

STUDIES ON THE EFFECT OF BROWNING REACTIONS ON SOME PRODUCTS OF FIG (*Ficus carica*).

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ABSTRACT

This study was carried out on fig products (syrup, jams and sheets) to investigate the effect of industrial food processing on browning reactions. During processing some changes in fig products are occurred with respect to colour and final aspects change. Thermal treatments during the preparation of fig syrup can effect on its quality through the non-enzymatic browning reactions. Different indicators were assayed to determine the extent of browning which include absorbance measurements at 420nm, colorimetric evaluations and determinations of sugar, furfural, hydroxymethylfurfural (HMF) and total phenols in the final product. hydroxymethylfurfural (HMF) content was increased after processing in fig syrup and sheets. On the other hand, total phenols and total flavonoids were decreased after processing in all products that refer to the activity of polyphenoloxidase. Fig sheets treated with SO₂ had higher color score compared with control sheets. Fig jam treated with lemon juice had higher taste and odor scores compared with fig jam produced from the residue of fig juice concentrate. Fig syrup had desirable organoleptic characteristic scores.

Regarding to free amino acid concentration, there is a decreased after manufacturing processes in some amino acids as valine, aspartate, glutamate, alanine, arginine, and lysine. This decrease reflects the consumption of these free amino acid during Millard reactions.

INTRODUCTION

Fig (*Ficus carica L.*) a deciduous tree belongs to the *Moraceae* family, it is one of the earliest cultivated fruit trees. Fig is widespread species commonly grown, especially in warm, dry climates. Mediterranean diets are characterized by abundant intake of this fruit, which can be eaten fresh, dried or processed as jam. A high part of dried fig are consumed in Egypt during the fast month (Ramadan) as a popular drink which an excellent source of minerals, vitamins , dietary fibres and amino acids, It's free of fat and cholesterol (Solomon *et al.*, 2006; Veberic *et al.*, 2008) .

A comparison of minerals contents of fig with those of other fruits indicates that fig have calcium contents higher than apples, dates, grapes, strawberries fruits, and contain more potassium than apples and dates fruits (Vinson 1999) .

Fig contains sugars and organic acids that influence their taste and quality, the fig fruits are very rich in sugars. Fructose and glucose are the major sugars in the fig .Some studies have described the presence of several phenolic compounds in these species, phytosterols and fatty acids in fruits and branches of fig trees and its antioxidant activity (Solomon *et al.*, 2006) .

The potential health-promoting constituents of fig fruits were studied with six commercial fig varieties differing in color (black, red, yellow, and green) for total polyphenols, total flavonoids, antioxidant capacity, and profile of anthocyanins. In the dark-colored mission and the red Brown-Turkey varieties, the anthocyanin fraction contributed 36 and 28% of the total antioxidant capacity, C3R (cyanidin- 3-O-rutinoside) contributed 92% of the total antioxidant capacity of the anthocyanin fraction. Fruits of the mission variety contained the highest levels of polyphenols, flavonoids, and anthocyanins and exhibited the highest antioxidant capacity. However, leaf, pulp and peels' metabolic profile and biological activity have not been compared. Fig is an excellent source of phenolic compounds such as pro-anthocyanidin (Montserrat *et al.*, 2008).

Phenolic compounds are secondary metabolites that are quite widespread in nature, these compounds play many physiological roles in plants and some of them are also favourable to human health, since they are able to act as antioxidant by different ways: as reducing agents, hydrogen donors, free radicals scavengers, and singlet oxygen quenchers and, therefore, as cell saviours (Merken and Beecher, 2000; Costa *et al.*, 2009).

