



PHYSICOCHEMICAL, MICROBIOLOGICAL AND SENSORY CHARACTERISTICS OF PERSIMMON FRUIT LEATHER

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ABSTRACT: Persimmon fruit leather is a dehydrated persimmon product, which was consumed as a chewy for preparation of valuable nutritive dessert. The aim of the present study was to utilize persimmon puree in the preparation of persimmon leather and study physicochemical, microbiological and sensory characteristics of persimmon leather. Persimmon fruit leather was prepared by drying a mixture of persimmon puree treated with hot break by steam (HST), mango puree, glucose syrup, sugar, pectin, citric acid and starch. Dehydration was performed in microwave at 55°C for 30 min. Leather was also prepared from persimmon leather using the same ingredients except starch. Results showed that texture properties of leather containing starch was higher than leather without starch. Moisture, ash content and acidity were close to each other in persimmon leathers with or without starch. TSS content in persimmon leather product samples were 78.89° Brix and 79.14° Brix, while total and reducing sugars of leather without starch recorded 83.26 and 45.08%, respectively. Persimmon leather with starch contained total and reducing sugars 81.48 and 44.90%, respectively. Ascorbic acid retained in persimmon leather containing starch was slightly higher (14.26 mg/100g) compared to leather without starch (13.52 mg/100g). Browning index increased when adding starch to the formula. Alcohol insoluble solids (AIS) and crude fibers content were 12.87 and 0.98% in persimmon leather with starch, respectively, whereas the respective values in persimmon leather without starch were 8.73 and 0.82%. Antioxidant activity and carotenoids contents were higher in persimmon leather containing starch than that without starch. Polyphenols, flavonoids and tannins contents were lower in persimmon leather containing starch than leather without starch. Pyrogallol and E-vanillic were the dominant compounds in both of persimmon leathers with and without starch. Vitamin K represented the highest content among all studied vitamins in persimmon leather. Lightness value (L*) was 33.81 in persimmon leather containing starch which is higher than lightness value (L*) in persimmon leather without starch (23.72). The values of (a*) and (b*) were higher in persimmon leather without starch (12.71 and 12.97, respectively) than in persimmon leather containing starch (8.10 and 8.16, respectively). Total bacteria count was 110 CFU/g in just first dilution in persimmon leather with starch but it was not detected in other dilutions, total count bacteria was not detected in persimmon leather without starch in all dilutions. Molds and yeasts and spore forming bacteria counts were not detected in all persimmon leather samples.

Key words: Persimmon fruit leather, microwave, physicochemical, microbiological and sensory characteristics.

INTRODUCTION

Persimmon (*Diospyros kaki* L.), belonging to family Ebenaceae, has been cultivated for

thousands of years. It is a native fruit of China. It was introduced first into Japan and Korea, and then USA and Europe in the 18th century and now it is growing in many countries. World

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production of persimmons reached from 4070375 tons in 2010 to 5190624 tons in 2014 (FAO, 2017). In Egypt, the annual production of persimmon is estimated at 14810 tones and the harvested area is 1787 faddans as documented in **Statistics of the Ministry of Agriculture (2014)**.

Persimmon fruit is rich in bioactive compounds, such as phenolic compounds, ascorbic acid and carotenoids, which contribute as antioxidant characteristics. Besides, it is also a good source of sugars, minerals and dietary fibers (**Hertog *et al.*, 1995; Gorinstein *et al.*, 1999; Rao and Rao, 2007**).

Persimmon fruit has been used for various medicinal purposes due its therapeutic properties such as lowering of blood pressure, diuretic and therapeutic effects on cardiovascular system diseases, cough treatment and dental caries (**Sakanaka *et al.*, 2005**) as well as on viral and bacterial infectious diseases (**Suzuki *et al.*, 2007**).

Recently, it has been revealed that persimmon reduces cholesterol, remedies digestive system diseases, strengthens the immune system and helps to prevent cancer. It has a therapeutic effect on weakness, vitamin deficiency, anemia and gastrointestinal diseases (**Bölek and Obuz, 2014**).

Therefore, there has been a pronounced increase in the production of persimmon fruits. This necessitates the utilization of surplus amounts in the manufacture of a variety of persimmon products. Processing of persimmon may take a different forms such as jam, puree, juices, nectars and dehydrated products like persimmon leather.

Mango are used in processing various kinds of products like nectar, pickles, chutneys, jam, squash, cereal flakes, baby foods, custard powder, toffee and mango leather. It is an important source of vitamin-C and vitamin-A in addition it has several minerals and other vitamins (**Reddy and Kumar, 2010**).

Fruit leather is a dehydrated fruit-based confectionery dietary product which is mostly eaten as dessert or snack (**Raab and Oehler, 1976**). Fruit pulp-based fruit leathers are distinguished with nutritions and they are organoleptically acceptable to consumers. They contain high quantities of carbohydrates, dietary fibers, minerals, vitamins, and antioxidants

(**Ayotte, 1980; Gujral and Brar, 2003**). Fruit leathers are restructured fruit made from fresh fruit pulp or a mixture of fruit juice concentrates and other ingredients after a complex operation that involves a dehydration step (**Maskan *et al.*, 2002; Huang and Hsieh, 2005**).

