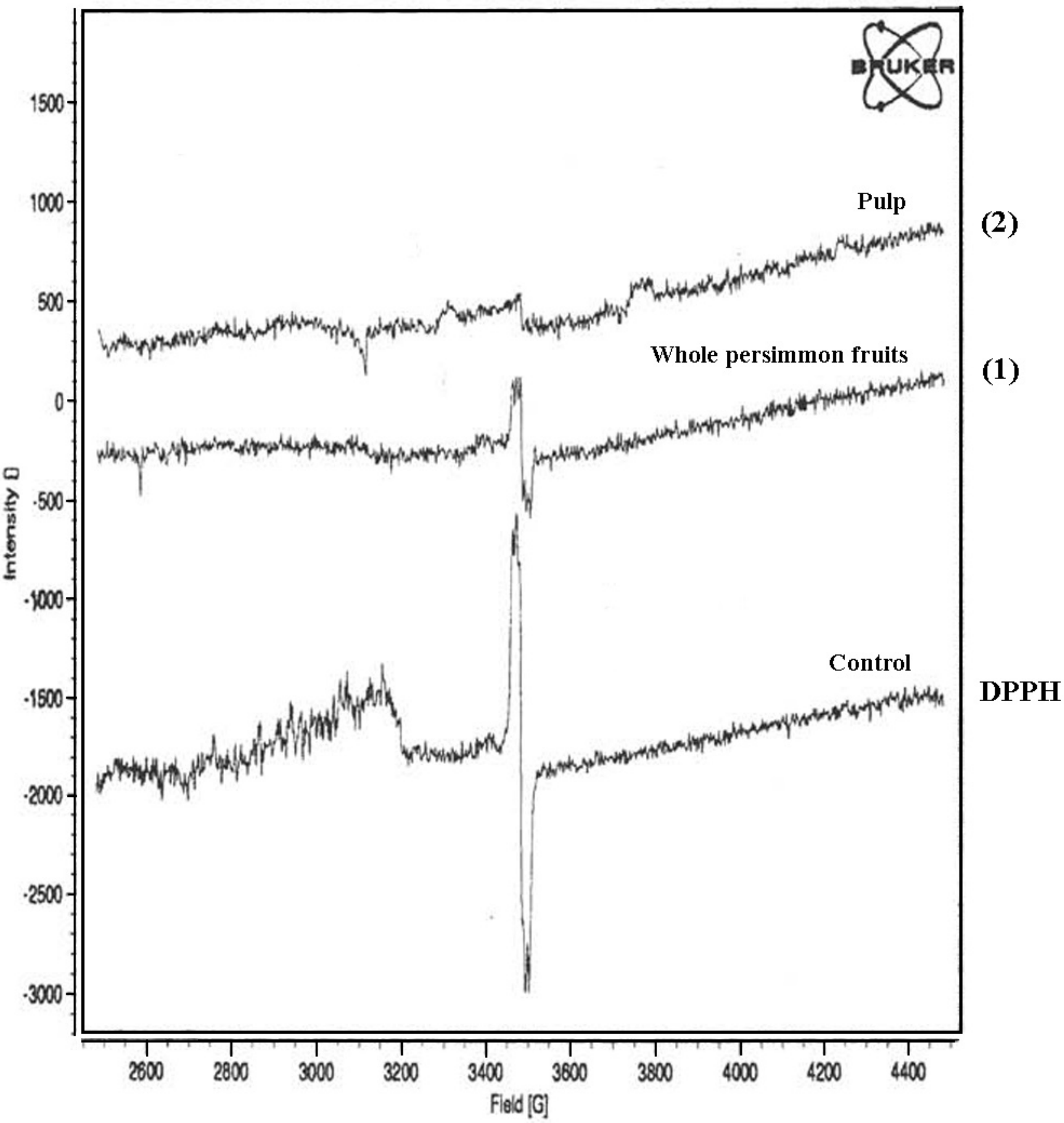

Fig. 1: Antioxidant activity of fresh whole persimmon fruits and pulp

as moisture content, total soluble solids and sulfur dioxide in whole fruits and pulp were studied and the results are shown in Table (3).

Data revealed that the moisture content of control samples were higher than all treated samples. Purée samples immersed in 0.3% sodium metabisulfite (T_2) had the lowest values of moisture content. These decreases in moisture content of all treated samples could be attributed to the evaporation of moisture and/or leaching out of some cell liquid through cell walls (Hassan, 1995). The boundary phase occurred on the product surface decreases the driving force between the solution and the product and hinders the mass transfer (Ertekin & Sultanoglu, 2002).