Fig has been used for its medicinal benefits as laxative, cardiovascular, respiratory, antispasmodic and anti-inflammatory remedies (Guarrera, 2005). Fig inhibits the growth of cancer. The latex in fig is a cytotoxic substance which inhibits the proliferation of many cancers because of the bioactive compounds like 6-O-acyl- β -O-glucosyl- β -sitosterols, the acyl moiety being primarily palmitoyl and linoleyl with minor amounts of stearyl and oleyl has been isolated as a potent cytotoxic agent from fig latex. Both the natural and the synthetic compounds showed in vitro inhibitory effects on proliferation of various cancer cell lines (Rubnov *et al.*, 2001).

In a study of fig extracts effect on liver cancer, the fig inhibited the cancer by 49.3%. Fig has an anticancer effect. Fig also contains three angiotensin I-converting enzymes peptides (ACE). Angiotensin I-Converting Enzyme is used to treat high blood pressure, type-2-diabetes and cardiovascular disease because it is a vasoconstrictor (Kalaskar *et al.*, 2010).

Fig syrup has been reported to promote health and quality of life in those who adhere to it, specifically by preventing pathophysiological conditions related to coronary heart disease and cancer (Saura and Calixto, 2009).

Fig "*ficus carica*" is considered to be one of the most popular fruits in Egypt, having pleasing taste, aroma, and easily digestible constituents. Most of the local production is consumed fresh while the remainder goes to jam processing. Some investigations were carried out to select the most suitable cultivar for processing, especially dehydration. The world production of figs is about one million tons; it is mostly concentrated in the Mediterranean. The first country for fig production is Turkey (254838 tones) which followed by Egypt (170000 tones) then Iran (76414 tones) and Syria produced (41000 tones) at 2010 (FAO, 2012).

The different products of fig (syrup, jams and sheets) have many changes during processing so; this study aimed to produce different untraditional products of fig and evaluate the quality attributes and nutritional aspects of these products after processing. Also, the browning discoloration of these products was studied.

MATERIALS AND METHODS

Materials

Fresh fig fruits (*Ficus carica*) of cultivar namely Sultani were obtained from the local market, Giza, Egypt.

Methods

Technological Methods

The fresh and dried fruits were washed with tap water, then cleaned and prepared for processing as follows:

1-Concentrated fig juice (Fig syrup):

Fresh fig (2kg) was extracted by water (1L) then heated at 100°C for 30 min. Extract was sieved and concentrated on a rotary evaporator at 65°C (until 67 % TSS).

2- Fig jams processing :

Fig sultani was processed to jam as follow:

2-1 Fig jam with lemon juice (J₁):

Sucrose was added to the prepared fruits (1:1 w/w), the mixture was cooked until 69% TSS, (20ml) lemon juice was added, then filled in glass jars, sterilized and stored at a room temperature.

2-2 Fig jam produced from the residue of fig juice concentrate (J₂):

The residue produced from fig juice concentrate was collected and used to prepare jam at ratio (300g) sucrose to (200g) fig fruit residue (w/w). The mixture was concentrated by cooking until 69% TSS, then filled in glass jars, sterilized and stored at a room temperature.

3- Dried fig sheets preparation:

3-1 Sheets control (S₁):

Fruits were mixed with tap water (1:1 w/v) and 20g pectin. Total soluble solid (TSS) was adjusted to 25 by adding sucrose. All ingredients were mixed, blended, then poured in trays and dried in air oven at 70 °C (Hassan, 1995).

3-2- Sheets treatment with SO₂ (S₂):

Fruits were mixed with tap water(1:1 w/v), 20g pectin and 500 ppm of SO₂ as sodium metabisulfite. Total soluble solid (TSS) was adjusted to 25 by adding sucrose. All ingredients were mixed, blended, then poured in trays and dried in air oven at 70 °C (Hassan 1995).

Analytical Methods

• Gross chemical composition

Moisture and ash contents were determined according to the methods of A.O.A.C (2007). Fiber content was determined as described in the method

of Ranganna (1979). Total and reducing sugars were determined using the method of Somogy (1952). Minerals contents were determined using atomic absorption spectroscopy (Perkin Elmer 372) as described in the methods of A.O.A.C (2007).

