Some Chemical Characteristics of White (Morus Alba L) and Black (Morus Nigra L) Mulberry Phenotypes in Tartus Syria

Georges Makhoul[*], Hafez Mahfoud[**], Hussam Baroudi[#]
*Prof,Department of Horticulture, Faculty of Agriculture, Tishreen University, Lattakia, Syria.
** Researcher, Department of Biotechnology, General Commission for Scientific Agriculture. Research, Lattakia, Syria.
[#]Postgraduate student, Department of Horticulture, Faculty of Agriculture, Tishreen University, Lattakia, Syria.

Abstract

In this study, some chemical properties (Glucose, Fructose, Sucrose, titratable acidity, vitamin C, total solid contents) of 33 phenotypes of white (*Morus alba L.*) and black (*Morus nigra L.*) mulberries phenotypes fruits grown in Tartus of Syria were investigated. The glucose content of mulberry phenotypes varied between 14.69 % (KH-9, black) and 0.72% (B-7, white). The fructose content varied between 11.01 % (KH-9, black) and 0.05 % (KH-5, white). The sucrose content varied between 0.03% (DN-4, black) and 2.37% (KH-1, black). Ascorbic acid (vitamin C) was in the range from 2 mg/100 g fresh weight (B-11, KH-5, D-7, M-7) to 42 mg/100 g fresh weight (A-2, black). Total acidity varied between 0.06 % (D-6, white) to 2.21 % (KH-3, black). The total solid contents % were in the range from 19.45 % (KH-9, black) to 5.6 % (M-2, white). The results were analyzed by (GenStat Release 12.1). The results of this study revealed that there were big differences in juice fruits contains (sugars, TSS, Vitamin C and TA) regardless of the specie and the location. The study showed the highest fructose, glucose and sucrose concentrations were observed in some black phenotypes 25.7 % (KH-9) followed by white mulberry phenotype 16.22 % (M-7). Some white mulberry phenotypes had the highest concentration of sucrose was 1.47% (DA-4). Black mulberry phenotypes were also found to be higher than of the white ones in ascorbic acid and total acidity contents.

Keywords: *Morus alba, Morus nigra, ascorbic acid, sugars, TSS, TA.*

I. INTRODUCTION

Horticultural plants show wide variability in terms of morphological, bio chemical and molecular characteristics. Syria is one of the main genetic diversity centers for numerous fruits species with diverse phytochemical profiles and potential health benefits important in pharmaceutical and functional food industries. Berries are very popular in the human diet due to their high anthocyanin content and antioxidant activities with potential health benefits on retarding aging, decreasing the risk of cardiovascular diseases and cancer, therefor many studies have become conducted on the chemical composition of berries [1].Mulberry genus *Morus* belongs to the family *Moraceae.Morus* is a typical east Asian genus distributed in tropical and sub–tropical to temperate regions of the world. Mulberry Can grow in a wide range of climatic to topographical and soil conditions ([2]; [3]).

Mulberry (*Morus spp*) leaves have been the traditional feed for silk worm (*Bombyxi mori L.*) the growth and development of the silk worm larvae and subsequently cocoon production are greatly influenced by nutritional quality of mulberry leaves. Mulberry leaves are rich source of proteins, carbohydrate, chlorophyll A and B, total chlorophyll, ascorbic acid and various mineral elements [4]. The main use of mulberry globally is as feed for the silk worm, but depending on the location it is also appreciated for its fruits (consumed Fresh, juice, or as preserves) ([4]; [5]). White mulberry is recognized as the primary food of silk worms and is widely cultivated in china but later it's dispersed to various parts of the world. *Morus rubra L.* is native to United states of America and grows in forests, its renowned as rich source of flavones namely rubraflavones. *Morus nigra L.* originated in Iran but was exported to Britain more than 500 years ago ([6]; [1]). Today it is cultivated in Southern Europe and Southwest Asia and its recognized as one of the most important fruits in Mediterranean [7]. It is mostly used for making processed foods such as pekmez, marmalads, juices, liquors, natural dyes and frozen fruits for ice cream [8]. In terms of food production *Morus* is a complex genus and has a great genetic variability. According to plants scientists it has 7 species *M. alba*, *M. nigra* and*M. rubra* are the most important throughout the world[2], Or it has 12 species [9], 14 [10], 30 [11] and 68 species [12]. White mulberry is 25 meters in the height, the leaves are usually rounded (cuneate to subcordate, lobes common

especially sprouts in sun), lower surface glabrous except of scattered short hairs (mostly 0.2-0.5 mm) on the major veins. Fruits are short –cylindric to elliptic (L/W mostly 1.5-3) [13]. The fruits of white mulberry are sweet but they are very perishable. The color of fruits doesn't identify the species, As the genotypes of *M. alba* can produce lavender white or black fruits which are very sweet but of lack tartness. Red mulberry fruits are usually deep red almost black and it has best clones and a flavor that almost equals of the black mulberry [14]. Black mulberry is small to medium tree that reaches nine meters in height, the leaves overall shape is ovate-cordate to suborbicular unlobed or rarely 3-lobed, lower surface softly pubescent. The flowers are mostly dioecious but sometimes monoecious. ripen fruits are syncarps to short-cylindric, ovoid with purple to black juicy edible pulp. The fruits of black mulberry are famous for their nutritional qualities flavor, and especially medicinal properties [4]. The fruits of *M. nigra* have a distinct flavor with juicy and acidic characteristics making them attractive to consumers and for use in processing industry in products because black mulberry fruits are large and have a good balance of sweetness and tartness that makes them the best flavored species of mulberry. The high fresh weight, black–purple color and extraordinary taste of black mulberry fruits increased the need of those plants.Flavor of fruits vary from cultivar to cultivar [15; 16]. The mulberry fruits are rich in anthocyanins and deserve to be exploited for industrial production of natural color to be used in the food industry. In particular, it is known to contain cyanin which contributes the red pigment that gives the fruits a red to purple color. Mulberry fruits changes color from green to purple black through red with maturity, some varieties introduced from mid- Asia have white fruits.