Fruit leathers are manufactured by dehydrating a fruit puree into a leather like sheet (**Raab and Oehler, 1976**). Moisture is removed from the wet purees, which are usually spread on a large flat tray until the fruit puree or a prepared boiled fruit juice with additives changes into cohesive "leathery" sheets (**Moyls, 1981**).

Fruit pulps are mixed with appropriate quantities of sugar, pectin and acid then dried into sheet-shaped products. **Chan Jr. and Cavaletto (1978)** used sucrose and sodiumbisulfite (SO₂) in processing papaya leathers. Various additives can be used, such as glucose syrup, sodium metabisulphite and sorbic acid depending on the types of fruit leather (**Demarchi *et al.*, 2013; Sharma *et al.*, 2013**).

Mir and Nath (1995) studied the sorption isotherms of fortified mango bars prepared from the puree of soft ripe mangoes. They prepared the mango bars by washing and peeling the mangoes, then pulping and heating the pulp at 91–93°C for 2 minutes. They added powdered cane sugar, 0.6% citric acid, and 1734 ppm potassium metabisulphite; the total solids of the mango puree was raised to 30%.The mango puree was spread uniformly on aluminum trays and dried for 14 - 16 hours in a cross-flow cabinet dryer at 63±2°C.

Zeid (1996) processed mango sheet by washing mango fruit, peeling, cutting into halves. Mango juice was extracted mechanically by using blender. The juice was then screened and pasteurized at 70°C for 3 min. The ingredients used were: 0.3% pectin and 0.3% citric, then divided into 4 parts. One part left without any treatment as a control. Second part contained 0.3% ascorbic acid, third part contained 0.3% ascorbic acid+0.05% ethylene diamine tetra acetic acid (EDTA) and fourth part contained 0.3% ascorbic acid+0.1% EDTA. Samples were poured into paraffin oiled stainless steel trays. Mango sheet was dehydrated at 60±1°C in thermostatically controlled cabinet-dryer. He concluded that the addition of 0.3% ascorbic

acid to mango juice before dehydration improved the quality of resultant dried sheets especially the colour and flavour. In addition to the presence of ascorbic acid reduced the bacterial, molds and yeasts count.

Gujral and Brar (2003) used sugars and pectin as additives to mango leathers. The sugar increased the solids content and granted the product a sweeter taste, then pectin was used to thicken the pulp and to ensure the retention of the shapes of the dried product and modify the flexible texture. Mango leather was also prepared with the addition of potassium metabisulphite to get better sensory properties and the results were satisfactory for consumers.

Azeredo et al. (2006) and **Pushpa et al. (2006)** processed mango sheets, and the latter estimated the effect of incorporating defatted soy flour to process nutritionally enriched mango fruit leather by microwave drying. Sugar (50 g), lime juice (2 g), corn flour (5 g), roasted defatted soy flour with a protein content of 51.8%, and skim milk powder in the ratio of 1 : 1 were added to the mango pulp at concentrations of 10%, 15%, 20%, and 25%. The mixture was heated at each concentration to 80°C for 15 minutes and then dried in a microwave dryer with a power cycle of 30 sec. on and 30 sec. off, respectively, until the sample reached a moisture content of 12–15%. They measured the colour and they reported that by increasing the soy flour concentration the value for yellowness was increased.

The objectives of this study are to evaluate the possibility of producing new product such as dehydrated sheets (leathers) from persimmon fruits and studying physicochemical, sensory and microbiological characteristics of resultant persimmon sheet (leather).

MATERIALS AND METHODS

Materials

Fresh ripe persimmon fruits (*Diospyrose kaki* L., Costata variety) and fresh ripe mango fruits (*Mangifera indica* L., Baladi variety) were obtained from hyper market, Cairo, Egypt, during the season of 2015.

Pectin and citric acid used in the present study were analytical grade (Sigma Aldrich, USA) obtained from El-Nasr Pharmaceutical Chemicals Co., Egypt. (ADWIC). Corn starch and glucose syrup were obtained from National

Co. For Maize Products S.A.E., Egypt. Sugar and sunflower oil were purchased from hyper market, Egypt.

Methods

Preparation of persimmon and mango puree

Fresh ripe persimmon fruits were carefully sorted, washed, peeled, crushed and heat treated at 95°C for 5 minutes according to **Antho et al. (2008)**, then the puree was made by hand electric blender (Braun 450 watt), yielding persimmon puree. For the preparation of mango puree, mango fruits were carefully sorted, washed and peeled. The kernel was removed from the edible part by knife, and the edible part was homogenized by hand electric blender (Braun 450 watt) to make mango puree.