- **Physical properties**

Acidity was measured according to the method of A.O.A.C (2007) and pH values were determined by using Beckman pH meter with glass electrode at 25°C. Viscosity was determined at 25°C and on 10 rpm by using Brookfield programmable Rheometer DV w Ultra, Spindle, No MA-07.

- **Determination of total Soluble Solid (TSS)**

It was measured by using refract meter.

- **Determination of total phenolic compounds and total flavonoids**

Total phenol content was determined according to the method described by Daniel and George (1979). The concentration of flavonoids in the methanol plant extracts was measured spectrophotometrically at 440 nm (Zhisen, 1999). Two milliliters of the samples (10 g/L) were transferred to a 10ml volumetric flask containing 2 mL of AlCl₃ (20 g/L in ethanol) and 6 mL of CH₃COONa (50 g/L in ethanol). The controls contained all the reagents except for the extract. After 2.5 h at 20°C the absorbance was measured at 440 nm. The same procedure was repeated for the standard quercetin solutions and the results was expressed in mg of quercetin per gram of extract (mg QE/g extract) and were presented as means of triplicates.

- **Determination of 1,1-Diphenyl-2-picrylhydrazyl (DPPH) radical scavenging antioxidant spectrophotometric assay:**

The potential antioxidant activity of fruit juice was assessed on the basis of scavenging activity of the stable of DPPH free radicals. The juice (1mL) was diluted with methanol 80%. The range the investigated juice was 5-50%. An aliquot (1mL) of diluted juice was added to 3mL of methanolic DPPH solution (concentration 6×10⁻⁵ mol /l). The mixture was shaken and left at a room temperature for ten min, then the absorbance was measured at 517 nm using UV-1800 spectrophotometer. The blank was methanol. The antioxidant activity on the basis of the capability to scavenge the DPPH radical (AA_{DPPH}) was estimated from the differences in absorbance of DPPH solution and the inhibition percent was calculated Burda and Oleszek (2001).

$$AA_{DPPH}(\%) = (A_{DPPH} - A_{sample}) / A_{DPPH} \times 100$$

A_{DPPH}: The absorbance of the methanolic DPPH solution, A_{sample}: The absorbance in the presence of the juice.

- **Determination of free amino acids**

Free amino acids were determined in fig fruit products (1-2 ml) using an automatic amino acid analyzer. The sample was then ready for analysis with Eppendorff LC3000 (Germany) amino acid analyzer under the following conditions: Flow Rate: 0.2 ml/minute, Pressure of buffer: 0 to 50 Bars, Pressure of Reagent: 0 to 150 Bars, Reaction temperature: 123° C.

Separation was achieved with a strong cation exchange column; post-column detection was done with ninhydrin (Pellet *et al.*, 1980).

- **Determination of Furfural and Hydroxy methyl furfural**

Furfural in fig samples was determined according to Ranganna (1979) by adding 12.5 g sample to 25 ml water, adding about 250 ml ethanol (50%), mixing and filtering, pipetting 100-200 ml of the filtrate. Steam distilled and collecting volume of distillate equal to that of volume taken for distillation then diluting the distillate with known volumes of 50% alcohol and it was measured at 277nm. Determine the Absorbance of standard solutions of furfural containing 0, 1, 2, 3, 4 and 5 mg of furfural per litre was determined then plotting a calibration curve of concentration against absorbance and reading concentration in the samples from the curve. Hydroxy methyl furfural was determined as described by Meydav and Berk (1978).

- **Determination of non-enzymatic browning**

Non enzymatic browning (brown color) in fig samples was determined according to Ranganna (1979). Ten gm of the blended fresh samples were mixed thoroughly with 10ml of distilled water and 30ml of ethyl alcohol then filtered. As for dried samples, an amount of 2.5 gm was extracted with 100ml of 60% ethyl alcohol for 12 hours and filtered. The absorbance of the clear solution was measured at 420 nm using 60% aqueous ethyl alcohol as blank. The increase in the absorbance reading (Optical Density) for the sample extract at 420 nm was taken as a measure of non-enzymatic browning.

