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EVALUATION OF FIVE VARIETIES OF JUJUBE FRUITS FOR THEIR PROCESSING SUITABILITY

BY

Youssef, S.M.
Department of Hort. Crops Processing, Food Tech. Research Inst., Agric. Res. Center, Giza, Egypt.

ABSTRACT

Fruits of five cultivars of jujube *(Ziziphus mauritiana L.)* namely : Zaytoni, Lee, Balahi, Lang and Tophahee were evaluated in subsequent years 2003 and 2004 for their chemical components. The highest values were in Tophahee variety for moisture, total acidity, protein, ash, crude fiber, carotenoids and total polyphenols, whereas the highest value for total sugars and pectic substances were in Balahi variety. Concerning, elements the highest values of Ca, Na and Mg were in the Balahi variety but the highest values of Zn and Fe were in Tophahee variety. However, Lang variety was the highest in Mn. As such, Tophahee and Balahi varieties could be considered the most nutritious varieties among all tested ones. Organoleptic parameters revealed that Balahi jam had the highest scores for color, taste, aroma, texture and overall acceptability. Conclusively, best varieties for jam industry could be for Balahi followed by Tophahee variety.

Polyphenols were isolated and tested for their antioxidant potency in sunflower oil. They proved to be natural inhibitors against oxidation since they improved the sunflower oil stability.

Key words: Jujube *(Ziziphus mauritiana L.)*, chemical constituents, polyphenols and processing.

INTRODUCTION

The jujube belongs to the genus *Ziziphus*, which is in the *Rhamnaceae* or buckthorn family. The genus includes about 40 species or plants in tropical and subtropical regions of the northern hemisphere, of which the species *(Z. jujube Mill)* and *(Z. mauritiana Lamk)* are the most important in terms of distribution and economic significance. *Ziziphus mauritiana* is evergreen and is commercially most important in India, where it is known as Indian jujube or *Ber*. Jujube fruits have a spongy, sweet-tasting pulp, and excellent source of ascorbic acid and carotenoids (Abbas, 1997).

Ristevski *et al.*, (1982) found that six *Z. jujube* fruits contained 28.73-40.34% dry matter, 24.60-33.40% sugars and 163.60-363.14 mg/100g ascorbic

acid, and were suitable for both fresh consumption and processing. Also, Sivakov *et al.*, (1988) reported that the stone was small (0.28-0.65g), whereas the fruits contained 30.6-34.92% dry matter, 24.54-30.86% sugars and 180.11-387.3 mg/100g ascorbic acid. The fruits had good flavour and were suitable for fresh consumption and for drying and processing. On the other hand, Abbas and Fandi (2002) stated that the jujube fruits *(Ziziphus mauritiana L.)* of cv. Zaytoni contained 20% T.S.S., 0.21% total acidity (as citric acid) and 2% protein (FWB) in fully ripe fruits.

Evaluation of mineral elements and ascorbic acid in fruits of some wild plants were studied by Eromosele *et al.*, (1991) who found that the concentration of ascorbic acid in fruit samples were in a range of 1.28 to 403.3 mg/100g (FWB). While, *Ziziphus mauritiana* contained of Mg 227.0 mg/100g, P in the fruits were in a range of 5 to 28 mg/100g and Fe concentration were in a range of 1.07 to 6.30 mg/100g, which are 2-5 times higher than the concentrations in either oranges (0.2 mg/100g) or mangoes (0.4 mg/100g).

Also, Bhargava *et al.*, (2003) reported that the *Ber* fruits contained in average 5.27 kg protein, 61.9 g P, 1.09 kg K, 120.8g Ca and 8.59g Fe in one ton of edible fruit parts.

Furthermore, Esterbauer *et al.*, (1992) reported that polyphenols have many favourable effects on human health, such as the inhibition of the oxidation of low-density lipoproteins, thereby decreasing the risk of heart diseases.

The purpose of this study was to find out the differences between five varieties of jujube fruits namely (Zaytoni, Lee, Balahi, Lang and Tophahee) pertaining chemical constituents and polyphenol compounds. The aim was also extended to find out their fitness of being used as antioxidant agent. Moreover, these varieties were tested for their suitability for jam manufacture.

MATERIALS AND METHODS

Materials:

Fruits of five jujube *(Ziziphus mauritiana L.)* varieties namely: Zaytoni, Lee, Balahi, Lang and Tophahee were used in the present study during both seasons of 2003 and 2004. The fruits were picked from experimental orchard of the Horticulture Research Institute, Agric. Res. Center, Giza, at the maturing stage and transferred in the same day of harvesting to the laboratories of Food Technology Research Institute.

