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CHARACTERIZATION OF THE EGYPTIAN MULBERRY (TUT) FRUITS FOR PREPARING PROCESSED PRODUCTS AND NATURAL COLOURS.

Amin, Wafaa A. * and R.S. Attia**

*** Dept. of Horticul. Crop Processing, Food Technol. Res. Inst. (ARC), Sabahia, Alex., Egypt.**

****Dept. Food Sci. & Technol., Fac. Of Agric., El Shatbi, Univ. of Alex., Egypt.**

ABSTRACT

General characteristics, proximate composition, minerals content and physicochemical properties of the two common Egyptian mulberry (tut) fruits species, *Morus alba* and *Morus nigra*, were studied. Different processed products (juice, syrup and jam) were prepared from mulberry fruits and their organoleptic properties were evaluated. The anthocyanins of black mulberry (*M. nigra*) fruits was extracted and their maximum absorption and heat stability at 80°C for 5 hrs were determined. The results showed that fruits of *M. alba* mulberry species were white in colour, larger in size, moderate weight, high in K, Cu, Zn, Mg and low in Ca, Fe, titratble acidity, ascorbic acid, pectin and fructose in comparing with the black fruits of *M. nigra* species. Proximate composition and other physicochemical properties were nearly similar in the fruits of both species. Reducing sugars (glucose and fructose) were the main constituents, it represented about 13.06% in both types of fruits. Glucose/fructose ratios of *M. alba* and *M. nigra* were 1:1.3 and 1:1.5, respectively. Panelists preferred significantly the pasteurized juice prepared by mixing mulberry black fruit juice with water at 1:3 v/v ratio and syrup made from 100% black mulberry juice. They also preferred both whole and mashed black mulberry jam more than those of white mulberry fruits. *M. nigra* could be considered as a good source of anthocyanins (200.96 mg/100g) .The maximum absorption of the anthocyanins extracted either by acidified ethanol or citric acid was 535 nm. Anthocyanins extracts displayed good heat stability even at 80°C for 5 hrs. The rate of the reduction was more pronounced in the extracted pigment by acidified ethanol than by citric acid.

INTRODUCTION

Mulberry fruit belongs to the genus *Morus*, family *Moraceae*. The trees of this fruit are able to grow under tropical, subtropical and temperate climatic conditions. The leaves of such trees use mainly for the rearing of silkworms (Gerasopoulos and Stavroulakis, 1997 and Machii, *et al.*, 2002).

The most important species of the *Morus* genus grow in Mediterranean area are *Morus alba* and *Morus nigra*. Both species produce satisfactory production of fruits (Machii, *et al.*, 2002). The mulberry fruits or tut have aromatic, cooling laxative, anti-pyretic actions and can use against chronic constipation. It's juice is also effective in case of diarrhea, gingivits, stomatitis and glassitis. On the other hand, the root has function to lower blood pressure (Ashour, 1985; Khafagi, 1987 and Huo, 2002).

Because the fruits have a very pleasant taste, they can be eaten fresh and processed into juices, jams, jellies and syrup. The natural pigment of black or deep red tut (anthocyanins) can be extracted to be used as a natural colour in food and in cosmetics industry (Gerasopoulos and Stavroulakis, 1997; Mattuk, 1998; Hamed, 1999). According to Hong *et al.*(1998) anthocyanins had an antioxidant activity equivalent to 3.5 times of vitamin E analog (Trolox). Huo(2002) stated that in recant years, mulberry fruit juice has been commercially produced as a popular healthy beverage in China. The two main constrains facing the utilization of such fruits are the too short fruiting season and the rapid softening that occurred during handling, transportation and marketing.

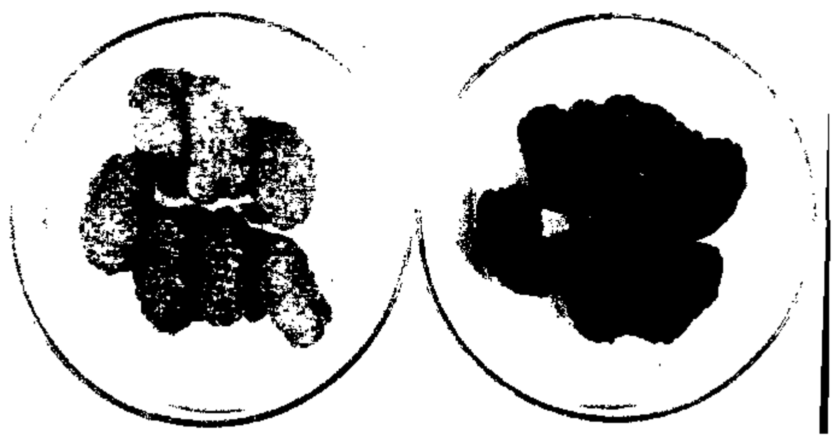
In Egypt, approximately 3 million old mulberry trees in the Delta area along the canals and roadsides were counted (Megalla, *et al.*, 1997). They were mainly cultivated for landscape then for shade and lastly for fruits. Generally, few studies have been carried out on mulberry fruits. Therefore, this work aims to identify the different characteristics of the two common species of this fruit in Egypt, *M. alba* and *M. nigra*, in addition to prepare simple rapid and edible products to overcome the main utilization problem. Also, the anthocyanins of the *M. nigra* fruits were extracted and their heat stability was evaluated.