Processing of persimmon leather

The persimmon puree was exposed to the hot break by steam (HST), and the optimal chosen mixing ratio from persimmon to mango puree was 80% to 20%, based on experimental trials, conducted by sensory evaluation. Mango puree was added to impart better flavour to persimmon leather.

Three treatments were conducted as follows:

- (A) 80g persimmon puree HST (52.28%), 20g mango puree (13.07%), 25g glucose syrup (16.33%), 25g sugar (16.33%), 1g pectin (0.65%) and 2g citric acid (1.30%).
- (B) 80g persimmon puree HST (52.45%), 20g mango puree (13.11%), 25g glucose syrup (16.39%), 25g sugar (16.39%), 1g pectin (0.65%) and 1.5g citric acid (0.98%).
- (C) 80g persimmon puree HST (50.79%), 20g mango puree (12.69%), 25g glucose syrup (15.87%), 25g sugar (15.87%), 1g pectin (0.63%), 1.5g citric acid (0.95%) and 5g starch (3.17%).

According to the organoleptic evaluation, the best formula chosen was realized when adding starch.

The mixture was boiled for 10 minutes and poured into Pyrex tray previously smeared with sunflower oil. The thickness was adjusted at 0.2 cm. Dehydration was performed in microwave Tornado TM-30S (rated voltage: 230V, 50Hz), with power (1450w) for 30 minutes. Figure (1) showed the persimmon leather manufacturing. The sheets were subjected to further analysis.

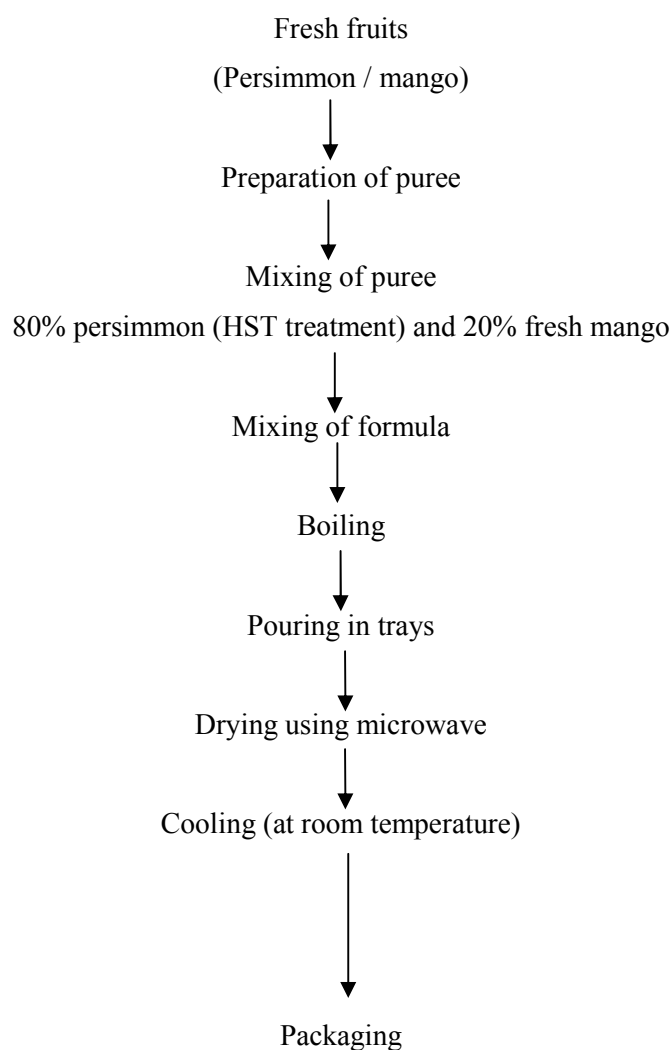


Fig. 1. Flow diagram of persimmon leather manufacturing

Analytical Methods

Physical analyses

Texture measurement was carried out according to **Bourne (2003)**. Leather samples were cut in a tape shape, approximately 7.5 cm long, 2 cm wide per sample. A load cell of 5 Kg was employed. For analysis, one tensile grip was fixed to the base of the textural analyzer, while the other one was attached to the load cell. Initial grip separation was 12.5 mm and cross-head speed was 1.0 mm/sec. until rupture. Each sample was placed between both tensile grips on the textural analyzer. Rupture force was taken as the maximum force peak height (N) required for breaking the sample.

Hunter L*, a* and b* values were measured by using a Hunter lab colourimeter (Hunter Lab Colour Flex EZ, USA) according to **Rao *et al.* (2011)**. The L* value (lightness index scale) ranges from 0 (black) to 100 (white) while a* value indicates the redness (+a) or greenness (-a*) and the b* value refers to the yellowness (+b) or blueness (-b*).

Total soluble solids were determined using refractometer (Bellingham + Stanley Limiteci) at 20°C.

Chemical analyses

Titrateable acidity, pH value, moisture, ash and crude fiber were determined according to the method described in **AOAC (2007)**. Total and reducing sugars were determined by the method of **Somogy (1952)** and **Nelson (1974)**.