Methods of analysis:-

Moisture content, total solids, total acidity (as citric acid), ash, protein (N x 6.25, Kjeldahl method), total sugars, crude fiber and ascorbic acid were determined according to methods described in the A.O.A.C. (1995). Total soluble solids (T.S.S) were determined by Abbe Refractometer and corrections were made for temperature differences. Carotenoids were determined according to the method described by Wettestein (1957). Total pectin was estimated as

(anhydrogalacturonic acid) according to Rouse and Atkins (1955). Polyphenol compounds were determined by Folin-Denis methods as reported by Swain and Hillis, (1959). Jam was prepared according to the method described by Cruess, (2000). Minerals content (Na, Ca and K) were estimated using emission flame photometer (Model Corning 410). The other minerals of Zn, Fe, Mg and Mn were determined using Atomic absorption spectrophotometer (Prekin-Elmer Instrument Model 2380).The oxidative stability of oils were determined by Rancimat 679 (Metrom Ltd.,CH 9100 Herisau,Switzerland) at 100°C according to the method described by the A.O.C.S.(1993).

Organoleptic evaluation:-

Color, taste, aroma, texture and overall acceptability of jujube jam were subjectively assessed using ten expert panelists of food science and technology. The panelists were asked to check the properties which could describe the samples and score them for acceptability based on hedonic scale as mentioned by Ranganna (1977). The data were statistically analyzed according to Ott (1984).

RESULTS AND DISCUSSION

Mature fruit of the jujube could be considered a good source of different micro-nutrients. Beside, they have a good taste and aroma. Results in Table (1) represent some chemical components for different jujube varieties. Data reveal that moisture contents were 72.63 and 77.98% on average in Balahi and Tophahee cultivars, respectively. Whereas, the moisture content in other cultivars were around 75%. On the other hand, total soluble solids (T.S.S) varied in different jujube varieties and clear differences could be observed since the highest value of T.S.S was 22.34% for Balahi jujube while the lowest value was 12.49% on average for Lang jujube. On the other hand, data in the same table indicate that the total acidity calculated as citric acid ranged from 0.238 to 0.338% (on fresh weight basis) on average for all tested jujube cultivars. Total soluble solids (T.S.S) and total acidity are in agreement with those obtained by Abbas and Fandi (2002), who found that the T.S.S and titratable acidity in fully ripe jujube were 20% and 0.21%, respectively.

Results in Table (2) represent some chemical constituents of different jujube varieties. Results reveal that the protein content were 5.82 and 7.51% (on dry weight basis) on average for Lang and Tophahee jujube cultivars, respectively. Whereas, the ash contents were in most cultivars had on average of 2.5% (on dry weight basis). Crude fibers have a special nutritional importance, they were 2.93 and 3.70% (on dry weight basis) on average for Zaytoni and Tophahee jujube cultivars, respectively.

Ascorbic acid was around 427 mg/100g (on dry weight basis) on average. However, jujube (Balahi variety) could be considered as a good source for ascorbic acid, since its value reached 508.84 mg/100g (on dry weight basis) on average. In general, all different jujube cultivars contained high level of ascorbic acid compared to other common fruits.

Table (1): Moisture content, total solids, total soluble solids (T.S.S) and total acidity (as citric acid) in fruits of different jujube varieties.

Jujube varieties	Moisture content (%)			Total solids (%)			Total soluble solids (T.S.S) %			Total acidity (as citric acid) (%) (FWB)		
	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.
Zaytoni	73.83	73.13	73.48	26.17	26.87	26.52	17.00	17.24	17.12	0.245	0.263	0.254
Lee	76.52	77.18	76.85	23.48	22.82	23.15	14.24	14.40	14.32	0.236	0.239	0.238
Balahi	72.87	72.39	72.63	27.13	27.61	27.37	22.14	22.54	22.34	0.272	0.254	0.263
Lang	77.33	77.11	77.22	22.67	22.89	22.78	12.58	12.40	12.49	0.256	0.236	0.246
Tophahee	77.62	78.34	77.98	22.38	21.66	22.02	15.75	15.91	15.83	0.322	0.353	0.338

Table (2): Protein content, ash, crude fibers and ascorbic acid contents in fruits of different jujube varieties (on dry weight basis).