MATERIALS AND METHODS

Materials:-

Ten kg of fresh white and black mulberry (*M. alba* and *M. nigra*) fruits (Fig. 1) were purchased from Alexandria local market, Egypt, at the first week of May, 2002. They were stored at 4°C in a refrigerator until processing and analysis.

Other materials included sugar, pectin, citric acid, glass jars and bottles were obtained from Alexandria market, Egypt.



A B

Fig. (1) White (A) and black (B) mulberry fruits.

Methods:-

1. Technological methods:-

Weight average (g), dimensions and size of fruits, juice and pomace yields were determined as mentioned by Vaidehi *et al.* (1991).

Figs. (2 and 3) describe the flow sheets used for producing the different products of mulberry fruits. Juice and syrup were prepared from black mulberry fruits only because of its pleased colour, where jam was prepared from both white and black fruits.

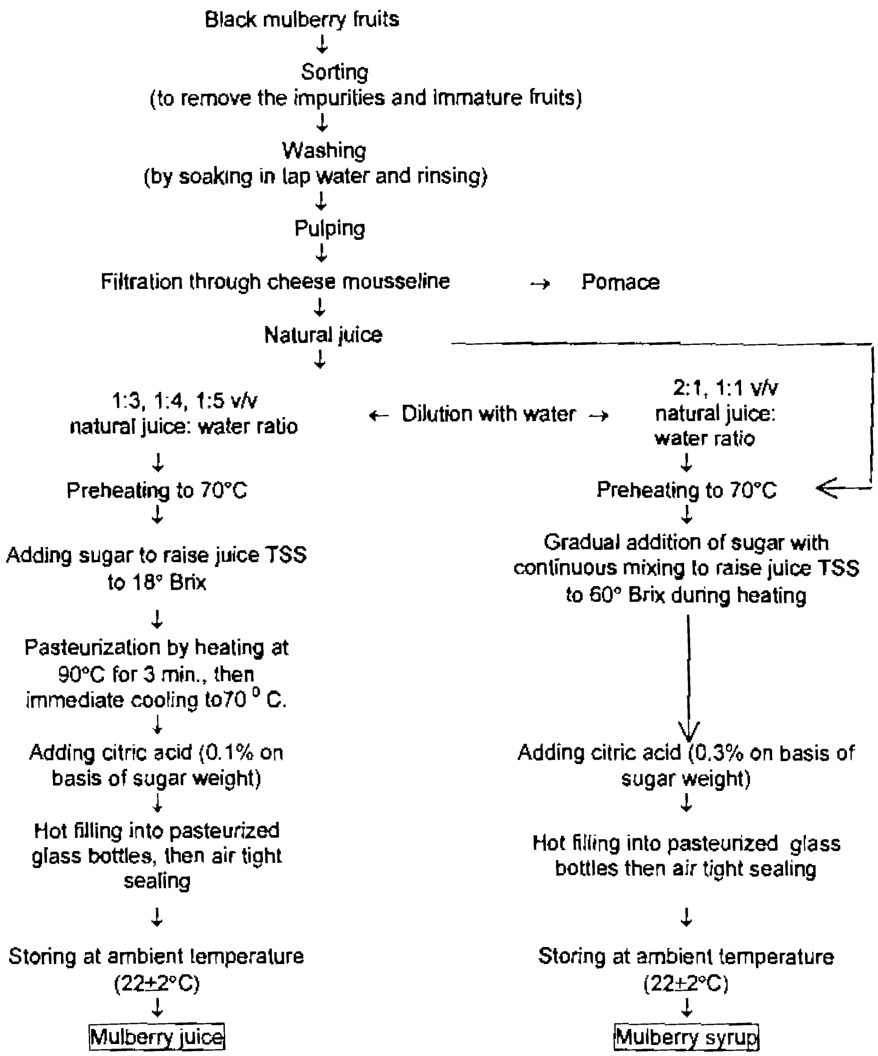


Fig. (2) Flow sheets of black mulberry juice and syrup processing.