- **Determination of total color density (TCD)**

0.5 gm of dried samples was extracted by distilled water (50 ml), then filtered and measured at 420, 520 and 700 nm by using spectrophotometer Somer (1971).

$$\text{TCD} = (\text{Abs } 420 + \text{Abs } 520) - 2(\text{Abs } 700)$$

- **Statistical analysis**

Data were analyzed statistically using the analysis of variance and the means were further tested using least significant difference test (LSD) as outlined by Steel and Torie (1980).

Means in the same column with different letters as superscripts are significantly different ($P < 0.05$).

RESULTS AND DISCUSSION

Effect of processing on gross chemical and physical properties of fig and fig products:

The effect of technological processing on some gross chemical and physical properties of fig and fig products are presented in Table (1). Data indicated that fresh fig had a high content of total sugars (61.7%), especially reducing sugars (56.8%). These results are nearly similar to those of Hassan (1995), who found that fresh fig contained a high content of total and reducing sugar especially glucose and fructose. A total and reducing sugars are found to be reducing in fig syrups because of the effect of extraction

processing on 100 ° C. These results are in agreement with those of Garza(1999) who resulted that the sugars participating directly in the browning reactions were analyzed as was sucrose, which can hydrolyze into glucose and fructose during thermal treatment .Total and reducing sugars are found be increasing in fig jams. Total acidity is increased slightly in concentrated fig juice (fig syrup) that help to improvement the taste and flavor. Fig syrup contained no fibers because the fibers were separated through the extraction process. Data indicate that total soluble solids in fig jam produced from the residue of fig juice concentrate were the highest in fig products. There were significant differences between samples of fig jams for moisture, total sugars, total acidity, total soluble solids and viscosity. While, there were no significant differences between samples of fig jams for ash, fibre, reducing sugar and pH value. Data indicate that there were significant differences between samples of fig sheets for total soluble solids. While, there were no significant differences between samples of fig sheets for moisture, ash, fibre, total sugars, reducing sugar, total acidity and pH value.

Table (1) Effect of processing on some gross chemical and physical properties of fig and fig products (on dry basis).

Items	Samples		Fig products			
	Fresh fig	Fig syrup (A)	Fig jams		Fig sheets	
			J ₁	J ₂	S ₁	S ₂
Moisture %	78.25	32.97	35 ^a	31.2 ^b	17.57 ^a	17.63 ^a
Ash %	2.39	1.281	0.883 ^a	0.229 ^a	2.058 ^a	2.88 ^a
Fibers %	2.31	N.D	0.771 ^a	0.82 ^a	3.02 ^a	3.13 ^a
Total sugars %	61.71	65.42	70.47 ^b	70.71 ^a	72.68 ^a	73.32 ^a
Reducing sugars %	56.82	57.04	58.52 ^a	58.54 ^a	60.76 ^a	62.65 ^a
Total acidity %	0.501	0.61	0.79 ^a	0.37 ^b	0.54 ^a	0.55 ^a
pH	5.3	4.79	4.39 ^a	5.642 ^a	5.02 ^a	5.07 ^a
Viscosity per cp	N.D	4000	12800 ^b	19400 ^a	N.D	N.D
Total soluble solid(TSS) %	12.5	67.03	65 ^b	68.8 ^a	25.46 ^a	24.37 ^b

Means in the same column with different letters as superscripts are significantly different (P < 0.05).