The highest values of total soluble solids (T.S.S) content were observed in the treated samples with 0.3% sodium metabisulfite solution (T_2). In the same Table (3), both of whole persimmon fruits and pulp treated with steaming (T_1) and 0.2% citric acid solution (T_3) was sulfer dioxide free.

Effect of pre-drying treatments on drying period and drying ratio of whole persimmon fruits and pulp sheets

The effect of different pre-treatments on the drying period and drying ratio of persimmon sheets of the two samples (whole fruits and pulp) was studied and the data are shown in Table (4).

It can be noticed that the control sample required 18.00 hr. for whole fruits and 17.30 hr. for the pulp to reach dryness, while samples treated with 0.2 % citric acid solution needed 19.15 and 17.40 hours, respectively. Data indicate also that the treated whole fruits needed relatively long drying period. Samples treated by steaming (T_1) showed a minimal increase in drying period. This may be attributed to the increase of binding water resulting in reducing evaporation and water loss (Elewa, 1982).

Regarding the sheets, it was obvious that all pre-treated samples of whole persimmon fruits and pulp recorded a slight decrease in the drying ratio as compared to untreat ones (control).

Physical properties

The physical characteristics of dehydrated persimmon sheets were evaluated. Colour index (Absorbance "A") and rehydration ratio are given in Table (5). Data show that persimmon pulp had higher absorbance reading than whole fruit in fresh or dried sheets. In this concern, samples T_1, T_3 showed higher colour index in comparison with the sulfured samples T_2. This means that, sulphiting induces a light colour of the dried products. This may be due to bleaching the persimmon pulp on one hand or prevention both types of browning inactivating irreversibly enzyme systems and blocking the reducing groups of sugars by SO_2 as reported by Somogyi & Luh (1986) and Akyidiz (2004).

The dried persimmon samples (whole fruits and pulp) as sheets were rehydrated with boiling water for 5 minutes and the results are shown in Table (5). The rehydration ratios ranged between (1.58–1.73) for control samples. Sulphited samples (T_2) had a good rehydration ratio as sulphiting facilitates the drying process by plazmolyzing the cell and sulphiting has the same stimulating effect on reconstitution, as reported by Hassan, (1995). Also, it could be noticed that steaming treatment improved the rehydration values of all dried samples. These results are in agreement with those obtained by Levi *et al*. (1988), who demonstrated that dried peach fruit samples treated before dehydration with SO_2 absorb more water than control ones.

Organoleptic characteristics of dried persimmon samples

Organoleptic evaluation of the dried persimmon sheets is considered as one of the important factors that affect, to a large extent, their acceptability for consumer. Therefore, the prepared dried samples were evaluated organoleptically by ten panelists immediately after drying process for colour, taste, appearance, texture, odour and overall acceptability and then statistically analyzed and the results are shown in Table (6), it could be noticed that the dried sheet samples of persimmon pulp treated with 0.3 % sodium metabisulfite (T_2) had the highest scores, followed by samples treated with 0.2 % citric acid (T_3) while the steaming samples (T_1) had the lowest value of appearance. These results are in accordance with those obtained by Hassan (1995).

Thus, sulphiting pre-treatment seems to prevent colour deterioration during dehydration, as it retards both enzymatic and non-enzymatic browning reactions. (Wetherilt *et al*., 1992).

The T_2 and T_3 treatments were quite comparable regarding the overall acceptability. However, there were significant differences between such treatments as compared to control and steaming samples.

CONCLUSION

In Egypt, persimmon is marketed on usual as fresh fruits. So, in order to extend its shelf life and to keep its biologically active compounds, we developed technology of drying by using different pre-treatments to provide high quality sheets.

Table 3: Effect of pre-drying treatments* on moisture, total soluble solids and sulfure dioxide of whole persimmon fruits and pulp puree(a)

Constituents	Whole fruits				Pulp			
	Control	T_1	T_2	T_3	Control	T_1	T_2	T_3
Moisture content %	73.78±1.382	70.61±1.338	64.45±1.381	70.35±0.977	77.89±0.977	73.66±1.910	68.12±1.046	73.90±1.665
Total soluble solids %	22.60±1.715	25.90±1.890	31.80±1.780	25.80±1.780	23.50±2.064	28.20±0.899	32.10±1.040	26.30±0.305
Sulfur dioxide (ppm)	---	---	1198±56.630	---	---	---	1215±57.622	---

*T_1: Steaming
T_2: Immersion in 0.3 % sodium metabisulfite solution
T_3: Immersion in 0.2 % citric acid solution
(a): Different letters within a row indicate significant difference (P< 0.05).