The differences between the mulberry varieties in terms of total anthocyanins content in fruits are highly significant [8]. Research on 31 cultivars of mulberry yielded a total anthocyanin level calculated as cyanidin – 3 – glucoside ranging from 147 – 68 to 2725.46 mg/ L juice. Total sugars, total acids and vitamin C remained intact in the residual juice after removal of anthocyanins and residual juice could be fermented in order to produce products such as juice, wine, sauce [17]. The object of our research was to identify and quantify some chemical characteristics (sugars (glucose, fructose, sucrose), citric acid, vitamin C, TSS) of local white and black mulberries phenotypes from Tartus, Syria. The obtained results may be taken into consideration in the selection of parents in future breeding programs. Mulberry plants are normally dioecious, but they can also be monoecious on different branches of the same plant [18]. The pendulous pistillate (female) and staminate (male) Catkins are arranged on spikes. The pistillate catkins in white mulberry are 0.5 – 2 cm long and staminate catkins are 2.5 – 4 cm long. The pistil ate catkins in red mulberry are 1-3 cm long and staminate Catkins are 3-5 cm long. The green female flowers have 4 sepals and 1 pistil. The ovary is about 2 mm long The style in white mulberry is red brown and 0.5 – 1 mm. All mulberries have hairy stigmas on the average 44% of the pistillate in florescences are parthenocarpic with seedless fruits being somewhat smaller than seeded fruits [19]. Mulberry species have been known and cultivated in Turkey for more than 400 years [15]. The reliable information on genetic identity and relationship among genotypes is necessary to develop corecollection for germ plasm maintenance [2]. Any fruit characters can be used as a selection criterion for fruit size depending on the heritability of the characters and simplicity for measurement, genetic diversity was studied based on horticultural traits and total solid content in mulberry (*Morus alba*) varieties, (fruits weight, Length, width) and TSS at immature, medium ripe and fully ripe stages. High variation were observed in 21 varieties. At the coefficient of determination (R^2) of 0.89 cluster analysis showed that 21 varieties of mulberry could be grouped into 6 distinct clusters. The results are helpful for germ plasm conservation, utilization and management for breeding of mulberry in the future [20]. Morphological diversity on fruits characteristics were studied among some selected mulberry genotypes from Turkey because Turkey has important mulberry genetic resources and mulberry tree is used only for fruits production not for sericulture, purposes some selected morphological fruit characteristics such as seed formation, fruit weight, TSS, TA, juice yield, pH of 34 selected genotypes found together in Turkey. The results showed that there were big differences among genotypes in terms of the most of the fruit characteristics. Fruit weight varied from 0.66 to 3.07g. TSS varied from 17.33% to 30.67% and TA varied from 0.06% to 1.62%, pH varied from 2.19 to 5.86 respectively [3]. Some morphological and agronomical characterization of native black mulberry (*M, nigra L.*) were studied in sutauler Turkey (Fruit diameter, Fruit length, fruit coloring, Fruit weight, TSS, pH, TA, vitamin C in order to identify with respect to some fruit and trees characters for conserving as a genetic resource for further breeding efforts especially variety improvement. The results showed that vitamin C contains were between 2.68 to 9.99 µg/g. TAc between 1.01 to 1.79%. TSS ranged from 13.91 to 18.36% [14].

Some phonological and pomological traits of mulberry crown in Turkey were studied in order to select the best mulberry genotypes for horticultural and ornamental uses (Fruit weight, pH, sugar content, TSS, water content, TA) of 25 selected mulberry genotypes were found as 1.38 to 3.08g, 5.6 to 7.4, 8.73 to 12.30, 15.79 to 19.71% and 76 to 83%, 0.16 to 0.26% respectively.