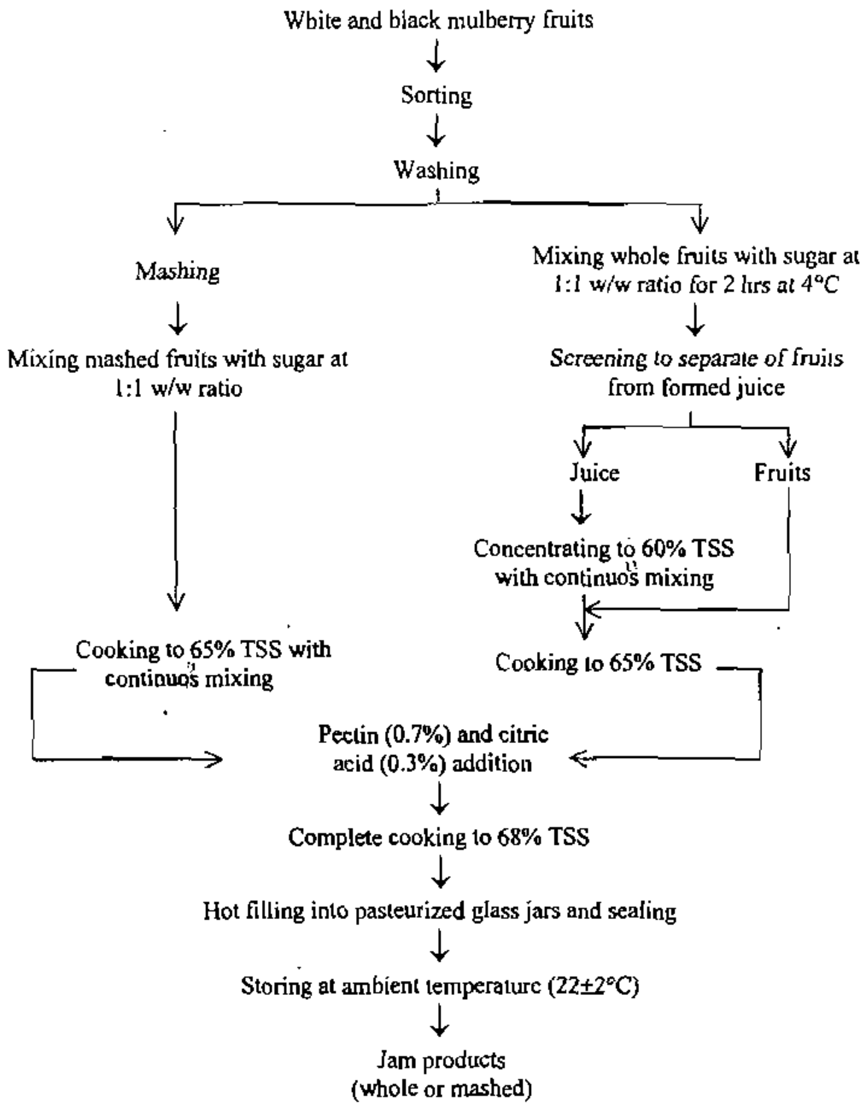


Fig. (3) Flow sheet of whole and mashed white or black mulberry jam processing.

2. Analytical methods:-

Fresh mulberry fruits were prepared for analysis (in triplicates) for total soluble solids (T.S.S.) at 20^{0}C by Abbè refractometer (Model 2 WAJ; China); pH by Cole Parmer pH meter; titratable acidity as % malic acid, ascorbic acid utilizing 2,6 dichlorophenol indophenol dye; content and maximum absorption of extracted anthocyanins at different wavelengths from 400 to 700 nm; and pectin as described by Rangana (1977). Also moisture content, crude ether extract, crude protein (N x 6.25), crude fiber and total ash of fresh fruits were estimated according to the AOAC (1990) methods. Reducing and total sugar (as inverted sugars) were determined by Lane-Eynon volumetric method (AOAC, 1990). Non reducing sugar (sucrose) was calculated from the difference between total and reducing sugars using the factor of 0.95 (AOAC, 1990). Fructose was estimated as mentioned by Jacobs (1951). Glucose was calculated by difference between reducing sugars and fructose. Total sugars extract was fractionated using a TLC technique according to the method of Plummer (1978) on 0.25 mm thickness silica gel plates, ethyl acetate: isopropanol: water: pyridine (26:14:7:2 by volumes) as developing solvent and aniline diphenylamine as visualization reagent before heating at 100°C for 10 min in an oven. K, Na, Ca, Mg, Fe, Cu, Mn, and Zn were determined in ash solution using Perkin Elmer atomic absorption spectrophotometer (Model 2380), while total phosphorus was colorimeterically assayed using Carl Zeiss Speckol Colorimeter at 630 nm (AOAC, 1990).

