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Utilization of Egyptian Mulberry in Manufacture of some High Nutritional ValueProducts

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ABSTRACT

Due to the high nutritional value of Egyptian mulberry and its short determined presence in the market, the aim of this study was to manufacture products such as dried white mulberry *Morus alba L.* and making molasses from black mulberry *Morus nigra L.* while preserving the health-related components of the mulberry products, where mulberry is considered a functional food. Therefore, the chemical composition of white mulberry (WM) and black mulberry (BM) fruits has been analyzed, Where the study showed the significant BM. ash (4.50%) and Carbohydrates (75.12%) contents. Potential antioxidant activity, content of antioxidant compounds (phenolic and flavonoids), tested by the DPPH method, the results are(245.66, 1364 and 254% fresh weight fruits), respectively and anthocyanins also recorded high rates (25 mg/100g fresh weight fruits) in BM. identification of the phenolic compounds by HPLC showed high contents of Pyrogallo, Protoctchoic, P-OH-benzoic (7.10, 8,23 and 7.11 % fresh weight of fruits), respectively in BM also, flavonoid compounds were of high contents Hespertin, Hesperdin, Kampferol (5.10, 5.17 and 10.00 % fresh weight fruits), respectively as well as Iso-flavonoid compound was high content of Genistein (4.00 g/100g fresh weight fruits). As an increase in total sugar, reducing sugar, non-reducing sugar (30.90, 17.50 and 13.40% fresh weight fruits). Fresh fruit analyzes showed increase of both moisture (72.50%*(* and pH *)*4.06% *(*in BM. while titratable acidity*)*2.2%*(* of total soluble solids (20.32%*(* and fruit color (*L*76.3 *a* -15.3 *b* 17.4) were high in BM. The high content of the following minerals was (K1069, Mg104, Zn 3.1, Mn 4.00 and Fe 4.2mg/100 g fresh weight fruits) in BM.was high in the content of vitamin A (1.72 g/100g fresh weight fruits) fat soluble vitamins and water-soluble vitamins contents C, B_1, B_9, B_{12} (22.12,1.30, 0.20 and 4.66 g/100g fresh weight fruits), respectively. In *M. nigra* molasses it could be realized that the percentage of color (*L*35.40 a +1.12 b -2.26) moisture (16.9%) pH (5.2%) titratable acidity (5.6%) and total soluble solids (50%) increased in comparison to fresh fruits which, were dried in the air oven and the oven under vacuum and a sensory evaluation of the dried *M. alba* was performed, the results of the sensory values were in favor of the dried *M. alba* in the oven under vacuum.

Keywords: Black mulberry- White mulberry – Minerals – Vitamins – HPLC - Sensory quality – Drying

1. INTRODUCTION

Mulberry is a plant which belongs family Moraceae and genus Morus. Mulberry is broadly distributed in temperate, subtropics and tropic regions **(Sharif et al.,2016).** The plant is easy to growth under difference climates, topography and soil conditions. Mulberry is a fast-growing deciduous plant and it grows under different climatic It has been cultivatedin the Northern hemisphere for centuries **(Yilmaz et al.,2012).** There are many types of Mulberries, which has been studied here are two types of, black mulberry *M. nigra L.* and white mulberry *M. alba L.* **(Gungor and Sengul, 2008).** White mulberryoriginated in Western Asia and black mulberry in Southern Russia **(Arabshahi-Delouee and Urooj, 2007).** In Turkey, Mulberry trees are extensively grown in southern Europe, India, China for its foliage as foods for silkworms. However, in Turkey and Greece mulberries are grown for fruit production rather than foliage **(Negro et al., 2019).**The black and white mulberries are widely cultivated in the Mediterranean and Middle Eastern countries.It has a very pleasant taste sour and sweet,when eaten fresh, are also used in jams, juices, liquors, natural dyes as well as in the cosmetics industry **(Bhattacharjya et al., 2020)**Egypt is one of the most important countries in the Middle East, which has known the cultivation of mulberry since ancient times, as the governorate of Sohag is famous for planting mulberry and using leaves in raising silkworms and making silk. The Egyptian government has also worked to increase the area planted with berries, as it established a project to cultivate one million mulberry trees in many governorates such as the Red sea,Al wadi Al gadid and the Delta **(Ahmed,2020)**shown in epidemiological and experimental studies reveal a negative correlation between the consumption of diets rich in fruits, and vegetables and the risks for chronic angiogenic diseases, such as cardiovascular diseases, arthritis, chronic inflammation and cancers, diabets, stroke, neurodegenerative diseases, and Alzheimer's diseases as well as inflammation and problems caused by cell and cutaneous aging. **(Ercisli and Orhan 2005)** Those physiological functions of fruits and vegetables may be partly attributed by their abundance of phenolics. Deep-colored vegetables and fruits are good sources for phenolics, including flavonoids and anthocyanins, and carotenoids.**(Lin and Tang 2007**) Fruits and vegetables contain many antioxidant compounds, including carotenoids, thiols, vitamins such as ascorbic acid, tocopherols, and phenolics.**(Rangkadilok et al., 2007)** Antioxidant components can delayrostpone or inhibit lipid oxidation, by inhibiting the intiation or propagation of oxidizing chain reactions, and are also involved in scavenging free radicals.