At the end of this study some promising mulberry genotypes were determined for horticultural and ornamental uses. Mulberry fruits contain Little sucrose but high amount of reduced sugars and the proportion of glucose to fructose is important. white mulberry had the highest total sugars content compared to black and red ones, therefore white mulberries can be important as raw materials in processing technology. Total acidity as malic acid TA% ranged from 0.2 – 2.5% [21]. In average of the sugar content is about 12%, but in some varieties it's more than 20 percent [22]. Biochemical constituents of different parts of mulberry genotypes were studied, so the results indicated that (AR-12) mulberry variety has recorded highest biochemical constituents. The carbohydrate content in mulberry fruit of Turkey region is 20.4%. Difference in the sugars content amongst cultivars has also been reported by other scientists, however values noted in present study were about those scientists. Another research reported total sugars content in mulberry fruits grown in Pakistan region ranged between 21.16 to 34.77% while it ranged between 0.37 mg/ gm to 0.65 mg/gm according to [4]. Mulberry is rich in alkaloids, polyphenols, flavonoids and anthocyanins, which have been suggested to be responsible for health benefits [4]. The chemical composition of white (*M. alba*) red (*M. rubra)* and black (*M. nigra*) mulberry fruits grown in turkey was studied;*M. alba* had the highest total fat content 1.1% Followed by *M. nigra* 0.95% and *M rubra* 0.85% respectively. the major Fatty acids in mulberry fruits were linoleic acid 54.2% palmitic acids 19.8% and oleic acid 8.91% respectively. The TSS content of mulberry species varied between 15.9% (*M. rubra L.*) and 20.4% (*alba*), Acidity between 0.25% (*alba*) and 1.90% (*nigra*) pH between 3.52 (*nigra*) and 5.60 (*alba*) and ascorbic acid 19.4 mg/ 100 g (*rubra*) and 22.4 mg/ 100 g (*alba*) respectively. Mineral compositions of the mulberry species were 0.83% N, 235 mg/ 100 g P, 1141 mg/ 100 g K, 139 mg / 100 g Ca, 109 mg/ 100 g Mg, 60 mg/ 100 g Na, 4.3 mg/ 100 g Fe, 0.4 mg/ 100 g cu, 4.0 mg/ 100 g N and 3.1 mg/ 100 g Zn respectively [7]. Bright black (*M. nigra*) and purple mulberry (*M. rubra*) are Particularly desirable fruits in Turkey, More recently the interest in these bright black and purple mulberry fruits has also increased, because of the popularization of healthy properties of these fruits, the study was carried out in 2008 aiming to determine the antioxidant activity, total phenolic, total anthocyanin, mineral, soluble solid, vitamin C, and total acid content of four black and four purple mulberry genotypes grown in Turkey. The results showed that black mulberry genotypes have a higher bioactive content than purple mulberry genotypes were 20149 µg of gallic acid equivalent GAE Per gram and 719 µg of cyaniding 3- glucoside equivalent per gram of fresh mass. In purple mulberry these values were for GAE 1690 µg/g and for cy-3-glu 109 µg/ g on fresh mass basis the TSS, Vc and TA of black and purple mulberry genotypes. TSS in genotypes varied from 16.95 to 18.4% in black. In red Mulberries, it ranged from 14.87% to 15.11% previous studies had shown that purple mulberry had lower TSS. The average of Vc content was 20.79 mg/100 g (black) to 18.87 (purple) mg/ 100 ml respectively. Total acidity of black mulberry was between 1.64 and 1.97% while in purple mulberry 0.96- 1.1%. it can be said that purple mulberry has lower acidity compared to black mulberry [23].Physicochemical properties (total soluble solid contents, pH, Titratable acidity, vitamin C, antioxidant activity, total phenolic and total anthocyanins of black mulberry fruits grow in Turkey were investigated. the TSS content of black mulberry varies between 15.65% and 22.1%. TA between 1.45 % to 1.185%, pH between 3.65 to 4.12, Ascorbic acid in the range from 18.40 to 23.67 mg/100 g Fresh weight. The results clearly indicate the difference between the phenotypes used grown in the same conditions [24]. Sugars (glucose and Fructose), organic acids (citric acid, tartaric acid, oxalic acid, malic acid, succinic acid and Fumaric acid), vitamin C, phenolic compounds and antioxidant capacity were determined in fruits of wild black berry. Black and white mulberries from southern Bulgaria Malic acid was the predominate organic acid for black and white mulberries citric and malic acids were represented with the highest content in black berries, the highest fructose concentration was observed in black berries 16.187 g/100 g, Black mulberries showed the highest antioxidant activity 12.230 µ mol TE/g Followed by white mulberries. The results illustrated significant phytochemical profiles of the studied berries which could contribute to the medical industry and provide valuable genetic resources for breeding programs. vitamin C content in black berries was 13.33 mg/100 g. Blackberry fructose content 16.18 g/100 g was higher than that in wild black and white mulberries [1]. The fresh juice of black berries was tested for antimicrobial various pathogenic, microorganisms, total antioxidant contents, total phenolic contents, total anthocyanins, trace minerals, total acid contents, total solids and ascorbic acid content were also evaluated. The results showed good antimicrobial activity. the black mulberry juice was rich in ascorbic acid 23.45 mg/100 g had low overall acid content 1.60% and had 19 % total soluble solids. the average total anthocyanins and total phenolic contents of black mulberry juice were 769 µg/ g of cyaniding -3-glucoside [8].

physicochemical characteristics of black mulberry genotypes from Northeast Anatolia region of Turkey were studied. some selected physicochemical properties (antioxidant activity, Ascorbic acid, fatty acids, fruit color, fruit juice yield fruit weight, organic acids, pH, total phenolic and TSS of 5 black mulberry genotypes

grown in Turkey. Fatty acids in fruits were determined by using chromatography, Total phenolic content was observed in black mulberry fruits between 1943 and 2237 mg gallic acid equivalents / 100 g fresh mass. The vitamin c content of genotypes varied between 14.9-18.7 mg/100 ml. The major fatty acids in all mulberry fruits were linoleic acid 53.57 – 64.41% and palmitic acid 11.36 – 16.41%. Antioxidant activity of black mulberry genotypes was found between 63% to 76% which lower than standard BHA and BHT. Regarding organic acid content mallic acid was the most predominant with rang of 123 – 218 mg/g followed by citric acid 21 – 41 mg/g. The results of the study are helpful for attempting crop improvement in black mulberry for bringing to cultivation [15].

II. MATERIALS AND METHODS

The presented study was conducted in Tartus, Syria in 6 locations, ranging from a height of between (0- 500 m). Total 33 mulberry trees were studied as phenotypes, white and black mulberries we presented in these locations.

A. Collection and Preparation of Black and White Mulberries Fruit Samples:

Mulberry fruits were harvested from *M. alba* and *M. nigra* phenotypes 22 of these types belong to *M. alba* (A-1, H-7, B-1, B-5, B-7, B-8, B-9, B-10, B-11, KH-2, KH-5, KH-8, D-1, D-3, DA-4, D-5, D-6, D-7, M-1, M-2, M-5) and 11 belong to *M. nigra* (A-2, H-5, B-2, KH-3, KH-4, KH-9, DN-4, D-8, M-4, M-6) these phenotypes were originated from seeds and were selected according to study the morphological diversity. All berries picked in ripe stage and harvest time according to ripening period for each phenotype during the summer of 2014 and 2015. The berries were selected according to uniformity of shape and color.The fruits were then transported to laboratory for analysis in the General Commission for Scientific Agriculture Research GCSAR. The chemical analysis of phenotypes fruits is the content of (sugars, ascorbic acid, total acidity, TSS) in order to evaluate and compare the phenotypes (white and black) in their contents and select the best phenotype to cultivation and genetic breeding for mulberry tree.