A: Concentrated fig juice. S₁: Sheets control.
 J₁: Fig jam treated with lemon juice. S₂: Sheets treated with 500 ppm SO₂.
 J₂: Fig jam produced from the residue of fig juice concentrate.
 N.D: Not Detected

Effect of processing on total phenols, total flavonoids and radical scavenging antioxidants of fig and fig products:

The effect of technological processing on total phenols, total flavonoids content and radical scavenging antioxidant in fig and fig products are indicated in Table (2).Data indicated that total flavonoids were decreased in fig syrup and fig jams. This may be due to the activity of polyphenol oxidase enzyme and high temperature in technological process. Radical scavenging antioxidant was increased in fig syrup and fig jams. These results are in agreement with those of Puoci *et al.*, (2011), who found that scavenging properties against DPPH showed the efficacy of the syrup in preventing damage induced by free radicals scavenging properties against DPPH. Data show that sheet treated with SO₂ was the highest in radical scavenging

antioxidants. Data indicated that there were significant differences between samples of fig jams for total phenols and radical scavenging antioxidant, while there were no significant differences between samples of fig jams for total flavonoids. There were significant differences between samples of fig sheets for total flavonoids and radical scavenging antioxidant.

Table (2) Effect of processing on total phenols, total flavonoids content and radical scavenging antioxidant of fig and fig products.

Samples Components	Fresh fig	Fig products				
		Fig syrup (A)	Fig jams		Fig sheets	
			J ₁	J ₂	S ₁	S ₂
Total phenols as gallic acid(mg/100g)	201.13	300.49	129.38 ^a	24.77 ^b	211.29 ^a	286.04 ^a
Total flavonoids as quercetin(mg/100g)	13.79	9.358	5.655 ^a	4.485 ^a	9.014 ^b	10.89 ^a
Radical scavenging oxidant%	32.04	48.96	32.77 ^a	33.2 ^a	57.69 ^b	74.63 ^a

Means in the same column with different letters as superscripts are significantly different (P < 0.05).

A: Concentrated fig juice.

S₁: Sheets control.

J₁: Fig jam treated with lemon juice.

S₂: Sheets treated with 500 ppm SO₂

J₂: Fig jam produced from the residue of fig juice concentrate.

J₂: Fig jam produced from the residue of fig juice concentrate.

Effect of processing on minerals contents of fig and fig products:

The effect of processing on minerals contents in fig and fig products is presented in Table (3). Data indicated that some minerals contents were increased in fig syrup such as Mg, K, Fe, and Zn but Na decreased in fig syrup. Ca and Fe are found to be increased in fig jam treated with lemon juice and fig sheet. While, Ca and Fe contents were decreased in fig jam produced from the residues of fig juice concentrate. The increasing of Fe refers to metal browning between Fe and phenolic compounds. The other minerals contents were decreased in fig jams such as Mg, K, Na and Zn. Data show that Ca and K are the highest in concentrated fig juice. Ca and K contents were the higher than Mg and Na in fig sheets. These results are in agreement with those of Hassan (1995), who found that Ca and K are the higher than Mg and Na of fig sheet treatment with SO₂. Data show that Fe in fig sheets is the higher than Fe in other products. Data indicated that there were significant differences between samples of fig jams in Ca and Na. While, there were no significant differences between samples of fig jams for Mg, K, Fe and Zn. There were significant differences between samples of fig sheets for Ca. While, there were no significant differences between samples of fig sheets in Mg, Na, Fe and Zn.

Table (3) Effect of processing on minerals content in fig and fig products (mg/100g on dry basis).

Minerals	Samples Fresh fig	Fig products				
		Fig syrup(A)	Fig jams		Fig sheets	
			J ₁	J ₂	S ₁	S ₂
Mg	155.12	196.83	145.64 ^a	17.120 ^a	135.06 ^a	149.57 ^a
Na	213.40	237.12	125.79 ^a	90.43 ^b	174.52 ^a	190.09 ^a
K	410.12	469.72	384.83^a	121.31^a	409.64^a	354.41^a
Fe	2.46	4.62	3.68 ^a	1.62 ^a	2.69 ^a	2.47 ^a
Ca	399.48	456.61	361.84^a	127.31^b	384.44^b	396.94^a
Zn	1.76	1.92	1.59 ^a	0.176 ^a	1.63 ^a	1.45 ^a

Means in the same column with different letters as superscripts are significantly different ($P < 0.05$).