This study was conducted to make products from black and white mulberry with high nutritional value and available in the market throughout the year.

2. MATERIALS AND METHODS

2.1. Materials:

2.1.1.Fruit materials

White mulberry *Morus alba L.* and black mulberry *Morus nigra L.* fruits were purchased from collectors near Food Technology Research Institute Giza, Government, fifty fruits from each species were used for analysis the mulberry was selected according to uniformity of shape and color. Fruits were thoroughly washed with tap water to remove surface dirt.

2.2. Methods

2.2.1. Preparation of raw materials

2.2.1.1. Preparation of Fresh Juice

The BM juice. was extracted mechanically by beating the fruit in a blender (Type: Moulinex MFP626 – 220V – 50-60Hz – 1000W – 250 ml France) and then filtering to obtain a clear juice **(Azofeifa et al., 2011)**

2.2.1.2. Preparation of molasses mulberry

Rotary vacuum evaporation technique: A 1-L BM juice sample was concentrated in a laboratory rotary flash vacuum evaporator (Stuart UK 3008 efficient) rotating at 66 rpm and 40°C. Samples were taken from the bulk of juiceperiodically to measure TSS and replaced again **(Dhumal et al., 2015)**

2.2.1.3. Preparation of Fresh fruit

After washing, the WM and leaving to filter water, the drying process was performed in an air oven and drying in the oven under vacuum **(Imran et al.2010)**

2.2.1.4. Dehydration in an air oven

The fresh WM was dried in an air oven (Type: VENTICELL55- Artikel Nr: 000721/10000 - Temp.Berech: 250°C – Anschlub:230V AC 50/60Hz – Leistungaufn. :1250W Germany) at 50°C for 24 days.

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2.2.1.5. Dehydration in under vacuum condition

500g of WM were dried in an oven under vacuum (NAPCO vacuum oven 5831) at 40°C for an hour.

2.2.2. Methods of analysis

chemical composition including crude protein, ash and crude fiber were determined according to the methods of **A.O.A.C. (2010)**. Allthe above-mentioned determinations were expressed as g/100g sample and performed in triplicate**.** Total carbohydrates were estimated by difference. % carbohydrates = 100- (% crude protein+ % crude fat+ % ash + % crude fibers). Moisture, and titratable acidity were determined according to **A.O.A.C.** (**2012). pH** was determined with a (Jenway3510 pH meter) and TSS determined with a Hand Refractometer (ATAGO Type 500 cat. No. 2340). For color analysis, the instrument was calibrated with a white reference before measurements. Color of mulberry fruit was analyzed by measuring Hunter (Model CR 200, Chromometer, Minolta, Japan)

2.2.2.1. Determination of Total Antioxidant Activity

Total antioxidant content (TAC) was estimated by using 2,2-diphenyl-1-picrylhydrazil (DPPH) assay to measure the free radical scavenging capacity **(Brand-Williams et al., 1995)**.

2.2.2.2. Determination of Total Phenolic percentage

Total Phenolic content (TP) of extracts was determined using Folin-Ciocalteu reagent as described previously by **(Velioglu et al. 1998).** The TP of extracts was expressed as milligrams of gallic acid equivalent (GAE) per 100 g sample.