Jujube varieties	Protein (%) (N x 6.25)			Ash %			Crude fibers %			Ascorbic acid (mg/100g)		
	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.
Zaytoni	6.30	6.81	6.56	2.48	2.57	2.53	2.98	2.87	2.93	387.81	366.23	377.02
Lee	6.39	6.92	6.66	2.30	2.63	2.47	3.19	3.37	3.28	392.69	407.18	399.94
Balahi	7.08	6.66	6.87	2.58	2.68	2.63	3.10	3.01	3.06	498.56	519.12	508.84
Lang	6.09	5.55	5.82	2.38	2.49	2.44	3.26	3.32	3.29	410.63	415.29	412.96
Tophahee	7.02	7.99	7.51	2.99	2.75	2.87	3.66	3.74	3.70	435.24	439.42	437.33

Pectic substances in general are considered an important component of fruits, high pectin fruits is recommended to be used in jam industry.

Results in Table (3) indicated that the amount of total pectic substance in different jujube varieties were 18.38 and 31.11 mg/100g (on dry weight basis) on average for Lee and Tophahee cultivars, respectively. Also, carotenoids values were around 3.5 mg/100g (on dry weight basis) on average in the different jujube cultivars.

Polyphenols compounds were extracted from different jujube varieties and the obtained results are shown in Table (3). The results show that most jujube cultivars contained a high amountes of polyphenols. The highest values were 657.47, 696.24 and 765.88 mg/100g on average (on dry weight basis) for Lee, Tophahee and Lang jujube cultivars, respectively. Also, the same Table (3) reveal that total reducing sugars were around 36% on average (on dry weight basis) in most jujube cultivars, except Balahi variety which had an average of 48.37% sugars (on dry weight basis).

Results in Table (4) reveal that macro-elements namely calcium, sodium and potassium ranged from 167.58 to 192.40, 132.72 to 152.14 and 122.75 to 145.39 mg/100g (on dry weight basis), respectively. The highest variety was Tophahee for calcium, Balahi for sodium and potassium, whereas, the lowest ones were Lang for calcium and potassium, Lee for sodium.

As for micro-elements, results in the same Table (4) reveal that zinc, iron, magnesium and manganese ranged from 3.89 to 5.72, 27.54 to 36.20, 13.78 to 17.37 and 1.13 to 2.37 mg/100g (on dry weight basis), respectively. The highest values were found in Tophahee for zinc and iron, Balahi for magnesium and Lang for manganese, whereas, the lowest ones were found in Lee for zinc and manganese, Balahi for iron and Zaytoni for magnesium. In general, these values fluctuated into a narrow range. Accordingly, differences among the studied varieties were moderate on average. Conclusively, these results indicate that jujube fruits in general were rich in minerals.

Organoleptic evaluation:-

Results in Table (5) show the different scores which were given for different quality parameters of jujube jams including color, taste, aroma, texture and overall acceptability.

The scores indicate that there were significant differences between jams prepared from fruits of different tested varieties.

The best cultivar for making jam was Balahi jujube, being due to the highest scores for color, taste, aroma, texture and overall acceptability followed by Tophahee variety. However, Lang, Zaytoni and Lee jams could be arranged in order according to different scores given to these different parameters, which reflected good quality.

Table (3): Total pectin, carotenoids, total polyphenols (mg/100g) and total sugars (%) in fruits of different jujube varieties (on dry weight basis).

Jujube varieties	Total pectin (mg/100g)			Carotenoids (mg/100g)			Total polyphenols (mg/100g)			Total sugars (%)		
	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.	2003	2004	Av.
Zaytoni	21.62	21.51	21.57	3.32	3.65	3.49	510.58	462.41	486.50	42.26	41.98	42.12
Lee	18.13	18.62	18.38	3.11	3.55	3.33	666.52	648.42	657.47	37.43	38.17	37.80
Balahi	28.41	30.32	29.37	4.13	3.73	3.93	480.46	479.75	480.11	47.70	49.04	48.37
Lang	25.45	25.82	25.64	2.73	2.93	2.83	739.35	792.40	765.88	35.45	33.65	34.55
Tophahee	30.12	32.09	31.11	3.40	3.79	3.60	712.10	680.38	696.24	45.78	46.14	45.96

Table (4): Minerals composition in fruits of different jujube varieties (mg/100g) (on dry weight basis).

Jujube varieties	Macro-elements			Micro-elements			
	Calcium	Sodium	Potassium	Zinc	Iron	Magnesium	Manganese
Zaytoni	181.12	145.32	141.76	5.14	31.14	13.78	2.28
Lee	174.24	132.72	127.82	3.89	29.24	15.52	1.13
Balahi	184.12	152.14	145.39	5.35	27.54	17.37	1.57
Lang	167.58	136.79	122.75	4.98	32.76	14.48	2.37
Tophahee	192.40	150.20	139.41	5.72	36.20	16.12	1.88

Table (5): Organoleptic evaluation of jujube jams prepared from tested varieties.