Table 4: Effect of pre-treatments* on drying period and drying ratio of whole persimmon fruits and pulp sheets(a)

Properties	Whole fruits				Pulp			
	Control	T_1	T_2	T_3	Control	T_1	T_2	T_3
Drying period (hr.)	18.00±0.130	18.50±0.210	19.10±0.447	19.15±0.715	17.30±0.586	17.40±0.535	17.20±0.387	17.25±0.595
Drying ratio	3.40:1	3.20:1	2.95:1	3.00:1	3.93:1	3.06:1	3.08:1	3.75:1

*T_1: Steaming
T_2: Immersion in 0.3 % sodium metabisulfite solution
T_3: Immersion in 0.2 % citric acid solution
(a): Different letters within a row indicate significant difference (P< 0.05).

Table 5: Effect of dehydration on colour index* and rehydration ratio of whole persimmon fruits and pulp sheets(a)

Physical properties	Whole fruits					Pulp				
	Fresh	Control	T_1	T_2	T_3	Fresh	Control	T_1	T_2	T_3
Colour index (A)	0.097±0.027	0.269±0.029	0.143±0.208	0.121±0.039	0.142±0.048	0.208±0.265	0.471±0.271	0.356±0.161	0.341±0.306	0.348±0.407
Rehydration ratio	---	1.730±0.398	2.170±0.297	2.290±0.081	1.990±0.575	---	1.580±0.479	2.130±0.210	2.210±0.293	1.890±0.338

*T_1: Steaming
T_2: Immersion in 0.3 % sodium metabisulfite solution
T_3: Immersion in 0.2 % citric acid solution
(a): Different letters within a row indicate significant difference (P< 0.05).

Table 6: Sensory evaluation of dehydrated whole persimmon fruits and pulp sheets(a)

Attributes	Whole fruits				Pulp			
	Control	T_1	T_2	T_3	Control	T_1	T_2	T_3
Colour	6.5c	7.0b	8.9a	8.0b	7.0b	7.3b	9.0a	8.8a
Taste	6.5b	8.3a	8.2a	8.3a	8.3a	7.8b	9.1a	8.9a
Appearance	6.5b	6.3b	8.6a	9.0a	6.3b	6.9b	8.5a	8.2a
Texture	7.1b	7.3b	8.2a	8.1a	7.3b	8.0a	7.9a	7.5a
Odour	7.5b	7.5b	8.0a	7.9a	7.5b	8.1a	8.2a	6.9b
Overall acceptability	7.1b	7.4b	8.9a	8.2a	7.4b	7.9b	8.7a	8.2a

*T_1: Steaming
T_2: Immersion in 0.3 % sodium metabisulfite solution
T_3: Immersion in 0.2 % citric acid solution
(a): Different letters within a row indicate significant difference (P< 0.05).

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تأثير معاملات ما قبل التجفيف علي كفاءة لفائف الكاكا المجففة

منال فتحي سلامة

معمل الصناعات الغذائية – المركز القومي للبحوث – الدقي– الجيزة

تهدف هذه الدراسة الي انتاج لفائف مجففة سهلة الاسترجاع من ثمار فاكهة الكاكا المنزرعة في مصر لامكانية استهلاكها في المواسم التي لا تتوافر فيها الثمار الطازجة. وقد اجريت بعض الدراسات الطبيعية والكيماوية لثمار الكاكا الكاملة و اللب بدون القشر حيث اثبتت النتائج احتواء الثمرة الكاملة علي مضادات أكسدة طبيعية و تانينات وألياف بتركيزات أعلي من الموجودة في اللب بينما يحتوي اللب علي نسب أعلي من الكاروتينات و حمض الأسكوربيك و محتوي المعادن الأساسية.

و تم ايضا في هذا البحث غسيل و تقطيع و هرس الثمرة كاملة بالقشر واللب بدون القشر ثم اجراء عدة معاملات ما قبل التجفيف وهي المعاملة بالبخار والنقع في محلول ٠.٣٪ محلول صوديوم ميتابيسلفيت و ٠.٢٪ محلول حمض الستريك و ذلك للحصول علي لفائف سهلة الاسترجاع في خلال ٥ دقائق محتوية علي نسبة رطوبة تصل الي ١٤٪ .

ومن النتائج المتحصل عليها تبين احتواء لب الثمار بدون القشر المعامل بالسلفيت علي نسبة أعلي من المواد الصلبة الذائبة الكلية وأيضا ارتفاع معامل اللون عن الثمار الكاملة بالقشر.

و أثبتت التجارب أيضا أن المعاملة باستخدام محلول صوديوم ميتابيسلفيت حصلت علي أعلي درجات للمحكمين بعد استرجاع لفائفهما المجففة من حيث اللون و الطعم و القوام و الرائحة.