B. Determination of Sugars (Glucose, Fructose, Sucrose) by HPLC:

The sugar composition in the berries was identified based on fruit juice standards.In sugar analysis HPLC (high-performance liquid chromatography) was used, samples required extensive treatment. The samples were prepared in these following ways: 5 g of mulberry fruits juice were taken and put them in titration crucible (flask) then mixed with 20 – 30 ml deionised water and 1 ml of carrez solution (1 g of K4Fe(CN)6.3 H_2o) and 100 ml deionised water in flask and 1 ml of Carrez 2 (30 g of ZN(OAC)2H_2o)and deionised water till 100 ml in flask. After that mixed the components for 1 minute then the analytical samples were diluted with deionised water and filtered through filter paper then we shut out the first 10 ml after that the sample were refilterd through micro filter 0.45µm and washed the syringe by deionised water then by standard solution 2-3 times then injected the sample directly after filtration. Combination of water or various organic liquid the most common are methanol and acetonitrile. when the sample is dissolved in the eluent good separation can be expected even for the sample whose peaks appear near the peaks of the standerd. Finally, we have got many gradients with peaks which showed us the sort of sugars, we record the areas, height, time of every gradient and followed the formula to determine the percentage of sugars %.

- The conc. of standerd is 4 ml g/ ml.
- The separate column for sugars NH_2.
-The eluent: acetonitrile and deionised water.
- the flow Rate: 0.85 ml / m.

$$X = \frac{A1}{A2} * C * \frac{100}{W} + \frac{100}{1000}$$

X: the cone of sugar %.
A1: the area of sample gradient cm^2.
A2: the area of standerd gradient cm^2.
C: the cone of standerd mg/g.
W: the sample weight g.

C. Determination of Ascorbic Acid (Vitamin C) in Mulberry Juice:

In this study titration method was used to determine the concentration of vitamin C in freshly prepared and packaged fruit juice samples. After pureeing and filtering the fruit juices samples, the juice was used for vitamin C analysis. Mulberry juice, Ascorbic acid standard solution Metaphosphoric acid, 2.6 Dichloro – Indophenol (DCIP) solution 250 ml Beaker, 25 ml measuring cylinder calibrated burette and chlorophorm $CHCl_3$ for black mulberry juice in order to determine the endpoint of titration. The endpoint is the point at which the titration is complete as determined by the color change of the indicator. DCIP solution changes to pink color when contacts with the ascorbic acid solution and it becomes colorless after shaking well. The end point is reached once a drop of DCIP solution is added and distinct light rose, pink color persists in the solution even after mixing thoroughly. Record the volume of DCIP solution added and Estimate the reading of burette up to two decimal

places. the following formula was used to determine the concentration of vitamin C [25]:

$$X = \frac{(V_1 - V_2) * R * 100 * 250}{W * 50 * V_3}$$

X: conc of Vc (mg/100g).
V_1: The milliliters of DCTP used to titrate the sample.
V_2: DCIP ml used to titrate standard.
R: Titer of DCIP
W: Sample weight g.
V_3: milliliters of mulberry juice.

$$R = \frac{w * V_1}{V_2 * V_3}$$

R: Titer of DCIP
W: weight of pure vitamin C g.
V_1: The ml of pure Vc.
V_2: DCIP ml used to titrated the standard.
V_3: The volume of flask ml.

D. *Determination of the Titratable Acidity (TAc)% in Mulberry Juice:*

Titratable acidity of mulberry was expressed as citric acid % (TAc). To determine the total acidity in mulberry in mulberry fruits juice, a known amount of mulberry juice was added to beaker (10 ml) then additional water (distilled water) was added If the juice is rather dark The amount of water isn't critical. Adding water doesn't change the total amount of acid in our samples however we did not add more water than 5 times the amount of mulberry fruits juice, then about 5 drops of phenolphthalein was added, it is an indicator, that is clear when it is in a solution that is acidic, but will change to purplish color when that solution becomes neutral to basic.

Then we started adding NAOH (0.1 N) (Normal sodium Hydroxide) until the solution started to turn pinkish and stayed pinkish then we noted the amount of NAOH used for the titration. The following formula was used to determine the TA of mulberry juice TAc [26].

$$X = \frac{T.V_1.K.100}{V_2}$$

X: Total acidity %.
V_1: The millimeters of NAOH ml.
V_2: The millimeters of mulberry fruits juice.
T: 0.1 N.
K: (0.0064 for citric acid).

E. *Determination of Total Soluble Solids in Mulberry Fruits (TSS):*

Total Solids that are dissolved within a substance. A common total soluble solid is sugar. The technique of measuring the concentration of total soluble solids is called refractometer which is used extensively in the food industry. TSS were determined by extracting and mixing one drop of juice from each fruit into a digital refractometer (Model MA881) at 20°C which had temperature compensation Capability.

F. *Statistical Analysis:*

The experiment was a completely randomized design. One-way analysis of variance (ANOVA) was used for assessment of the differences in the chemical parameters between white and black mulberries. Mean separation was performed by Duncan's. Statistical evaluation was made via GenStat (release 12.1) at 5% significance level.

III. RESULTS

A. *Sugars (glucose, fructose, sucrose) in Mulberry Fruits:*

In white mulberry phenotypes the fructose concentration varied from 0.05% (KH-5) to 7.3% (D-6) with an average of 11.78%, The glucose concentration phenotypes ranged from 0.72% (B-7) to 10.7% (KH-8) with average 4.53%, the sucrose concentration varied from 0.13% (D-7) to 1.47% (DA-4) with average of 0.48%. while in black mulberry phenotypes the fructose concentration varied from 2.25% (KH-3) to 11.01% (KH-9) with an average of 4.91%, The glucose concentration ranged from 2.21% (KH-4) to 14.69% (KH-9) with an average 6.32%, the sucrose concentration varied from 0.03% (DN-4) to 1.47% (KH-1) with average 1.2%.

The mulberry phenotypes had glucose and fructose regardless of the species (black and white). The mulberry juice had the highest amount of glucose compared to fructose (Fig 1), mulberry juice contained a little amount of sucrose in mulberry fruits (10 phenotypes). As it seen in (fig 2) the total sugars content (glucose+ fructose+ sucrose) among white mulberry phenotypes were ranked as between 3.84% (B – 5) and 15.64% (KH- 8) with average 8.56%, while in black mulberry phenotypes the total sugars content (glucose+ fructose+ sucrose) were varied from 4.53% (KH-4) to 25.7% (KH-1) with average 11.4%. [23] reported that mulberry genotypes contained a little amount of sucrose and highest amount of glucose comparing to black mulberry genotypes. one-way analysis of variance (ANOVA) with multiple range significant difference (LSD 5%= 6,233). The statistical analysis results revealed that the phenotype (KH–9) showed high significant difference among 33 phenotypes followed by (KH –1) Except (M-7, KH-8,

D-6, M-6, D-1, D-8) which showed no significant difference. The Result of statistical analysis showed no significant difference between the 21 phenotypes.