Anthocyanins were extracted from black mulberry fruits using two solvent systems, ethanol acidified with HCl and water acidified with 2% citric acid, as described by Fuleki and Francis (1968) and Mattuk (1998), respectively. The two extracts were centrifuged at 3000 rpm for10 min then, concentrated to 50% of it' s volume by a rotary evaporator at 50°C. After recentrifugation, appropriate amounts of mulberry anthocyanins concentrate were diluted with citric phosphate buffer at pH 3 and the O.D were measured at zero time at 535 nm using Carl Zeiss Spekol Colorimeter before estimating the heat stability according to Mok and Hettiarachony (1991). Ten ml of anthocyanins buffer solution were placed in screw capped tubes and heated in a water bath at 80°C for 0.5 up to 5 hrs. The tubes were cooled in iced water and the O.D were measured as mentioned previously.

$$\%\text{Retention of anthocyanins} = \frac{\text{O.D after heating}}{\text{O.D at zero time}} \times 100$$

3. Sensory evaluation:-

Taste, odour, colour, texture and overall acceptability of the prepared mulberry fruit products, juice, syrup and jam were assessed by ten panelists of Food Science and Technology Department, Faculty of Agriculture, Alexandria University, Egypt using hedonic scale as proposed by Kramer and Twigg (1970).

4. Statistical analysis:-

Standard Deviation of the results of the fruit characteristics, physical, physicochemical and chemical properties, as well as analysis of variance of edible products were calculated using the methods described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Mulberry fruits characteristics:-

1. General characteristics:- Fruits of *M.alba* mulberry species or white tut had larger parameter (weight average, size, length and diameter) than those of *M.nigra* species or black tut as shown in Table (1). The length of the fruits of both mulberry species was longer than their diameters. Thus the mulberry fruit had nearly the cylindrical or oval shape. Generally different wide values were reported in literatures about weight average and dimensions of mulberry fruits. According to the results of Vaidehi *et al.* (1991) the values of weight average, length and diameter of black mulberry fruits varied from 1.2 to 2.8g, 2.04 to 3.0 cm and 1.11 to 1.56 cm, respectively. In contrast to those findings, Gerasopoulos and Stavroulakis (1997) found the weight averages of the *M.nigra* and *M.alba* fruit were 7g and from 3 to 3.8g, respectively. Such results are not only high but also opposite to our data. Singh *et al.* (1985) showed that Indian *M.alba* fruits had 2.94 cm length and 0.72 cm diameter. The variations between our results and those reported in literatures may be due to soil conditions, environmental and agricultural factors.

Table (1) General characteristics and some physicochemical properties of Egyptian mulberry fruits.

Character	Mulberry fruits species	
	M. alba	***M. nigra***
Fruit weight (g)	2.59±0.05	1.89±0.07
Fruit dimensions:-		
Length (cm)	2.13±0.04	1.93±0.03
Diameter (cm)	1.35±0.03	1.23±0.03
Size (cm^3/fruit)	2.4±0.17	1.66±0.04
Juice yield (%)	77.72±2.78	76.54±1.86
Pomace yield (%)	22.28±0.34	23.46±0.39
Total soluble solids (T.S.S) (%)	16.25±0.28	17.70±0.36
Total sugars (%)	12.96±0.05	13.70±0.04
Reducing sugars (%)	12.64±0.08	13.48±0.03
Glucose (%)	5.51±0.03	5.28±0.03
Fructose (%)	7.13±0.12	8.20±0.19
Glucose/ Fructose ratio	1:1.29	1.:1.55
Non reducing sugars (%)	0.32±0.03	0.22±0.01
PH value	6.46±0.27	5.70±0.19
Titratable acidity (T.A) (%) (expressed as malic acid)	0.148±0.01	0.343±0.01
Ascorbic acid mg/100g	3.42±0.08	4.15±0.18
Pectin (%)	1.01±0.01	1.74±0.02
Anthocyanins (mg/100g)	N.D*	200.96±0.99

Values = Mean ± Standard deviation.
***N.D = Not determined.**

Generally, mulberry fruit consisted of seeds embed in pulpy tissue. Bad handling, transporting, storing at unsuitable relative humidity (R.H) and temp. reduce the shelf life of the fruits, release their juice out of their turgid cells, lost their colour and soften their texture. As seen from (Table, 1) juice yield of both species represented more than 75% of fruit weight. The rest part was the yield . of seeds and other cell tissues, pomace. Nearly the fruits of both mulberry species had very close values of juice and pomace. Such results were not much far from those stated by Vaidehi *et al.* (1991). The taste of *M.alba* fruits was less sour and more sweet than those of *M.nigra* species. These due to the lower titratable acidity in fruits of the first species than those of second one (Table, 1).