2.2.2.3. Determination of Total Flavonoid percentage

Total flavonoid content (TF)was measured using $AlCl_3$, a colorimetric method **AOAC** (**2006)** The absorbance was measured at 510 nm using the spectrophotometer. The TF of extracts was expressed as milligrams of catechin equivalent (GAE) per 100 g sample.

2.2.2.4. Determination of Total Anthocyanin content

10 g fruit were homogenized in methanol solution that included HCl 1 %. After a night of standing, the samples were filtered using a filter paper. The absorbance overnight, then the samples were read against the blank at the wavelengths of 530 and 700 nm **(Giusti and Wrolstad, 2001)**.

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2.2.3.1. HPLC analysis of major Antioxidant

2.2.3.2. Identification and quantification of phenolic compounds from BM and WM usingHPLC

Phenolic compounds from white and black mulberry fruits using HPLC were extracted according to the method of **(Goupy et al., 1999)**

2.2.3.3. Identification and quantification of flavonoid compounds from BM and WM using HPLC

Flavonoid compounds were determined by HPLC according to the method of **(Mattila et al.,2000)**

2.2.3.4. Identification and quantification of isoflavonoid compounds by from BM and WMusing HPLC

isoflavonoids compounds of BM and WM fruits were determined using the method of **(Kaufma et al., 1997)**

2.2.3.5. HPLC analysis of major vitamins

2.2.3.6.Identification and quantification of fat-soluble vitamins A and E from BM and WM using HPLC

Vitamin A analysis of the retinal isomers was performed with a HPLC according to the methods of **(Noll, 1996).** Vitamin E analysis using HPLC according to the method of **(Pyka and Sliwiok, 2001)**

2.2.3.7. Identification and quantification of water-soluble vitamins Cand B by from BM and WM using HPLC

Vitamin C content was determined using HPLC according methods described **(Romeu-Nadal et al., 2006)**. Vitamin B separation and identification using HPLC were carried out according to the method of **(Batifoulier et al., 2005)**

2.2.4.1. Determination of mineral

Mineral content iron (Fe), zinc (Zn), calcium (Ca), potassium (K) and phosphorus (P) were determined using by Agilent Technologies (model 4210 MPAES), atomic absorption spectrophotometer according to the method of **A.O.A.C. (2011)**

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2.2.5.1. Determination of sugars

Extraction and determination of total water-soluble sugar, reducing sugar, were carried by **AOAC (2003)** methods. The non-reducing sugar was obtained by subtraction of reducing sugar from total water-soluble sugar.

2.2.6.1. Sensory evaluation

The sensory properties of BM juice concentrate, prepared by evaporation technique, the sensory evaluation of dried WM were evaluated by different methods. The organoleptic properties are colour, taste, oder, appearance, tenderness, sweetness and general acceptability, and the evaluation was carried out by 10 Food Tech judges. Rec. Using a 10-point pleasure scale. samples receiving an overall quality score of 7 or above were considered palatable. according to the method of (**Hojjatpanah et al., 2011)**

2.2.7.1. Statistical analysis

One way analysis of variance (ANOVA), with multiple range significant difference (LSD) test Standard error was determined (SE) ($p < 0.05$) were carried out using SPSS according to **(Afghah, 2018)**

3. RESULTS AND DISCUSSIONS

3.1. Chemical composition of mulberry cultivars

Comparison of the chemical composition of BM and WM as presented in the **Table 1.** Notice that height of each of crude proteins (7.40%), Fats (10.18%) and Crude fiber (4.40%) in WM, while the BM rise both ash (4.50%) and carbohydrates (75.12%). Despite the high and low of some ingredients in two types of mulberry, but the percentages are close, these results are in symmetry with **(Abbasi et al., 2016)**

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Table (1): Chemical composition of white mulberry (WM) and black mulberry (BM)

Constituents (%)	Fruit	
	Morus nigra	*Morus alba*
Crude Protein	7.35±1.15[b]	7.40±1.10[a]
Fat	8.83±1.15[b]	10.18±0.90[a]
Ash	4.50±0.10[a]	4.20±0.34[b]
Crude fiber	4.20±0.10[b]	4.40±1.24[a]
Carbohydrates	75.12±2.25[a]	73.80±3.22[b]