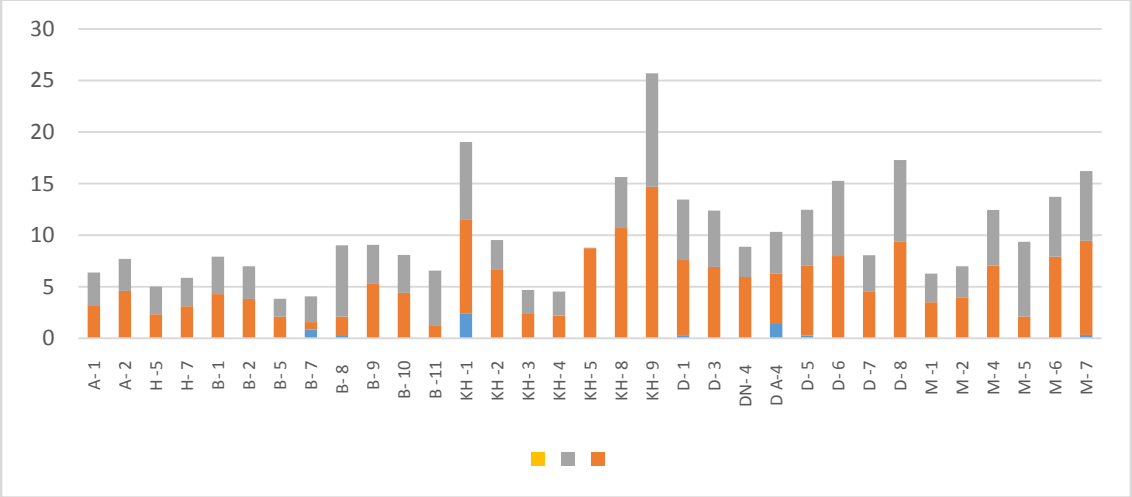

Fig 1. Percentage of Fructose, Glucose and Sucrose in White and Black Mulberries Phenotypes Fruits.

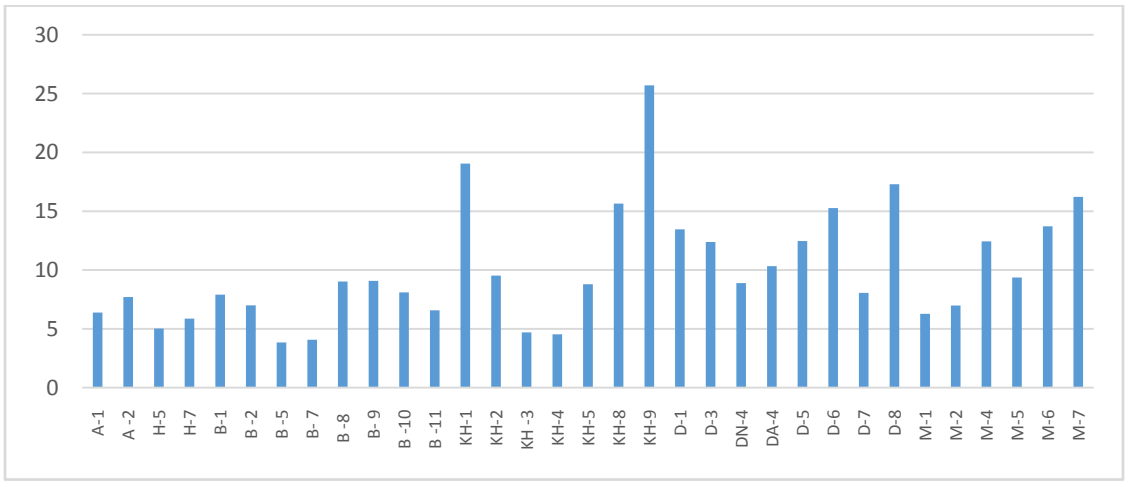

Fig 2. Percentage of Total Sugars (fructose+ glucose+ sucrose) in White and Black Mulberries Phenotypes Fruits.

B. Ascorbic Acid content in Mulberry Fruits Juice (mg/100g):

The content of ascorbic acid of mulberry phenotypes in fresh white mulberry juice was found to be from 2 mg/100 g (D-7) to 16 mg/100 g (D-6) with average 3.90 mg/100 g. while in black mulberry varied from 3 mg/100g (KH-9) to 42 mg/100 g (A-2) with average 21.27 mg/100 g. In particular, the highest ascorbic acid content was found in *M. nigra* compared to *M. alba* (fig 3). In the earlier work conducted on the northeast Anatolia region of Turkey reported that vitamin C contents of black mulberry cultivars varied from 14.9 to 18.8 mg/100 ml. [23] reported that the average of vitamin C content in black and purple mulberries as 20.79 and 18.87 mg per 100 ml extract respectively. [27] reported that vitamin C content in black and purple mulberries was 16.6 and 11.9 mg/100 ml extract. [15] reported that vitamin C content of *M alba* was (17.8 mg/ 100 ml) followed by *M. nigra* (16.6 mg/ 100 ml) and *M. rubra* (11.9 mg/ 100 ml). the results obtained by [8] reported 23 mg/100 ml of ascorbic acid. [22] reported the ascorbic acid content ranged between 18.40 to 23.76 mg/100 g. the statistical analysis results revealed that the phenotypes (KH-9, A-

2) belong to black mulberry showed a high significant difference in ascorbic acid content except (KH-3, M-6) *nigra*. (M-6) surpassed with a high significant to all phenotypes, the statistical analysis results showed that there was no significant difference between (H-5 and M-4). Finally, there wasn't a significant difference between the 25 mulberry phenotypes.