Browning index was measured according to **Ranganna (1979)** method by ethanol 60% using multi cell Janway 6705 UV/VIS Spectrophotometer at 420 nm.

Alcohol insoluble solids were determined according to the method of **Thomas and Thibault (2003)** with slight modification. The samples were kept in ethanol (70%) for 15 min, brought to boil for 30 min, filtered and washed with ethanol 70% through Buchner funnel under suction. The washing step was repeated until a sugar-free extract was obtained. The residue was washed successively with 96% ethanol (3 times) and acetone (3 times), then air-dried overnight at 40°C, vacuum-dried for 12 hr., at 40°C, and weighed (AIS).

Alcohol insoluble solids (%) = $\text{Wt. of residue} \times 100 / \text{Wt. of sample taken for estimation}$.

Ascorbic acid content was determined using 2,6 dichlorophenol indophenol dye according to the method reported by **Ranganna (1979)**. The results were expressed as mg/100g.

The scavenging ability of antioxidant against DPPH (2, 2'- Di Phenyl-1Picryl Hydrazyl) as free radical agent which can react directly with antioxidant, was determined according to the method described by **Gorinstein et al. (2004)**.

The ability of scavenging the DPPH radical was calculated with the following equation: $\text{Inhibition \%} = [(A_0 - A_1) / A_0] \times 100$

Where :

A₀ is the absorbance of the control

A₁ is the absorbance in the presence of sample.

Carotenoids content was determined by mixing ten grams of the sample with 30 ml of 85% acetone in a dark bottle and left to stand for 15 hours at room temperature. The sample was then filtered through glass wool into a 100 ml volumetric flask, and made up to volume with 85% acetone solution. The crude pigment is assayed spectrophotometrically. Absorptions were recorded at wavelengths of 662, 644 and 440 nm and then calculated using the formula of **Holm (1954) and Wettstein (1957)** as follows (mg/l):

Chlorophyll a = $9.784.A_{662} - 0.990.A_{644}$

Chlorophyll b = $21.426.A_{644} - 4.650.A_{662}$

Chlorophyll a + b = $5.134.A_{662} + 20.436.A_{644}$

Carotenoids = $4.695.A_{440} - 0.268.(a + b)$

Where

A = absorbency at corresponding wave length.

The amount of total phenols in extract was determined with the Folin-Ciocalteu reagent according to the method described by **Sahu and Saxena (2013)**. Gallic acid was used as a standard and the total phenols were expressed as mg/g gallic acid equivalents (GAE). Flavonoids content was determined using the method of **Barros et al. (2010)**. Total tannins content was determined by the vanillin assay according to the method of **Price et al. (1978)**.

Phenolic and flavonoid compounds were determined by HPLC according to method of **Goupy et al. (1999)** and **Mattila et al. (2000)** respectively, as follow: 5 gms of sample were mixed with methanol and centrifuged at 10000 rpm for 10 min and the supernatant was filtered through a 0.2µm Millipore membrane filter, then 1-3 ml was collected in a vial for injection into HPLC Agilent 1200 series equipped with quaternary pump, Auto sampler, column compartments at 35°C, ultraviolet (UV) detector set at 280 nm for detection phenols and 330 nm for flavonoids, degasser, column used for fraction Zorbax ODS. 4.6×250 mm and the flow rate of mobile phase during run was 1 ml/min. Retention time and peak area were used for calculation of phenolic compounds concentration by the data analysis of HEWLLET packared software.

Sugars were determined by HPLC according to the methods of **Zalyalieva et al. (1999)** and **Zielinski et al. (2014)** using HPLC Agilent 1200 series equipped with Quarternary pump, auto sampler injector, solvent degasser, column used for fractionation was Aminex-carbohydrate HPX-87°C, 300 mmx 7.8 mm.

Vitamins were determined by HPLC Agilent 1200 series equipped with an autosampler, quaternary pump degasser and column compartments set at 35°C. Analyses were performed on a C18 reverse phase (BDS 5 µm, Labio, Czech Republic) packed stainless-steel column (4×250 mm, I.D.). Vitamin A was

determined according to **De Vries and Silvera (2002)**, vitamin E was determined according to **Pyka and Sliwiok (2001)**, vitamin D was determined according to **Gàmiz-Gracia *et al.* (2000)** and vitamin K was determined according to **Pérez-Ruiz *et al.* (2007)**.

Microbiological analyses

Total bacteria counts, yeasts and moulds were determined according to the methods recommended by the **American Public Health Association (1992)**. Total bacteria counts were determined using plate count agar medium. One ml from each dilution was plated on the plate count agar medium in three replicates and incubated at 37°C for three days. Yeasts and moulds were estimated using malt extract agar medium. One ml from each dilution was plated on the malt extract agar medium in three replicates and incubated at 25°C for up to five days. Spore forming bacteria was determined according to the method described in **American Society for Microbiology (1982)**.