2. Physicochemical characteristics:- As shown in Table (1) total soluble solids (TSS) of *M.alba* and *M.nigra* fruits were 16.25 and 17.70 %, respectively. Such values agree well with those obtained by Singh *et al* (1985). According to Gerasopoulos and Stavroulakis (1997), the rang of soluble solids of *M.nigra* fruits was 19-22%, while Maftuk (1998) mentioned a lower TSS value (13.78%) for the fruits of the same species. The following findings could be concluded from the results of sugar analysis in both white and black mulberry fruits:-

a- In both type of fruits, total sugars represented 79.75-77.4% from their TSS.

b- Reducing and non reducing sugars in both types of fruits represented 97.75 to 98.39% and 1.6 to 2.25% from their total sugars, respectively.

c- Reducing sugars in both types of fruits consisted mainly of glucose and fructose. Meanwhile, sucrose was the only non reducing sugars. These results were confirmed from the thin layer chromatography (TLC) separation of the total sugars as illustrated in Fig. (4). Also data of Wrolstad *et al.* (1981 and 1982) and Bazzarini *et al.* (1986) showed that fructose was higher than glucose in mulberry fruits, while sucrose found in less value.

d- The sweet taste of both type of mulberry fruits was mainly due to the presence of fructose in higher level than glucose. According to Ninkovski *et al.* (1990) and Plowman (1991) glucose:fructose ratio in mulberry fruits was ranged from 1:1 to 1:1.02.

Generally, the total and reducing sugars in Egyptian mulberry fruits were the same as reported by Machii *et al.* (2002) and relatively higher than those mentioned by Ninkovski *et al.* (1990), Mattuk (1998) and Huo (2002).

Due to high pH of the mulberry fruits of both species for more than 4.5 (Table 1), such products were classified as low acid food. These results were agreed with those stated by Vaidehi *et al.* (1991). The pH value of fully mature three cultivaris of *M.alba* varied from 6.8 to 7.8 as reported by Gerasopoulos and Stavroulakis (1997). Generally, the pH value was lower and titratable acidity was higher for black mulberry fruits than those of white one. According to Vaidehi *et al.* (1991); Alleyne and Clark (1997) and Gerasopoulos and Stavroulakis (1997) blackberry species was lower in pH value and higher in acidity than the corresponding values obtained in the present study. On the other hand, Aksu and Nas (1996) found that the pH of 20 samples of black mulberry was very close to that found in the present study (5.7).

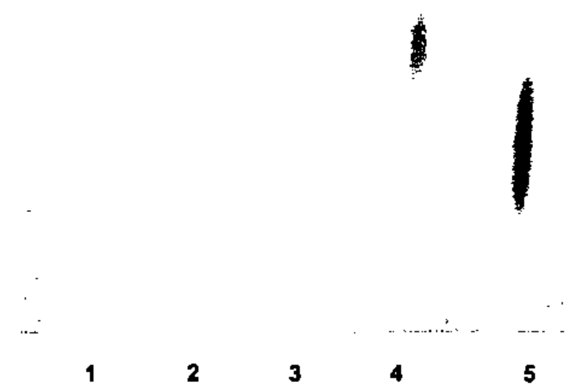


Fig (4) Thin layer chromatogram separation of total sugars of white and black mulberry fruit.
1- White mulberry. 2 -Black mulberry. 3- Glucose standard.
4- Fructose standard. 5- Sucrose standard.

As stated in Table (1), white and black mulberries had low ascorbic acid. These results agree well with those found by Aksu and Nas (1996) and relatively higher than that mentioned by Vaidehi *et al.* (1991) and Mattuk (1998). Comparing with other fruits, mulberry considers poor source of vitamin C. Table (1) revealed that the white and black mulberry fruits had 1.01 and 1.74% pectin, respectively.

From the data given in Table (1), black mulberry fruits are rich in anthocyanins. They had 200.96 mg/100g anthocyanins on fresh weight basis. This figure was higher than that found by Mattuk (1998) (100.76 mg/100g) for the fruits of the same species. The result obtained in this study was in the range comparing with those reported by others (Torrie and Burritt, 1977 and Kalt and McDonald, 1996) for other berries. Their results were 325.9 and 170.02 mg/100g on Fw for, black berries and lowbush blueberry, respectively.

3. Proximate composition and minerals content:- Data in Table (2) indicate that fruits of both Egyptian mulberry species, white and black, were nearly similar in their proximate composition. Generally black fruits contained relatively higher levels of ether extract, protein, ash and slightly lower values of crude fiber and nitrogen free extract. These results lie in the range reported by other investigators for fruits of both species such as in FAO (1982), Mattuk (1998) and Huo (2002).

Results in Table (2) show also, that white mulberry species had higher content of K, Mg, Cu and Zn, while lower values of P, Ca and Fe in comparing with these of black one. In both fruit species, Na did not detect. Generally, the fruits of two species are considered a good source of P, K, Ca, Mg and Fe. Duke (1983) mentioned that *M.alba* fruits contained higher amount of K and Ca and lower value of P and Fe where, FAO (1982) reported amount of Ca, Fe and Mn close to our findings.

Table (2) Proximate composition and minerals content of Egyptian mulberry fruits.