Values ±(SE) in the same line with different letters are significantly different at $P < 0.05$. **FW**: fresh weight. Carbohydrates were calculated by difference {100- (Protein+ + Fats+Ash+ Crude fiber)}

3.2. Determination of total antioxidant contents (TAC), total phenolic (TP), total flavonoids (TF) and total anthocyanin (TA) in cultivars mulberry

Antioxidants are the most frequent and broadly disseminated group of which are ever present in fruits and vegetables, antioxidant activity contents of the fruits on fresh weight basis are mentioned in **Table 2,** showed significant high TAC (245.66/%) and TP (1364 %fw) in BM Compared with WM, less percentages were recorded in both TAC (176.67% fw) and TP (980.6%). Also, the percentage of TF in BM (254 %fw) is higher than in WM (129 % fw). Anthocyanins TA are a member of flavonoids group of substances, contributing to the antioxidant power of fruits and vegetables. Small fruits are rich in TA **(Koca et al. 2008)** reported TA of some small fruits, including BM (25 %fw), TA of WM is generally lower (1.58 %fw) than the values reported of BM.

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Table (2): Determination of total antioxidantcontents (TAC), total phenolic, (TP) total flavonoids (TF) and total anthocyanin (TA) of cultivars mulberry

Species	TAC	TP	TF	TA
Morus nigra	245.66±1.53[a]	1364±2.0[a]	254±1.53[a]	25±1.00[a]
Morus alba	176.67±1.52[b]	980.6±2.08[b]	129±1.0[b]	1.58±0.10[b]

Values ±(SE) in the same line with different letters are significantly different at $P < 0.05$. **FW:** fresh weight.

3.3.1. Identification and quantification phenolic compounds of cultivars mulberry using (HPLC)

The data in **Table 3.** showed that methanolic extract of mulberry cultivars BM and WM contained twenty phenolic compounds, where the amount of these compounds varied from one variety to another, you may notice an increase some compounds in BM., such as Pyrogallo, Gallic acid, Protocatechuic acid, Catechol, P-OH-benzoic acid, P-coumaric acid, Iso- ferulic acid and 3,4,5, methoxy cinnamic acid (7.10, 16.0, 8.23, 6.00, 7.11, 4.40, 3.33 and 4.34%), respectively. While those compounds4-Amino benzoic, Benzoic acid, Vanillic acid, Caffeine acid and Alpha coumaric acid (9.90, 9.80, 3.60, 8.74 and 5.00 %), respectively were found in a high percentage in WM these results are in agreement with those recorded by **(Radojković et al., 2012)**

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Table (3): Identification and quantification phenolic compounds (%) of cultivars mulberry using (HPLC)

Peak No.	Components	R.T.	Cultivars mulberry	
			M. nigra	*M. alba*
1.	**Pyrogallo**	3.55	7.10	5.10
2.	**Gallic acid**	5.80	16.0	1.41
3.	**3-OH-Tyrosol**	6.85	1.04	1.50
4.	**Protoctchoic**	7.09	8.23	5.60
5.	**Catechol**	7.24	6.00	4.60
6.	**4-Amino benzoic acid**	7.49	4.10	9.90
7.	**Catechin**	7.57	2.00	2.10
8.	**Chlorogenic**	7.77	1.32	1.30
9.	**P-OH-benzoic acid**	8.08	7.11	5.11
10.	**Benzoic acid**	8.23	4.34	9.80
11.	**Vanillic acid**	8.58	2.10	3.60
12.	**Caffeic acid**	8.63	0.30	0.12
13.	**Caffeine**	9.24	3.00	8.74
14.	**P-coumaric acid**	9.93	4.40	1.50
15.	**Ferulic acid**	10.15	0.70	0.07
16.	**Iso- ferulic acid**	10.71	3.33	2.00
17.	**Alpha coumaric acid**	11.28	3.00	5.00
18.	**Oleuropein**	11.55	0.50	0.20
19.	**Coumarin**	11.96	1.70	1.43
20.	**3,4,5, methoxy cinnamic acid**	12.41	4.34	2.30

FW: fresh weight

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3.3.2. Identification and quantification flavonoid compounds (%) cultivars mulberry using (HPLC)