A: Concentrated fig juice.

S₁: Sheets control.

J₁: Fig jam treated with lemon juice.

S₂: Sheets treated with 500 ppm SO₂

J₂: Fig jam produced from the residue of fig juice concentrate.

Effect of processing on free amino acids of fig and fig products:

The effect of processing on free amino acids composition of fig and fig products are indicated in Table (4). Free amino acids are considered an indication to browning reaction. The data show that loss of free amino acids in fig jams is higher than fig syrup. Serine content was the highest in fresh fig and fig sheets. While, proline content is the highest in fig syrup. The data indicate that phenyl alanine content was the highest in fig jam treated with lemon juice. While, tyrosine content was the highest in fig jam produced from the residue of fig juice concentrate. The data show that 13 free amino acids in *figus carica* fruit were detected. Data indicate that loss of free amino acids was the highest in fig jam with lemon juice because browning may be occurred in fig jam in which endogenous ascorbic acid is oxidized to dehydroascorbic acid, which then reacts with free amino acids to yield deep brown colors by the Millard reaction. These results are in agreement with those of Kacem *et al.*, (1987), who found that browning is occurred in some fruits in which endogenous ascorbic acid is oxidized to dehydroascorbic acid, which then reacts with free amino acids. The increase in some amino acids could be caused by asparagine degradation, initially in large proportion, either by acid hydrolysis giving aspartic acid and ammonia or by the loss of an amino group in the intermediate or advanced Millard reactions stages. Data indicate that glutamic acid content in fig syrup was higher than glutamic acid in fig jam produced from the residue of fig juice concentrate because it is hydrophilic amino acid. Data indicated that the alpha- amino nitrogen content was decreased in samples because the reaction took place between amino acids and reducing sugar present in products.

Table (4) Effect of processing on free amino acids composition of fig and fig products (mg/100gon dry basis)

Samples	Fresh fig	Fig products				
		Fig syrup (A)	Fig jams		Fig sheets	
			J ₁	J ₂	S ₁	S ₂
Free amino acids						
Essential free amino acids						
Threonine	22.2	26.5	15.2	8.1	47.6	84.7
Valine	33.7	14.3	25.6	14.1	14.4	26.6
Isoleucine	30.4	36.8	12.9	7.8	20.8	21.6
Leucine	84.9	30.5	49.2	20.4	37.9	44.4
Phenyl alanine	218.3	78.3	113.5	80.5	198.1	202.1
Lysine	35.9	12.7	18.9	11.1	7.9	7.1
Non-essential free amino acids						
Aspartic	75.2	26.7	52.2	44.5	23.03	44.9
Serine	295.9	59.4	238.02	129.5	229.4	260.01
Glutamic acid	106.9	138.9	76.3	33.8	26.7	33.8
Glycine	5.9	4.8	1.5	1.2	9.3	5.6
Alanine	86.8	45.7	47.8	16.5	20.5	39.2
Tyrosine	156.5	138.7	42.5	63.9	101.9	214.8
Histidine	36.2	31.1	22.6	6.2	30.1	46.1
Arginine	78.5	18.5	71.02	13.7	52.9	56.9
Proline	288.3	282.9	157.03	95.04	139.2	154.1
Amide NH ₄ ⁺	204.3	27.5	54.4	29.2	46.8	61.6

N.D: Not Detected

A: Concentrated fig juice.

S₁: Sheets control.

J₁: Fig jam treated with lemon juice.

S₂: Sheets treated with 500 ppm SO₂

J₂: Fig jam produced from the residue of fig juice concentrate.