The variation of TAc in white mulberry fruits juice was ranged from 0.06% (D-6) to 0.375% (H-7, B-1) with average 0.19%. while in black mulberry fruits juice was between 0.38% (B-2) to 2.21% (KH-3) with average 1.16% (fig 4) which is a little lower than those reported for black mulberry genotypes was varied between 1.64 - 1.97%, whereas these values were between 0.96 – 1.10% in purple mulberry genotypes. ([15]; [8]) reported 1.6% of total acidity.

C. Total acidity (TAc%) in mulberry fruits:

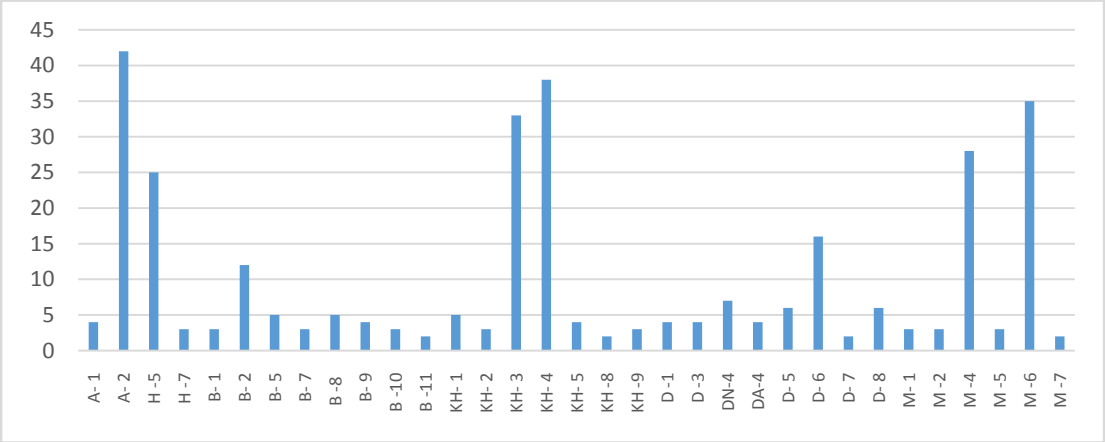

Fig 3. Ascorbic Acid Content in White and Black Mulberries Phenotypes Fruits.

[24] reported that the titratable acidity ranged between 1.45 to 1.85%. As it seen black mulberry had the highest amount of total acidity comparing to white mulberry. The statistical analysis results revealed that the black mulberry phenotypes showed a high significant difference (except B-2) to all white mulberry types. there was a high significant difference in black mulberry phenotypes as followed (KH-3, KH-4, respectively, there isn't significant difference between (DN-4, KH-9).

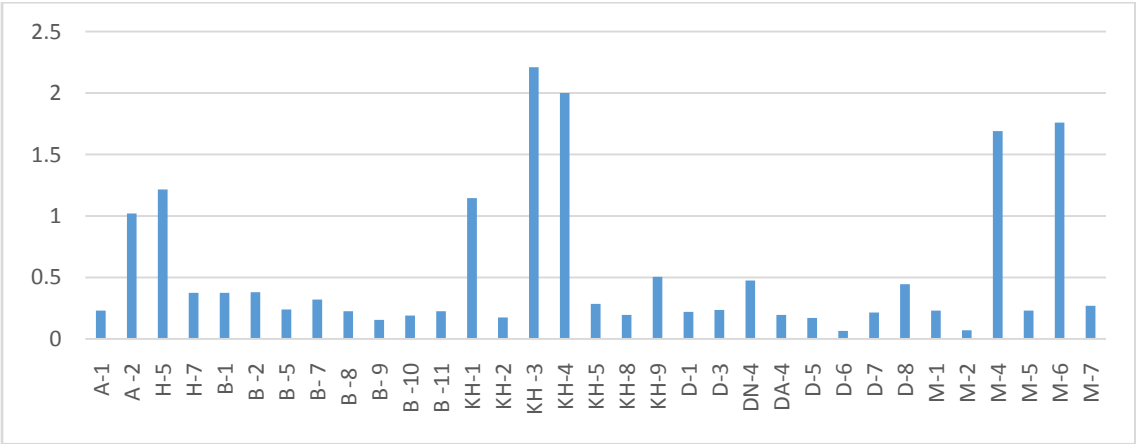

Fig 4. Total Acidity % In White And Black Mulberries Phenotypes Fruits.

D. Total soluble solid % in Mulberry Fruits Juice:

The TSS content in white mulberry phenotypes varied from 5.6% (M-2) to 15.6% (M-5) with average 11.57%. while in black mulberry was between 8% (KH-3) to 19.45% (KH-9) with average 11.94% (fig 5). [8] reported that TSS in black mulberry juices averaged 19.4%. [14] reported 13.11 to 16.23% total soluble solids in black mulberry genotypes. [23] also reported that TSS in mulberry grow in different agro-ecological regions ranges from 15 to 31%. [24] showed that TSS of black mulberry varied from 15.65 to 22.1%.

The statistical analysis results (LSD= 0.446) revealed that the phenotype (KH-3) showed the highest TSS content with a high significant difference comparing to the total phenotypes while (KH-4) had a high significant difference compared to all phenotypes except (M-4 and M-6) which didn't have any significant difference. (KH-1, H-5, A-2) surpassed to 26 phenotypes with a high significant difference.