Character	Mulberry fruits species			
	M. alba		*M. nigra*	
	On Fw	On Dw	On Fw	On Dw
Moisture (%)	79.92±1.20	-	79.68±0.52	-
Ether extract (%)	1.18±0.03	5.88±0.13	1.23±0.04	6.05±0.21
Crude protein (%)	1.78±0.03	8.86±0.15	1.93±0.03	9.50±0.13
Crude fiber (%)	1.11±0.02	5.53±0.09	1.09±0.03	5.36±0.13
Nitrogen free extract (%)	14.99±1.02	74.65±1.11	15.01±0.03	73.87±0.13
Ash (%)	1.02±0.01	5.08±0.05	1.06±0.03	5.22±0.15
Minerals (mg/100g):-				
P	60.32±0.07	300.40±0.35	63.95±0.06	314.71±0.30
K	268.00±0.02	1334.66±0.10	201.00±0.11	989.17±0.54
Ca	40.00±0.50	199.20±2.49	53.00±0.51	260.83±2.52
Mg	39.39±0.04	196.17±0.20	27.93±0.05	137.45±0.25
Fe	2.51±0.05	12.50±0.25	2.81±0.01	13.83±0.05
Cu	0.36±0.02	1.79±0.10	0.23±0.02	1.13±0.10
Zn	0.53±0.02	2.64±0.10	0.35±0.02	1.72±0.10
Mn	0.17±0.00	0.88±0.00	0.17±0.02	0.84±0.10

Values = Mean ± Standard deviation.

Mulberry fruit products:- The above data showed that mulberry fruits were juicy, poor in ascorbic acid, total acidity, crude fibers, high in pH, moderate in pectin and rich in reducing sugars especially fructose. Therefore, such fruits are considered suitable for preparing juice, syrup and jam after adding citric acid, pectin and sugars. Also, the presence of anthocyanins in considerable levels in black mulberry fruits makes it one of the promising source of extracting such pigments to be utilized as a natural colour.

1. Processed products:- Table (3) summarized the different trials made to prepare juice, syrup and jam from mulberry fruits and their influence on the organoleptic properties of such products. Generally all products of mulberry fruits were acceptable by panelists.

1.1. Juice:- Except appearance, panelists preferred juice of black mulberry fruits which prepared by diluting the extracted juice with water at 1:3 or 1:4 v/v ratio (Table, 3). Increasing dilution level lowered the panelists acceptability from very to moderate acceptable. The appearance of juice of the 1:4 v/v whole mulberry juice to water ratio was significantly preferred than that prepared at 1:3 and 1:5 ratios.

Table (3) Organoleptic properties of processed mulberry products.

Product		Colour	Taste	Odour	Texture	Appearance	Overall acceptability
		Organoleptic properties*					
Juice	Ja	8.00±0.93a	7.65±1.00a	8.20±0.70a	-	7.24±1.09b	Very acceptable
	Jb	8.33±0.79a	8.42±0.77a	8.25±0.65a	-	8.30±0.70a	Very acceptable
	Jc	6.10±1.47b	6.21±1.57b	6.34±0.73b	-	6.03±1.69c	Moderately acceptable
	LSD	0.811	0.858	0.512	-	0.905	
Syrup	Sa	8.43±0.73a	8.42±0.59a	8.76±0.42a	-	8.57±0.80a	Extremely acceptable
	Sb	7.32±1.34b	7.00±0.66b	6.23±1.57b	-	6.50±0.91b	Acceptable
	Sc	5.90±1.37	6.11±0.95c	4.65±0.73c	-	5.72±0.69c	Moderately acceptable
	LSD	0.871	0.552	0.757	-	0.592	
Jam	B	7.80±0.78a	7.87±1.13a	7.53±0.92a	8.10±0.86a	7.80±0.86a	Very acceptable
	Bm	7.50±0.68a	8.00±1.00a	7.87±1.13a	8.53±0.52a	7.53±1.25a	Very acceptable
	W	6.75±0.79b	6.65±1.03b	6.93±1.54a	7.13±0.92b	7.26±0.89a	Acceptable
	Wm	6.80±0.94b	6.90±0.76b	7.10±1.31a	7.67±1.05b	7.23±0.75a	Acceptable
	LSD	0.586	0.722	0.909	0.627	0.709	

***Mean ±S.D.**

In all products, means in column that are not sharing the same letter are significantly different at > 0.05.

Ja = 1:3 v/v non diluted juice to water. **Sa = non diluted juice.**

Jb = 1:4 non diluted juice to water. **Sb = 2:1 v/v non diluted juice to water.**

Jc = 1:5 v/v non diluted juice to water.. ***Sc = 1:1 v/v non diluted juice to water.***

W = White mulberry. **B = black mulberry** **m = mashed mulberry.**

1.2.Syrup:- As seen from Table (3), syrup prepared from non diluted *extracted black mulberry juice had the best organoleptic characteristics* followed by those prepared from the diluted juice at 2:1 and 1:1 v/v juice:water ratios, respectively. It is known that syrup preparation required more excessive heating treatment than pasteurized juice. Such treatment affects colour, flavour and other organoleptic properties. Therefore syrup made of undiluted juice was the best one.