The flavonoid compounds extracted from cultivars mulberrywere determined and the results were listed in **Table 4.** The data showed that methanolic extract of cultivars mulberry contained nine flavonoid compounds. These compounds were found highly in BM which Naringin, Rosmarinic, Rutin and Kampferol (3.51,3.00,57.34 and10.005%), respectively. On the other hand, WM recorded high levels of these compounds Hespertin, Qurectrin, Naringenin, Hesperdin and Apigenin (10.00, 3.51,5.18,7,50 and 8.00%), respectively. The variation of phenolic compounds in the extract depends on many factors, such as degree of maturity at harvest, genetic differences and environmental conditions during fruit development **(Rodrigues et al., 2019)**

Table (4): Identification and quantification flavonoid compounds cultivars mulberry of using (HPLC)

Peak No.	Components	R.T.	Cultivars mulberry	
			M. nigra	*M. alba*
1.	Naringin	10.88	3.51	2.50
2.	Rosmarinic	10.89	3.00	2.10
3.	Hespertin	11.13	5.10	10.00
4.	Rutin	11.31	57.34	31.24
5.	Qurectrin	12.17	1.03	3.51
6.	Naringenin	13.27	3.00	5.18
7.	Hesperdin	13.75	5.17	7.50
8.	Kampferol	14.64	10.00	6.00
9.	Apigenin	14.92	4.03	8.00

FW: fresh weight.

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3.3.3. Identification and quantification of Iso-flavonoid compounds cultivars mulberry of using (HPLC)

From the **Table 5.** the data showed that methanolic extract of mulberry cultivars **c**ontained five compounds of isoflavonoids. The majority of these compounds are present in varieties, but they are found in BM at a higher than in WM, as it was found that BM contain the compound Daidzein (4.11%) at a higher rate than WM .These results are consistent with **(Aljane and Sdiri, 2016)**

Table (5): Identification and quantification of Iso flavonoid compounds (%) cultivars mulberry of using (HPLC)

Peak No.	Components	R.T.	Cultivars mulberry	
			M. nigra	*M. alba*
1.	**Rhamentin**	1.93	3.00	1.30
2.	**Daidazein**	3.16	3.00	4.11
3.	**Genistein**	4.016	4.00	2.01
4.	**Iso formention**	6.33	2.10	1.43
5.	**Biochainin**	9.55	2.00	1.23

FW: fresh weight fruits

3.3.4. Identification and quantification of vitamins cultivars mulberry of using (HPLC)

In **Table 6.** It is shown that the water-soluble vitamins are higher than the fat-soluble vitamins for each of the cultivars mulberry. It could be noticed that the proportion of both (vitamin C) and (vitamin B12) is higher in BM (22.12g/100gfw), (4.6612g/100gfw), respectively than in BM (20.07g/100gfw), (2.40g/100gfw) respectively, while vitamin B6 is higher in WM (3.30g/g100fw) than BM (1.10g/100gfw). As for the fat-soluble vitamins, vitamin A and vitamin K, they were higher in BM (1.72g/100gfw), (1.17 g/100gfw), respectively than white berries (1.64 g/100gfw), (1.22 g/100gfw), respectively, these results according to **(Imran et al., 2010)**

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Table (6): Identification and quantification vitamins(g/100gfw) cultivars mulberry of using (HPLC)

Cultivars mulberry	Vitamins (mg/100 g)							
	Fat soluble vitamins		Water soluble vitamins					
	A	**E**	**C**	**B1**	**B2**	**B6**	**B9**	**B12**
M. nigra	1.72	1.17	22.12	1.30	0.10	1.10	0.20	4.66
M. alba	1.64	1.22	20.07	1.10	0.11	3.30	0.10	2.40

FW: fresh weight fruits

3.3.5. Mineral contents of cultivars mulberry

The mineral contents of cultivars are shown in **Table 7.** differences cultivars were observed based on the mineral compositions. study showed an increase in the percentage of both K, Zn and Mn (1069, 3.1 and 4.00mg/100 g) in BM. While the highest percentage of Ca and Na (151 and 61 mg/100 g) in WM and despite the difference in the percentage of mineral elements from one cultivars mulberry to another, the difference between them is small. This difference due to the conditions of growth, climate and other factors. results are in harmony with **(Khalid et al., 2011)**

Table (7): Mineral contents

Cultivars mulberry	Mineral elements (mg/100 gfw)						
	Ca	K	Mg	Na	Zn	Mn	Fe
M. nigra	134^{b}	1069^{a}	104^{a}	58^{b}	3.1^{a}	4.00^{a}	4.2^{a}
M. alba	151^{a}	924^{b}	103^{a}	61^{a}	2.6^{b}	3.8^{b}	4.1^{a}

FW: fresh weight.