Jujube varieties	Parameters*				
	Color	Taste	Aroma	Texture	Overall acceptability
Zaytoni	5.80 ± 3.35	6.65 ± 2.35	7.00 ± 1.05	7.25 ± 1.32	6.50 ± 2.58
Lee	5.65 ± 3.85	5.50 ± 3.94	5.70 ± 3.78	6.25 ± 2.79	5.85 ± 3.27
Balahi	8.00 ± 1.63	8.25 ± 1.26	8.25 ± 2.06	9.00 ± 1.15	8.65 ± 1.35
Lang	7.00 ± 1.83	7.25 ± 1.29	7.75 ± 2.07	7.25 ± 0.85	7.25 ± 1.66
Tophahee	7.25 ± 1.89	7.75 ± 2.06	7.75 ± 2.07	8.25 ± 1.26	8.00 ± 1.50
L.S.D ($P \leq 0.05$)	1.089	1.933	1.270	1.279	1.159
L.S.D ($P \leq 0.01$)	1.527	2.711	1.781	1.794	1.626

* Values are means ± standard deviation.

Effect of adding polyphenolic compounds extracted from jujube fruits on the oxidative stability of sunflower oil:-

The polyphenolic compounds extracted from jujube fruits ranged from 480.11 to 765.88 mg/100g (on dry weight basis) on the average as tannic acid. Polyphenolic compounds extracted from jujube fruits were added to sunflower oil at various levels 0.02, 0.04, 0.1 and 0.2%.The stability of all samples measured by Rancimat method at 100°C. The results were tabulated in Table (6) as induction periods.

Results indicate that adding polyphenolic compounds increased the stability of sunflower oil at all concentrations from 8 hours in sunflower oil without addition of polyphenolic compounds to 10, 12, 13 and 14 hours for sunflower oil with 0.02, 0.04, 0.1 and 0.2% polyphenolic compounds, respectively.

Table (6): Effect of adding polyphenolic compounds (%) extracted from jujube fruits on the oxidative stability of sunflower oil.

Items	Induction period at 100°C in hours
Sunflower oil	8
Sunflower oil + 0.02 %	10
Sunflower oil + 0.04 %	12
Sunflower oil + 0.1 %	13
Sunflower oil + 0.2 %	14

It could be noticed that all concentrations used improved the oxidative stability of sunflower oil, being in accordance with results obtained by (Kiritsakis

et al., 1983) who mentioned that polyphenols are natural inhibitors adhering in olive leaves while were found to favour the stability of olive oil.

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تقييم خمسة أصناف من فاكهة العِناب لمدى قابليتها للتصنيع

سعد ميخائيل يوسف

قسم تصنيع الحاصلات البستانية- معهد بحوث تكنولوچيا الأغذية- مركز البحوث الزراعية- جيزة- مصر

تم تقييم خمسة أصناف من فاكهة العِنَاب للموسمين المتتاليين (٢٠٠٣، ٢٠٠٤) وهم (زيتونى ، لى ، بلحى ، لانج ، وتفاحى) وذلك بالنسبة لمكوناتها الكيميائية وقد وجد أن أعلى قيم للرطوبة والحموضة الكلية والبروتين والرماد والألياف الخام والكاروتينات والفينولات العديدة الكلية توجد في الصنف التفاحى ، في حين أن أعلى قيم للسكريات الكلية والمواد البكتينية وجدت في الصنف البلحى. أما بالنسبة للعناصر المعدنية وجد أن أعلى نسب للكالسيوم والصوديوم والمغنسيوم كانت في الصنف البلحى ولكن أعلى نسب للزنك والحديد وجدت في الصنف التفاحى في حين أن الصنف اللانج كان يحتوى على أعلى النسب من عنصر المنجنيز. وعلى ذلك وجد أن كلا من الصنفين (التفاحى والبلحى) يعتبران أفضل الأصناف من الناحية الغذائية.

واظهر التقييم الحسي أن الصنف البلحى من أفضل الأصناف لصناعة المربى من حيث اللون ، الطعم ، النكهة ، القوام والقبول العام. وبصفة عامة فان الصنف البلحى يلية الصنف التفاحى كانت أفضل الأصناف لصناعة المربى. كما اختبرت قدرة الفينولات الكلية العديدة المعزولة على العمل كمضادات للأكسدة بالنسبة لزيت عباد الشمس ووجد أن جميع النسب المختبرة أدت إلى تحسين ثباتية زيت عباد الشمس.