1.3.Jam:- Data in Table (3) reveal that panelists preferred significantly the organoleptic properties of the black mulberry jam than of white one. Also, they did not notice significant differences between whole and mashed jam products.

2.Natural colour:-

2.1.Maximum absorption:- Figure (5) shows the spectra analysis of anthocyanins of black mulberry fruits by acidified ethanol. The maximum absorbence was at 535 nm. This was more or less in accordance with those reported by Hamed *et al.* (1989); Sallam *et al.* (1996) and Mattuk (1998). They found that the maximum absorbance of anthocyanins varied between 510 to 545 nm.

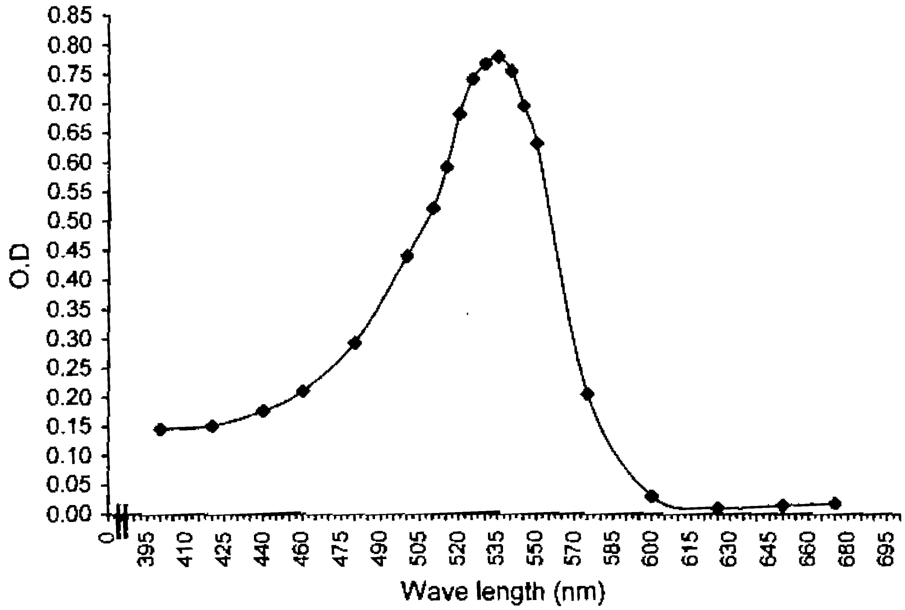


Fig. (5) Qualitative spectra for anthocyanins extracted from black mulberry fruits.

2.2. Heat stability:- As reported by XueQun *et al.* (2001a, b) and Marti *et al.* (2001) instability is the main problem of using natural pigment as food colour. Also, they stated that factors affecting colour stability are pH, heating, light, oxygen, metals and other fruit components such as ascorbic acid and phenolic acid compounds. Degradation may occur during extraction, purification and normal food processing and storage conditions (Abou Rayan, 1997). Fig. (6) shows anthocyanins stability as a % retention of the prepared two black mulberry extracts during heating at 80°C. The %retention of anthocyanins was gradually decreased with increasing the time of heating. The rate of decreasing of the colour intensity was more pronounced in acidified ethanol extract than in citric acid one after the first hour of heating. This may be due to the ability of citric acid to chalets metals (Main *et al.*, 1978).

At the end of heating (5 hrs), the colour retention of the acidified ethanol and citric acid extracts were 66.42% and 75.05%, respectively. Therefore, it is recommended to use water acidified by citric acid than acidified ethanol in extracting mulberry anthocyanins since it has the advantage of producing product safe for human consumption and stable to heat treatment. Abou Raya *et al.* (1999) showed that the anthocyanins pigment was considerably heat tolerance. Only high temperature more than 80°C caused loss in its content. Abou Rayan *et al.* (1998) found that the thermal degradation of anthocyanins increased progressively with increasing time of heating at 80 and 95°C. Mattuk (1998) stated that anthocyanins is more stable at low temperature. To further explore the utilization of black mulberry anthocyanins, further research has to be done to study the extraction, purification, stability of anthocyanins and its application field in food processing.

In a conclusion, mulberry fruits had good technological properties due to its physical and sensory properties. The above results indicate that mulberry fruits especially black one is considered a good source for anthocyanins production to be utilized as a natural colours instead of synthetic ones and also for preparing easily rapid acceptable products.