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3.4. Sugar content

The data on total sugar content in mulberry cultivars **Table 8** recorded high total sugars BM (30.90g/100 g fw) while recorded. the reducing sugars in fresh fruits, in the BM (17.50 g/100 g fw) while decrease in*M. alba* (13.68 g/100 g fw). Also, **Non-reducing sugar:** the results indicated that non-reducing sugars content varied significantly among the cultivars mulberry where it was in BM (13.40 g/100 g fw) while WM (7.17 g/100 g fw) Therefore the presence of sugars in the fruits may encourage their use as sugar sources in different food recipes **(Iqbal et al., 2010)**

Table (8): Total Sugars content of cultivars mulberry fruits (g/100 g FW)

Cultivars mulberry	Total sugars	Reducing sugars	Non-reducing sugars %
Morus nigra	30.90±2.21[a]	17.50±0.95[a]	13.40±1.25[a]
Morus alba	20.85±0.97[b]	13.68±0.40[b]	7.17±0.60[b]

Values ±(SE) in the same line with different letters are significantly different at P < 0.05.**FW:** fresh weight fruits

3.5. Determination of Fruit fresh weight, fruit color, moisture, pH, titratable acidity and total soluble solids contents of mulberry cultivars fruits

The FW (fresh weight fruit), fruit color, moisture, pH, TAc (titratable acidity), TSS (total soluble solids) and contents of cultivars mulberry were given in **Table 9.** fruit weight of mulberry cultivars ranged between 3.90g and 4.00g WM having the biggest fruits. The moisture contents were from 72.50% BM to 74.31% WM, pH from 4.06 BM to3.62 WM TAc from 1.6 % BM to 2.2% WM, TSS from 19.37 % BM to 20.32 % WM. Fruit colour was determined as *L* value, from +16.5 BM to +76.3 WM, value from -15.3 BM to 8.03 BM and *b* value from 1.83 BM to 17.4 WM. According to these results, there is a difference in the ingredients between the two varieties of berries, there are some components that increase their percentage, and components whose percentage decreases, but the difference is not significantly due to the different varieties of berries These results are in harmony with **(Kamiloglu et al., 2013).**

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Table (9): FW (fruit fresh weight), color, moisture, pH, TAc (titratable acidity) and TSS (total soluble solids) contents of mulberry species

Mulberry Cultivars	FW (g)	Fruit color			Moisture (%)	pH	TAc (%citric acid)	TSS (%)
		L	*a*	*b*				
Morus nigra	3.90[b]	16.5[b]	8.03[b]	1.83[b]	72.50[b]	4.06[a]	1.6[b]	19.37[b]
Morus alba	4.00[a]	76.3[a]	-15.3[a]	17.4[a]	74.31[a]	3.62[b]	2.2[a]	20.32[a]

4.1. Sensory evaluate ability of black (Morus nigra L.) mulberry molassesproduct.

Results of the sensorial evaluation in term of appearance, color, taste, flavor, sweetness, and overall acceptability for scales are shown in **Table 10.** it could be noted that the sweetness recorded (score10.00) the highest in mulberry molasses, then the taste (score 9.33), followed by the flavor (score 9.0), and the product achieved a high rate of overall acceptability (score 9.43) (**Tangkham and Le Mieux, 2017)**

Table (10): Sensory evaluation of black (Morus nigra L.) mulberry molasses

Characteristics	Mean Score
Color	8.66±0.57
Taste	9.33±0.58
Oder	9.0±0.00
Sweetness	10.00±0.00
Appearance	8.67±0.59
Overall acceptability	9.43±0.33