The browning parameters of fig and fig products:

The browning parameters of fig and fig products are shown in Table (5). The obtained data indicate that hydroxy methyl furfural (HMF) was increased in concentrated fig juice (fig syrup) due to non-enzymatic browning reaction but it was decreased in fig jams. Hydroxy methyl furfural (HMF) content was the highest in fig sheet control. Data indicate that furfural was the highest in fresh fig. Furfural is reduced in the technological process. The data showed that total color density and color index on 420nm in fig syrup were a higher than fig jams and fig fruit. These results are agreement with those of Olano (2002) who investigated to the difference between the fig jam and fig fruit. He showed that the variations of Hydroxy methyl furfural (HMF) contents in the analyzed samples considered an indication of differences in the processing conditions. Data indicated that hydroxy methyl furfural (HMF) content in fig jam with lemon juice was (0.68 mg/100g) and total acidity content was (0.79 %). These results may be due to added lemon juice. These results in a agreement with those of Vivanti (1995) who found that these processes may be lead to Millard reaction and caramelisation of carbohydrates in the acid medium of jams. Data indicate that total phenols contents were increased in the fig products after processing from (201.13 mg/100g) in fresh fig to (300.49 mg/100g) in fig syrup, (211.29 mg/100g) in fig sheet control and (286.04 mg/100g) in fig sheet with 500 ppm SO₂ but they were decreased to (129.38 mg/100g) in fig jam treated with lemon

juice,(24.77mg/100g) in fig jam produced from the residue of fig juice concentrate because of the effect of polyphenol oxidase enzyme. Data indicate that there were significant differences between samples of fig jams in total acidity, total phenols and hydroxy methyl furfural content, while, there were no significant differences between samples of fig jams in pH, furfural and color index at 420nm and total color density. There were significant differences between samples of fig sheets for hydroxy methyl furfural content while, there were no significant differences between samples of fig sheets for total acidity, total phenols, pH, furfural, color index at 420nm and total color density.

Table (5) The browning parameters of fig and fig products (on dry basis).

Samples	Fresh fig	Fig products				
		Fig syrup (A)	Fig jams		Fig sheets	
			J ₁	J ₂	S ₁	S ₂
Total acidity %	0.501	0.61	0.79 ^a	0.37 ^b	0.54 ^a	0.55 ^a
pH	5.3	4.79	4.39 ^a	5.642 ^a	5.02 ^a	5.07 ^a
Total phenols as gallic acid(mg/100g)	201.13	300.49	129.38 ^a	24.77 ^b	211.29 ^a	286.04 ^a
Furfural (mg/100g)	1.10	7.13	2.66 ^a	3.59 ^a	7.91 ^a	7.44 ^a
Hydroxy methyl furfural(mg/100g)	0.54	3.52	0.68 ^a	1.90 ^b	2.57 ^a	1.64 ^b
Color index at 420nm(OD)	0.318	0.711	0.378 ^a	0.361 ^a	0.529 ^a	0.477 ^a
Total color density(OD)	0.466	0.486	0.342 ^a	0.357 ^a	0.425 ^a	0.435 ^a

A: Concentrated fig juice.

S₁: Sheets control.

J₁: Fig jam treated with lemon juice.

S₂: Sheets treated with 500 ppm SO₂

J₂: Fig jam produced from the residue of fig juice concentrate.

Organoleptic characteristics of fig products:

Organoleptic characteristics of fig products are shown in Table (6).The data indicate that Fig jam treated with lemon juice has higher color, taste and odor scores compared with fig jam produced from the residue of fig juice concentrate because lemon juice caused an improvement of flavor. Data indicate that sheet treated with 500 ppm SO₂ had higher color score compared with sheet control because sodium metabisulfite was added to improve the color of sheets. Data indicate that there were slightly significant differences between Fig jam with lemon juice and Fig jam produced from the residue of fig juice concentrate for color, odor and texture. While, there were no significant differences between Fig jam with lemon juice and Fig jam produced from the residue of fig juice concentrate for taste and appearance. There were significant differences between sheets control and sheet treatment with SO₂ for color, texture and appearance .While; there were no significant differences between sheets control and sheet treatment with SO₂ for taste and odor. Data indicated that color of fig syrup was better than fig jam produced from the residue of fig juice concentrated and sheet control.