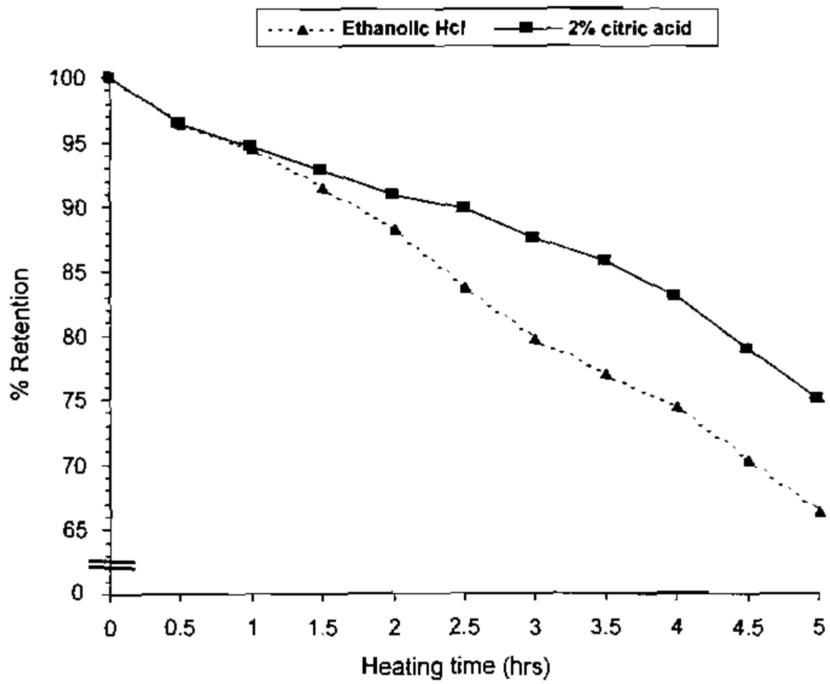


Fig. (6) Effect of heating time at 80°C and extraction media on the retention of Black mulberry fruits anthocyanins.

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صفات ثمارالتوت المصرى لإعداد منتجات مصنعه وألوان طبيعية

وفاء على أمين[1] - رمضان شحاته عطيه[2].

١- قسم بحوث تصنيع الحاصلات البستانية- معهد بحوث تكنولوجيا الأغذية - مركز البحوث الزراعية- الصبحية- إسكندرية- مصر.

٢- قسم علوم وتكنولوجيا الأغذية- كلية الزراعة -الشاطبى-جامعه الإسكندرية -مصر.

تم دراسة كل من الصفات العامة و للتركيب الإجمالي و المحتوى من المعادن والخواص الكيموطبيعية لثمار نوعي (*Morus alba* and *Morus nigra*)التوت المصرى الشائعين. ولقد تم إعداد منتجات غذائية مختلفة (عصير، شراب، مربى) من ثمار التوت وتقويم الخواص العضوية الحسية لها. واستخلصت صبغات الأنثوسيانينات من ثمار التوت الأسود (*M.nigra*) وقدر لها قيمة أقصى امتصاصية والثبات الحرارى عند ٨٠°م لمدة ٥ ساعات. أوضحت النتائج أن ثمار التوت (*M.alba*) ذات لون أبيض، أكبر فى الحجم والوزن وأعلى فى محتواها من البوتاسيوم، النحاس، الزنك، والمنجنيز وأقل فى الكالسيوم، الحديد، الحموضة التنقيطية، حامض الأسكوربيك، البكتين والفركتوز مقارنه بثمار التوت الأسود. ووجد أن التركيب الإجمالى والخواص الكيموطبيعية متشابهه تقريبا فى النوعين. وتمثل السكريات المختزلة (جلوكوز- فركتوز) المكون الرئيسي من ثمار التوت (حوالى ١٣,٠٦%) ونسبة الجلوكوز : الفركتوز ١: ١,٣ ، ١: ١,٥ لثمار التوت الأبيض والأسود على التوالى. وكان تفضيل المتذوقين معنويا للعصير المبستر المحضر بخلط عصير ثمار التوت الأسود بالماء بنسبة ١: ٣ (حجم:حجم) والشراب المحضر من ١٠٠% عصير توت أسود. وأيضا فضلوا المربى المحضرة من الثمار الكاملة أو المهروسة للتوت الأسود عن تلك المحضرة من التوت الأبيض. ويمكن اعتبار ثمار التوت الأسود مصدرا جيدا للأنثوسيانينات حيث أحتوت على ٢٠٠,٦٩ ملجم/١٠٠جرام. ووجد أن أقصى امتصاصية لصبغات الأنثوسيانينات المستخلصة إما بالايثانول المحمض أو بحامض الستريك كانت عند طول موجة ٥٣٥ نانو ميتر. وأظهرت مستخلصات الانثوسيانينات ثباتا حراريا جيدا عند ٨٠°م لمدة ٥ ساعات. وكان معدل الفقد للصبغات المستخلصة بالايثانول المحمض أعلى من تلك المستخلصة بحامض الستريك.