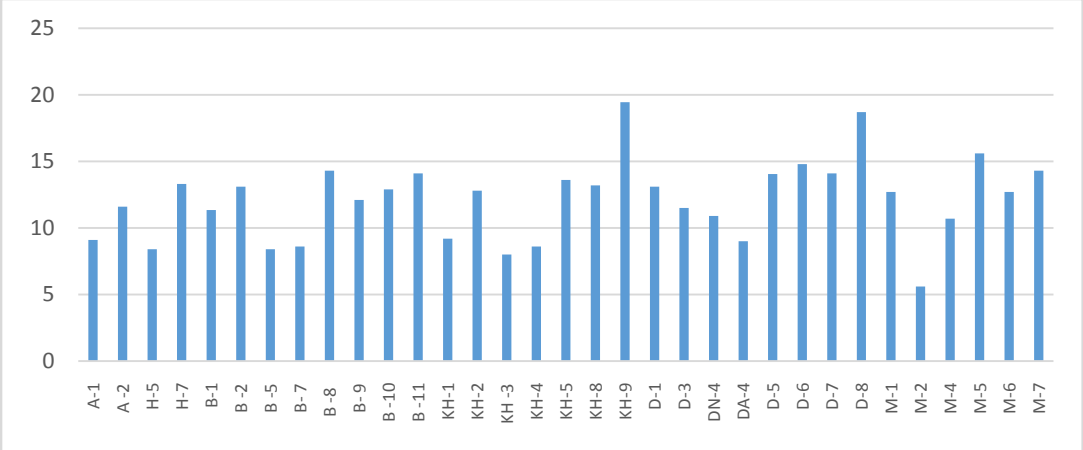

Fig 2. Total Soluble Solid% in White and Black Mulberries Phenotypes Fruits.

IV DISCUSSION

The results clearly indicate the differences between white and black mulberry phenotypes. The differences between them may be a reflection of the chemical differences between the mulberry phenotypes. The white and black mulberries phenotypes have a good vitamin C, TSS, TAc, sugars (glucose and fructose) content. These phenotypes can be used for future breading activities**.** The results showed that the mulberry types fruits had the highest amount of monosaccharides (Glucose, Fructose) regardless of the species while the phenotypes had a little amount of sucrose (10 phenotypes) most of them belong to white mulberry. The data about chemical parameters in white and black mulberry phenotypes available so far are still not understood well. Therefor more studies should be performed. In this research the glucose and fructose sugar content were shown to be higher when compared to those reports by [1]. [(8]; [17]) reported that *Morus nigra* had the highest amount of TAc, vitamin C and anthocyanins comparing to *Morus alba*, therefor black mulberry has the best good combination of TSS and TA so it's been also preferred as fresh fruits and it has been using to treat mouth lesions along time as well. while white mulberry can be important as raw materials in processing technology. There was not a clear variation in TSS content while there was a variation among phenotypes that belong to one species (*alba or nigra*). The variation of fruit weight, TSS, pH in black mulberry fruits could be result of heterozygote nature of seed propagated genotypes and the effect of different environmental conditions where genotypes grown [15].

We can say that the difference of mulberry types in terms of above characteristics is supposed to it genetic derivation as well because all plants found approximately in the same age and ecological, it's previously reported that plant genotype effects the content of berry group fruits.

Finally, it can be said that mulberry fruits are a valuable horticultural nutrient composition. Certain growing condition and cultural management techniques affecting

the nutritional value of mulberry species will be the subject of further research project.

Table 1. Fructose, Glucose, Sucrose, Vitamin C, Titratable acidity, TSS Composition of White Mulberry Phenotypes.

Phenotype	Fructose	glucose	Sucrose	Total sugars	vitamin C	Titratable acidity	TSS
A-1	3.17gh	3.21h	0.00e	6.37 h	4.000 e	9.10 a	0.2300 ef
H-7	2.76hi	3.10h	0.00e	5.85 f	3.000 e	13.30 a	0.3750 def
B-1	3.62fg	4.29g	0.00e	7.91 I	3.000 e	11.35 a	0.3750 def
B-5	1.75k	1.99ij	0.10 e	3.83 a	5.000 de	8.40 a	0.2400 ef
B-7	2.51hig	0.72k	0.84 c	4.06 b	3.000 e	8.60 a	0.3200 def
B-8	6.93c	1.78ij	0.31 de	9.02 p	5.000 de	14.30 a	0.2250 ef
B-9	3.80fg	5.27f	0.00e	9.07 p	4.000 e	12.10 a	0.1550 f
B-10	3.68fg	4.41g	0.00e	8.09 m	3.000 e	12.90 a	0.1900 ef
B-11	5.38de	1.19k	0.00e	6.57 i	2.000 e	14.10 a	0.2250 ef
KH-2	2.91hi	6.62e	0.00e	9.52 r	3.000 e	12.80 a	0.1750 ef
KH-5	0.05l	8.74cd	0.00e	8.79 n	4.000 e	13.60 a	0.2850 def
KH-8	4.94de	10.70b	0.00e	15.64 x	2.000 e	13.20 a	0.1950 ef
D-1	5.86 d	7.29de	0.30de	13.45 u	4.000 e	13.10 a	0.2200 ef
D-3	5.46de	6.92e	0.00e	12.39 t	4.000 e	11.50 a	0.2350 ef
DA-4	4.07f	4.78fg	1.47b	10.32 s	4.000 e	9.00 a	0.1950 ef
D-5	5.39de	6.80e	0.27e	12.45 t	6.000 de	14.05 a	0.1700 f
D-6	7.30b	7.79cd	0.00e	15.27 w	16.000bcde	14.80 a	0.0655 f
D-7	3.49fg	4.44g	0.00e	8.05 m	2.000 e	14.10 a	0.2150 ef
M-1	2.78hi	3.49gh	0.00e	6.28 g	3.000 e	12.70 a	0.2300 ef
M-2	3.01hi	3.97gh	0.00e	6.97 j	3.000 e	5.60 a	0.1400 f
M-5	7.25b	7.05e	0.00e	9.36 q	3.000 e	15.60 a	0.2300 ef

Table 2. Fructose, Glucose, Sucrose, Vitamin C, Titratable Acidity, TSS Composition of Black Mulberry Phenotypes.