4.2. Sugars contents of black (Morus nigra L.) mulberry molasses product.

It is noted in the **Table 11.** the high total sugars in the mulberry molassesproduct (63.53g/100 g), as reducing sugars were represented (35.96 g/100 g), while non-reducing sugars were contaminated (28.23g/100 g) determined by (**Tangkham and Le Mieux, 2017)**

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Table (11): Sugars contents of black (Morus nigra L.) mulberry molasses (g/100 g)

Mulberry Cultivar	Total sugar	Reducing sugar	Non-reducing sugar
Morus nigra	63.53±0.85	35.96 ±1.60	28.23±1.03

4.3. Determination of total antioxidant contents (TAC), total phenolic, (TP) total flavonoids (TF) and total anthocyanin (TA) contents of black (Morus nigra L.) mulberry molasses (mg/100 g)

The results of previously described analysis are shown in **Table 12.** As shown in the table where the results showed an increase in (TP) 400.66mg/100 g, followed by (TAC)167mg/100 g, while (TF) 86mg/100 g recorded a lower percentage of (TP) and (TA) 2.5 mg/100 g recorded the lowest decrease (**Tangkham and Le Mieux, 2017)**

Table (12): Total antioxidant contents (TAC), total phenolic (TP), total flavonoid (TF) and total anthocyanin (TA) contents of black (Morus nigra L.) mulberry molasses product mg/100 g

Cultivar mulberry	TAC	TP	TF	TA
Morus nigra	167±1.00	400.66±1.52	86±2.00	2.5±0.10

4.4. Determination color, moisture, pH, titratable acidity and total soluble solids of black (Morus nigra L.) mulberry molasses product.

Table 13. included the content of black mulberry molasses from the molasses colour, moisture, pH, TAc (titratable acidity), TSS (total soluble solids). It was moisture contents16.9%, pHvalue in black mulberrymolasses5.2, TSS in black mulberrymolasses50%, TAc 6.5%. Molasses colour was determined as *L* value +35.40, *a* value +1.12 and *b* value -2.26.

Table (13): Color, moisture, pH, TAc (titratable acidity) and TSS (total soluble solids) of black (Morus nigra L.) mulberry molasses.

Mulberry Cultivar	Molasses color			Moisture (%)	pH	TAc (%citric acid)	TSS (%)
	L	*a*	*b*				
Morus nigra	35.40	+1.12	-2.26	16.9	5.2	6.5	50

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5.1. Effect of different drying methods on the sensory evaluation of white (Morus alba L.) mulberry

From **Table 14.** it is evident that highest overall acceptability (score 8.90) of WM was noted in drying in oven under vacuum method as compared to drying in an air oven. This can be attributed to relative retention of colour, high aroma, sweet taste and tenderness. It turns out that drying in the oven under a vacuum helps to preserve the fruit closer to nature and without losing much of its quality characters, and this helps to preserve it for a long time as reported by **(Ukav, 2018)**

Table (14): Effect of different drying methods on the sensory evaluation of white (Morus alba L.) mulberry

Drying Method	Color	Taste	Oder	Tenderness	Appearance	Overall acceptability
Drying in oven under vacuum	8.0 ± 1.0^{a}	8.87 ± 0.76^{a}	9.0 ± 1.0^{a}	8.99 ± 0.95^{a}	8.75 ± 0.86^{a}	8.90 ± 0.92^{a}
Drying in an air oven	6.66 ± 0.58^{b}	7.66 ± 0.57^{b}	7.0 ± 1.0^{b}	6.63 ± 0.57^{b}	6.67 ± 0.58^{b}	7.0 ± 0.21^{b}

Values ±(SE) in the same line with different letters are significantly different at $P < 0.05$. **FW:** fresh weight fruits

4. CONCLUSIONS

Evaporation method gave the best color in final product. The concentration of black mulberry juice by using influenced the physicochemical constituents and sensorial attributes. Rotary vacuum evaporator gave the highest recovery of juice concentrate with maximum retention of quality parameters. Atmospheric heating process required less time heating in preparing juice concentrate of desired 50°Brix. According to results, vacuum concentration could be used in production of black mulberry juice concentrate successfully. From the experiment it can be concluded drying in oven under vacuum method as compared to drying in an air oven best to preserve the fruit (white mulberry) closer to nature and without losing much of its nutritional value and retain its sensory properties.

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