Table (6) Organoleptic characteristic scores of fig products.

Samples	Organoleptic characteristic score				
	Color	Taste	Odor	Texture	Appearance
Fresh fig	10 ^a	9.29 ^a	9.71 ^a	9.86 ^a	9.71 ^a
Fig syrup (A)	7.71 ^{bc}	8 ^b	7.14 ^c	7.071 ^c	6.79 ^c
Fig jams					
J ₁	8.14 ^{bc}	8.29 ^b	8.14 ^b	7.43 ^{bc}	7.21 ^{bc}
J ₂	7.36 ^c	7.5 ^b	7.14 ^c	8 ^b	7.21 ^{bc}
Fig sheets					
S ₁	7.29 ^c	8.071 ^b	7.14 ^c	7.86 ^b	7.43 ^{bc}
S ₂	8.57 ^b	7.5 ^b	7.071 ^c	7.71 ^{bc}	7.86 ^b

Means with the same letter in the same row are not significantly different ($P < 0.05$).

A: Concentrated fig juice.

S₁: Sheet control.

J₁: Fig jam treated with lemon juice.

S₂: Sheet treated with 500 ppm SO₂

J₂: Fig jam produced from the residue of fig juice concentrate.

Conclusion

The obtained results concluded that fig syrup and fig sheets had a high content of free amino acids which is valuable as special diet. There were many kinds of essential free amino acids needed by human body in fig syrup and fig sheets. The obtained data showed that fig syrup and fig sheets had a high content of phenolic compounds and scavenging properties against DPPH. The efficacy of syrup in preventing damage induced by free radicals scavenging properties against DPPH, so the fig syrup can be used in bakery products and further studies are needed to be carried out.

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**دراسة على تأثير تفاعلات براون اللونية على بعض منتجات التين البرشومي
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أجريت هذه الدراسة على التين السلطاني ومنتجاته (دبس ومربى ولفائف التين) وذلك لمعرفة تأثير عمليات التصنيع الغذائي على تفاعلات براون اللونية . لوحظ أثناء عمليات التصنيع حدوث بعض التغيرات في اللون وفي شكل المنتج النهائي. أدت المعاملات الحرارية أثناء عمليات الإعداد إلى التأثير على جودة دبس التين من خلال تفاعلات براون اللونية الغير انزيمية. تم تقدير مختلف العوامل التي يعزى اليها التلون البني وهي قياس الامتصاص اللوني على طول موجي ٤٢٠ و كذلك تقدير السكر ومركبات الفورفيورال والهيدروكسي مثيل فورفيورال والفينولات الكلية للمنتج النهائي. وجد زيادة في محتوى الفورفورال الهيدروكسي مثيل فورفيورال. على العكس من ذلك وجد انخفاض في محتوى الفينولات في بعض المنتجات والفلافونويد الكلية في كل المنتجات وذلك يرجع إلى نشاط إنزيم البولي فينول أكسيديز. وجد أن لفاائف التين المعاملة بالكبريتة أفضل من اللفاائف الغير معاملة من حيث اللون ، ووجد أن مربى التين مضاف إليها عصير ليمون أفضل من مربى التين التي تم إنتاجها من مخلف الثمار الناتج من عملية استخلاص العصير المستخدم في إنتاج دبس التين من حيث الطعم والنكهة ، ووجد أن لدبس التين صفات حسية مرغوبة. بالنسبة لتركيز الأحماض الأمينية الحرة ، وجد انخفاض في بعض الأحماض الأمينية بعد عملية التصنيع كالفالين والأسبرتات والجلوتامات والألانين والأرجنين والليسين ويرجع هذا الانخفاض في الأحماض الأمينية الحرة إلى حدوث تفاعل ميلارد .

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