Sensory evaluation

Sensory properties were evaluated at Food Technology Research Institute (FTRI). Ten panelists from food chemistry laboratory (FCL) were asked to evaluate taste, colour, texture and overall acceptability according the method of **Pushpa *et al.* (2006)**.

Statistical analysis

Results were statistically analyzed by the least significant differences (LSD) at the levels of probability procedure, according to **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSION

The optimal chosen mixing ratio from persimmon to mango puree was 80% to 20% in processing persimmon leather. Mango puree was added to impart better flavour to persimmon leather.

Sensory Evaluation

Sensory evaluation was carried out between three samples as follows:

Sample (A) contained 80g persimmon puree HST, 20g mango puree, 25g glucose syrup, 25g sugar, 1g pectin and 2g citric acid.

Sample (B) contained 80g persimmon puree HST, 20g mango puree, 25g glucose syrup, 25g sugar, 1g pectin and 1.5g citric acid.

Sample (C) contained 80g persimmon puree HST, 20g mango puree, 25g glucose syrup, 25g sugar, 1g pectin, 1.5g citric acid and 5g starch.

The results showed that sample (C) had the highest score in all parameters of sensory evaluation comprised taste, colour, texture and overall acceptability compared to the other samples. While, sample (A) showed the lowest score in all parameters as they are shown in Table 1.

Therefore, the two samples (B) and (C) were used to study the physicochemical properties.

Physicochemical Characteristics

Texture of samples (B) and (C) persimmon leather measured and compared with texture of commercial apricot sheet (Q). Table (2) shows the results of texture properties, whereas commercial apricot sheet showed the highest texture value. While, sample (B) recorded the lowest texture value. The texture of sample (C) was 3.24 and higher than sample (B) due to the presence of starch. High pectin content in apricot fruits (**Baker, 1997**) as well as the quality of pectin is responsible for the high texture of commercial apricot sheet compared to persimmon sheet.

Results in Table 3 shows the Hunter colour values in persimmon leathers (B) and (C). It can be seen that lightness value (L*) was 33.81 in leather sample (C) which is higher than lightness value (L*) in leather sample (B) (23.72). This is may be due to the addition of starch to the sample (C). Lightness value increased in mango fruit leather by increasing the soy flour concentration (**Pushpa *et al.*, 2006**).

In respect of (a*) and (b*) values, they were higher in persimmon leather sample (B) than in sample (C). They recorded 12.71 and 12.97 in persimmon leather sample (B) and 8.10 and 8.16 in persimmon leather sample (C), respectively.

Karaman *et al.* (2013) found that lightness value (L*), (a*) and (b*) values were 50.56, 6.52 and 17.09, respectively in the ice-cream which enriched with 40% persimmon puree.

Tables 4 and 5 show physicochemical properties and bioactive compounds of persimmon leather product. Moisture contents were 6.36 and 6.55% in persimmon leathers (B) and (C), respectively. TSS contents in persimmon leather samples were 79.14° Brix and 78.89° Brix for sample (B)

Table 1. Sensory evaluation of persimmon leather products dehydrated by microwave

Sensory property (10)	(A)	(B)	(C)	LSD (P≥0.05)
Taste	6.85 ^c ± 0.88	7.05 ^b ± 0.95	8.50 ^a ± 1.29	0.971
Colour	7.10 ^b ± 0.87	7.65 ^a ± 0.81	8.65 ^a ± 1.56	1.044
Texture	7.35 ^a ± 0.94	7.75 ^a ± 0.79	8.05 ^a ± 1.46	1.012
Overall acceptability	6.75 ^b ± 0.79	7.20 ^b ± 1.22	8.50 ^a ± 1.26	1.025

A: Persimmon leather with 2g citric without starch.

B: Persimmon leather with 1.5g citric without starch.

C: Persimmon leather with 1.5g citric and 5g starch.

Table 2. Texture measurement of persimmon leather product compared to commercial apricot sheet

Sample	Maximum force (N)
Q	5.30
B	2.65
C	3.24

Q: Commercial apricot sheet. B: Persimmon leather without starch. C: Persimmon leather with starch.

Table 3. Hunter colour values of persimmon leather without starch (B) and persimmon leather with starch (C)

	L*	a*	b*
Persimmon leather (B)	23.72	12.71	12.97
Persimmon leather (C)	33.81	8.10	8.16

L* defines the lightness and a*, b* define the red-greenness and blue-yellowness, respectively.