Phenotype	fructose	glucose	Sucrose	vitamin C	TA	TSS
A-2	3.10hi	4.60g	0.00e	42.000a	11.60 a	1.0200 cdef
H-5	3.17gh	2.33hi	0.00e	25.00 abcd	8.40 a	1.2150 bcd
B-2	3.17gh	3.82gh	0.00e	12.000 cde	13.10 a	0.3800 def
KH-1	7.50b	9.18c	2.37a	5.000 de	9.20 a	1.1450 bcde
KH-3	2.25g	2.44h	0.00e	33.000 ab	8.00 a	2.2100 a
KH-4	2.32g	2.21hi	0.00e	38.000 a	8.60 a	2.0000 ab
KH-9	11.01a	14.69a	0.00e	3.000 e	19.45 a	0.5050 def
D4-N	2.94hi	5.91f	0.03e	7.000 de	10.90 a	0.4750 def
D-8	7.50b	9.40c	0.00e	6.000 de	18.70 a	0.4450 def
M-4	5.39de	7.05e	0.00e	28.000 abc	10.70 a	1.6900 abc
M-6	5.81d	7.91cd	0.00e	35.000 ab	12.70 a	1.7600 abc

***Same letters Within Each Row Indicate Significant differences between means ($p < 0.05$).**

REFERENCES

[1] M.Akin, S. Eyduran, S. Ercisli, V. K. Toteva, E. Eyduran. "phytochemical profiles of wild black berries, black and white mulberries from southern Bulgaria". Biotechnology and biotechnology equipment. 30. 5. 889- 906. 2016.

[2] P.P. Srivastava, K. Vijayan, A. K. Awasthi, B. Saratchandra. "Genetic analysis of Morus alba through RAPD and ISSR markers". India journal of biotechnology.3. 527-532. 2004.

[3] K.U. Yilmaz, Y. Zengin, S. Ercisli, M. N. Demirtas, T. Kan, A. R. Nazli. "Morphological diversity on fruit among some selected mulberry genotypes from Turkey". The journal of animal and plant sciences.22(1). 211-214. 2012.

[4] R.K. Venkatesh, S. Chauhan. "Biochemical constituents of different parts of mulberry genotypes". International journal of agriculture sciences.3(2). 90-96.2011.

[5] B K. Singhal, M. A. Khan, A. Dhar, F. M. Baqual, B. B. Bindroo. "Approaches to industrial exploitation of mulberry (Mulberry spp) fruits".18. 83-99. 2010.

[6] I.Doymaz. "Pretreatment effect on sun drying of mulberry fruits (Morus alba) ". journal of food engineering.65. 205-209. 2004.

[7] S.ERCISLI, E. ORHAN. "Chemical composition of white (Morusalba), red (M. rubra), and black (M. nigra) mulberry fruits". foodchemistry.103.1380-1384.2007.

[8] N.Khalid, S. Fawad, I. Ahmed. "Antimicrobial activity, phytochemical profile and trace minerals of black mulberry (Morus nigra L.) fresh juice". Medical plants conservation and sustainable use. 43.91-96.2011.
[9] H.W. Freeman. "Temperate-zone pomology". freeman and company sanfransisco.428. 1978.
[10] Y.Huo. "Mulberry cultivation and utilization in china mulberry for animal production". FAO animal production and health paper.147. 11-44. 2002.
[11] G.Martin, F. Reyes, I. Hernandez, M. Milera. " Agronomic studies with mulberry in Cuba mulberry for animal production". FAO animal production and health paper.2002.
[12] K.R. DATTA. " Mulberry cultivation and utilization in India mulberry for or animal production. FAO animal production and health paper.147. 45-62. 2002.
[13] J.CAMPHELL. "A mess of Muddled Mulberries". Bluegrass. 2014.
[14] F.Koyuncu. "Morphological and agronomical characterization of black mulberry (Morus nigra L.) insutculer, Turkey". 2004.
[15] S.Ercisli, E. Orhan. "Some physico-chemical characteristics of black mulberry (Morus nigra. L) genotypes from northeast Anatolia region of Turkey". scirntia horticulturae.116. 41-46.2008.
[16] F.Koyuncu, E. Senel. "Rooting of black mulberry (Morus nigra L.) hard wood cuttings". Journal of fruits and ornamental plant research.11. 53-57. 2003.
[17] S.Dharmananda. Fruit as medicine, Morus fruit (mulberry).ph. D. director. institute of traditional medicine, Portland, Oregon. 2014.
[18] Fnaec. " Flora of north America editorial committee". flora of north America north to Mexico.3. 390-392. 1997.
[19] Lw. Griggs, B. Lwakri. "Development of seeded and parthenocarpic fruits in mulberry (Morus rubra L.).journal of horticulture science.48. 83-97.1973.
[20] N.Bootprom, P. Songsri, N. Kongpun, A. K. Sabrao. "Genetic diversity based on horticultural traits and total soluble solid content in mulberry (Morus alba) varieties". Journal of breeding and genetics. 46 (2). 231-240. 2014.
[21] I.Cam, N. Turkoglu. "Studies on some phonological and pomological traits of Mulberry grown in Edremit and Gevas region. jagric.sci.14(2).127-131. 2004.
[22] H.Machii, A. Koyana, H. Yamanouchi. "Mulberry breeding cultivation and utilization in Japan". National institute of sericulture and entomological science.1999.
[23] S.Ercisli, M. Tosun, V. B. Duralija, M. Sengul. " Phytochemical content of some black (Morus nigra L.) and purple (Morus rubra L.) Mulberry genotypes. Food technol. Biotechnol. 48(1).102-106. 2010.
[24] V.Okatan, M. Polate, M. Askin. "Some physico-chemical characteristics of black mulberry (Morus nigra L.) in Bitlis. Series B, Horticulture. 2286-1580.27-30. 2016.
[25] J.I.Geon, G. W. Ikins. " Analyzing food for nutrition labeling and hazardous contaminants". M. Dekker, New York. 363-421. 1995.
[26] J A. Ruck."chemical methods for analysis of fruit and vegetable products". Department of agriculture Sumner land research station. Canada. 27-30. 1969.
[27] H.Lale, R. Ozcagiram. " A study on pomological and phonological and fruits quality characteristics of mulberry (Morussp) species", Derim.13.177