Table 4. Physicochemical characteristics of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Physicochemical characteristics	Persimmon leather (B)	Persimmon leather (C)	LSD (P≥0.05)
*Moisture (%)	6.36 ^b ± 0.02	6.55 ^a ± 0.009	0.035
*TSS (%)	79.14 ^a ± 0.01	78.89 ^b ± 0.025	0.043
Titrateable acidity (as citric acid) (%)	1.82 ^a ± 0.02	1.78 ^a ± 0.03	0.068
*pH value	4.16 ^a ± 0.001	4.11 ^b ± 0.001	0.049
Total sugars (%)	83.26 ^a ± 0.74	81.48 ^b ± 0.64	0.258
Reducing sugars (%)	45.08 ^a ± 0.85	44.90 ^a ± 1.49	1.596
* Browning index (as OD at 420 nm).	0.100 ^b ± 0.001	0.139 ^a ± 0.001	0.005
Ash (%)	1.12 ^a ± 0.06	1.10 ^a ± 0.02	0.107
AIS (%)	8.73 ^b ± 0.003	12.87 ^a ± 0.011	0.019
Crude fibers (%)	0.82 ^b ± 0.002	0.98 ^a ± 0.001	0.005

B: Persimmon leather without starch.

C: Persimmon leather with starch.

* on fresh weight basis.

Table 5. Bioactive compounds of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Bioactive compounds	Persimmon leather (B)	Persimmon leather (C)	LSD (P≥0.05)
Ascorbic acid (mg/100g)	13.52 ^a ± 0.58	14.26 ^a ± 1.01	1.884
Antioxidant activity (%)	83.53 ^b ± 1.91	87.08 ^a ± 0.52	3.189
Carotenoids content (mg/100g)	0.414 ^b ± 0.001	0.554 ^a ± 0.01	0.017
Total phenols (mg/g)	37.46 ^a ± 0.39	29.91 ^b ± 1.52	2.533
Total flavonoids (mg/g)	7.89 ^a ± 0.10	6.50 ^b ± 0.05	1.191
Total tannins (%)	7.45 ^a ± 0.36	5.75 ^b ± 0.41	0.877

B: Persimmon leather without starch.

C: Persimmon leather with starch.

and (C), respectively, the acidity was slightly increased in sample (B) being 1.82% than (C) having 1.78%, in addition to total and reducing sugars were slightly higher in (B) than (C). Total and reducing sugars recorded in leather without starch were 83.26 and 45.08% and recorded 81.48 and 44.90%, respectively, in persimmon leather containing starch.

Ash content in persimmon leather (B) (1.12%) and in leather (C) (1.10%) was almost identical.

AIS and crude fibers were 8.73 and 0.82 % in persimmon leather (B), and were 12.87 and 0.98% in persimmon leather (C), respectively.

Ascorbic acid was higher in persimmon leather (C) (14.26 mg/100g) compared to (B) (13.52 mg/100g) and also browning index which was 0.139 in leather (C) and 0.100 in leather (B). **Zeid (1996)** observed that ascorbic acid content was higher in mango sheet containing 0.3% ascorbic acid than control sample, but colour index decreased.

Antioxidant activity was higher in persimmon leather (C) (87.08%) than (B) (83.53%). Carotenoids content recorded 0.55 mg/100g in

leather (C) and 0.41 mg/100g in leather (B). The presence of starch probably has protective effect for the antioxidants. This is confirmed by the results obtained by **Pajak *et al.* (2017)**. They stated that the use of starch films as a carrier of antioxidants, prolonged the storage life and improved quality of fresh-cut apples at the end of storage.

Also, **Zeid (1996)** found that carotenoids content was higher in dried mango sheet which had 0.3% ascorbic acid than control.

As for polyphenols content, it was higher in persimmon leather (B) (37.46 mg/g) than persimmon leather (C) (29.91 mg/g).

Comparatively, **Karaman *et al.* (2014)** reported that the unenriched ice cream samples with persimmon puree showed the lowest total phenolic content compared with the samples enriched with persimmon puree, but ash content was the highest in unenriched ice-cream samples with persimmon puree.

Total flavonoids content were 7.89 and 6.50 mg/g in persimmon leather (B) and (C), and total tannins content were 7.45% and 5.75% in persimmon leather (B) and (C), respectively. It was observed that total contents of phenols,

flavonoids and tannins were lower in persimmon leather (C) than (B), this reduction in persimmon leather (C) may be due to the added starch in the processing of leather (C) in which panelists noticed the reduction of astringency taste compared to (B) which was without starch addition. **Castelló et al. (2011)** reported that processing of fresh persimmon to obtain a spreadable product resulted in a reduction of soluble tannins, which implied a lower astringency in the product than in the fresh fruit.

Identification of phenolic and flavonoid compounds by HPLC in persimmon leather without starch (B) and leather with starch (C) are shown in Tables 6 and 7. Pyrogallol and E-vanillic were the dominant compounds in both of persimmon leathers (B) and (C), besides, gallic acid, protocatechic, catechin, catechol are also included as shown in the Tables. Gallic acid concentrations were 3.359 and 5.380 mg/100g in persimmon leathers (B) and (C), and catechin was 1.157 and 1.193 mg/100g in persimmon leathers (B) and (C), respectively. **Oksuz et al. (2015)** identified the gallic acid, catechin in persimmon jam which were (3.09 mg/100g) and (3.79 mg/100g), respectively, but caffeic acid wasn't detected. However, it was detected in the present study in persimmon leather samples (B) and (C) which recorded 0.342 and 0.157 mg/100g, respectively.

Sugars were identified by HPLC in persimmon leather without starch (B) and leather with starch (C) are shown in Table 8. It was observed that sucrose wasn't found in samples. **Karaman et al. (2013)** processed ice cream of persimmon based and they reported that the sucrose content of ice cream samples decreased rapidly after the addition of persimmon puree.

Glucose content was identified in persimmon leathers (B) and (C) and valued 28.363% and 56.971%, respectively. The respective values of fructose were 28.908% and 42.696% in samples (B) and (C).

Vitamin K has important functions in the body, it is an anticancer, anticalcification, bone-forming and insulin-sensitising molecule. Moreover vitamin K antagonists such as warfarin may cause detrimental side effects, which may partly be blunted through vitamin K supplementation (**DiNicolantonio et al., 2015**). The determination of vitamins A, D, E and K are given in Table 9. It was observed that vitamin K was the highest content of all determined vitamins in persimmon leather products. It recorded 9.985 and 69.448 mg/100g in persimmon leathers product samples (B) and (C), respectively. It was observed that all vitamins mentioned above were higher in persimmon leather product sample (C) than persimmon leather (B).

Results obtained in this study showed that the total count of bacteria was 110 CFU/g in just first dilution in persimmon leather product sample (C) but it was not detected in other dilutions. Total count of bacteria was not detected in persimmon leather product sample (B) in all dilutions. Molds & yeasts and spore forming bacteria counts were not detected in leather samples (B) and (C), these results might be due to the high sugars, low moisture, using thermal treatment in processing and addition of some ingredients in processing such as citric acid. **Aly (1999)** reported that low microbial load of mango sheets might be due to the high sugar, low moisture, pH value and the presence of SO₂ in mango sheet. **Castelló et al. (2011)** also reported that the incorporation of citric acid, used in spreadable product of persimmon fruit in order to achieve a final pH around 3.5, prevents microorganisms from growing.

From the previous results, it can be concluded that persimmon leather sample (C) had the highest quality in sensory evaluations and texture measurement in addition to the other quality parameters compared to persimmon leather sample (B). Current study recommends that persimmon puree can be marketed as untraditional fruit leather in the form of persimmon leather as prepared in sample (C).

Table 6. The identification of phenols (mg/100 g) of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Phenol compound	Persimmon leather (B)	Persimmon leather (C)
Pyrogallol	30.956	44.612
Gallic	3.359	5.380
4-amino benzoic acid	0.211	0.225
Protocatechic	2.451	2.521
Catechein	1.157	1.193
Catechol	3.043	3.147
Epi-Catechin	1.932	0.683
P-OH benzoic	0.326	0.193
Caffeine	0.502	0.276
Chlorogenic	0.556	0.806
Vanillic	0.472	0.415
Caffic	0.342	0.157
P-Coumaric	0.290	0.276
Ferulic	0.200	0.168
Iso ferulic	0.114	0.040
E-Vanillic	5.196	8.027
Resveratrol	0.206	---
Oleuropen	3.476	---
Alpha Coumaric	0.053	0.184
Benzoic	0.680	0.422
Ellagic	0.139	0.142
3.4.5.methoxy cinnamic	0.936	0.857
Coumarin	---	0.384
Cinnamic	0.014	0.014
Salicylic	0.882	0.136

B: Persimmon leather without starch.

C: Persimmon leather with starch.

Table 7. The identification of flavonoids (mg/100g) of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Flavonoids compound	Persimmon leather (B)	Persimmon leather (C)
Luteolin 6-glucose 8-arabinose	0.437	0.601
Apigenin 6-arabinose 8-glactose	0.452	0.662
Apigenin 6-rhamnose 8-glucose	---	0.918
Apigenin 6-glucose 8-rhamnose	0.300	---
Luteolin 7 glucose	0.085	0.128
Hesperidin	2.095	3.033
Quercetin-3-0 glucose	---	0.145
Rutin	0.434	1.121
Apigenin-7-0-neohes	----	0.139
Kaempferol 3-7-diramoside	0.273	0.265
Qurectrin	0.063	0.478
Rosmarinic	0.087	0.065
Qurestin	0.039	0.079
Narengenin	0.040	0.125
Acacetin neo. Rutinoid	0.120	0.575
Kaempferol 3-2-p-coumaroylglucose	0.431	---
Hespertin	0.083	---
Kampferol	0.014	0.047
Rhamnetin	0.012	0.025
Apigenin	0.003	0.053
Saffranal	0.050	0.091
Acacetin	1.229	1.680

B: Persimmon leather without starch.

C: Persimmon leather with starch.

Table 8. Fractionation and identification of sugars (%) of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Sugar	Persimmon leather (B)	Persimmon leather (C)
Stachyose	--	0.877
Galactouronic acid	0.234	--
Glucose	28.363	56.971
Rhamnos	0.373	1.337
Fructose	28.908	42.696
Manitol	0.016	0.053
Sorbitol	0.037	0.042

B: Persimmon leather without starch.

C: Persimmon leather with starch.

Table 9. Vitamins contents (A, D, E and K) (mg/100g) of persimmon leather without starch (B) and persimmon leather with starch (C) (on dry weight basis)

Vitamin	Persimmon leather (B)	Persimmon leather (C)
Vitamin A	0.025	0.086
Vitamin D	0.0004	0.002
Vitamin E	0.002	0.003
Vitamin K	9.985	69.448

B: Persimmon leather without starch.

C: Persimmon leather with starch.

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الخواص الفيزيوكيميائية والميكروبيولوجية والحسية للفائف ثمار الكاكي

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تعتبر لفائف الكاكي منتج مجفف من ثمار الكاكي، حيث يمكن ان تستهلك كحلول مطاوية في اعداد الحلويات ذات القيمة الغذائية، وتهدف هذه الدراسة الى استخدام بيوريه الكاكي في اعداد لفائف الكاكي ودراسة خواصها الطبيعية، الكيميائية، الميكروبيولوجية والحسية، حيث تم إعداد لفائف الكاكي من خلال تجفيف خليط من: بيوريه الكاكي المعامل بحرارة البخار بالكسر على الساخن، بيوريه المانجو، شراب الجلوكوز، السكر، البكتين، حمض الستريك والنشا، وتم التجفيف باستخدام الميكروويف على درجة حرارة ٥٥ °م لمدة نصف ساعة، كما تم اعداد لفائف اخري من لفائف الكاكي باستخدام نفس المكونات ماعدا النشا، وقد أظهرت النتائج أن خواص القوام للفايف المحتوية على النشا هي الاعلى من تلك التي بدون النشا، وكان محتوى الرطوبة والرماد ونسبة الحموضة متقاربا في كل من لفائف الكاكي المحتوية وغير المحتوية على النشا حيث كان محتوى المواد الصلبة الكلية في عينات لفائف الكاكي هي ٧٨,٨٩ و ٧٩,١٤ ° بر كس. وسجل محتوى السكريات الكلية والمختزلة في لفائف الكاكي غير المحتوية على النشا ٨٣,٢٦ و ٤٥,٠٨ %، بينما كانت في لفائف الكاكي المحتوية على النشا ٨١,٤٨ و ٤٤,٩٠ % على التوالي، واحتفظت لفائف الكاكي المحتوية على النشا بحامض الاسكوربيك بتركيز اعلى بنسبة خفيفة (١٤,٢٦ ملجم/١٠٠جم) مقارنة باللفائف غير المحتوية على النشا (١٣,٥٢ ملجم/١٠٠جم)، وازداد مدلول التلون البني عند اضافة النشا الى التركيبة، وكان محتوى المواد الصلبة غير الذائبة في الكحول والالياف الخام هي ١٢,٨٧% و ٠,٩٨% على التوالي في لفائف الكاكي المحتوية على النشا، بينما كانت هذه القيم في لفائف الكاكي غير المحتوية على النشا هي ٨,٧٣% و ٠,٨٢%، كان النشاط المضاد للاكسدة ومحتوى الكاروتينات اعلى في لفائف الكاكي المحتوية على النشا عن تلك اللفائف غير المحتوية على النشا، وكان محتوى البولي فينولات، الفلافونيدات والتانينات اقل في لفائف الكاكي المحتوية على النشا عن تلك اللفائف غير المحتوية على النشا، اما بالنسبة الى مركبات البيروجالول والإفانيليك فكانت هي المركبات السائدة في كل من لفائف الكاكي المحتوية وغير المحتوية على النشا. ويمثل فيتامين ك الاعلى تركيز من بين الفيتامينات التي تمت دراستها في لفائف الكاكي، وبالنسبة للقيم اللونية فكانت قيم (L) (٣٣,٨١) في لفائف الكاكي المحتوية على النشا والتي كانت اعلى من قيم (L) في لفائف الكاكي غير المحتوية على النشا (٢٣,٧٢)، اما عن قيم (a) و (b) فكانت مرتفعة في لفائف الكاكي غير المحتوية على النشا حيث كانت ١٢,٧١ و ١٢,٩٧ مقارنة بتلك القيم في لفائف الكاكي المحتوية على النشا حيث كانت ٨,١٠ و ٨,١٦ على التوالي، وأظهرت نتائج التحليل الميكروبيولوجي ان العدد الكلي للبكتيريا هو ١١٠ مستعمرة/جم في التخفيف الاول فقط في عينة لفائف الكاكي المحتوية على النشا ولكن لم تتواجد في التخفيفات الأخرى، أيضا لم يتم تواجد اعداد كلية للبكتيريا في جميع تخفيفات عينة لفائف الكاكي غير المحتوية على النشا، وبالنسبة للفطريات، الخمائر والبكتيريا المكونة للجراثيم فلم يتواجد اي ظهور لها في جميع عينات لفائف الكاكي.

المحكمون:

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