Evaluation of elite mulberry genotypes for fruit yield and biochemical compositions

Abstract:

The study was conducted to find the best mulberry genotypes for fruit purpose, eight elite mulberry genotypes were evaluated forfruit and biochemical traits at Department of Sericulture, GKVK, Bengaluru.The saplings of these genotypes were produced and planted on 90th day in the main field with a spacing of 5×3 feet in RCBD design with three replications. The performance of elite genotypeswas evaluated for fruit traits.In case of fruit traits, ME-0006 recorded superior performance in fruit length (3.16 cm), fruit width (2.01 cm), fruit weight (3.02 cm) and fruit yield per plant (166.55 g). Followed by ME-0220 produces higher number of fruits per plant (77.32). Biochemical analysis of fruits indicated that ME-0220 recorded higher TSS (19.71^{o}B), carbohydrate (166.49 mg/g), anthocyanin (38.41 mg/g) and zinc (mg/100g). ME-0006 recorded higher calcium (153.80 mg/100g). MI-0014 contains higher phosphorus, potassium and magnesium. ME-0086 recorded a higher content of micronutrients and vitamin C (34.17 mg/100g).

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Keywords: Elite mulberry genotypes,Mulberry fruit, Fruit purpose, Biochemical analysis.

Introduction

Mulberry (*Morus* spp.), a perennial woody-deciduous tree belonging to the Moraceae family, is renowned primarily as the primary host plant for silkworms. However, the significance of mulberry extends well beyond its role in sericulture, as it offers notable nutritional and health benefits.The mulberry fruit, a succulent and oval-shaped berry composed of multiple drupes, is a remarkable feature of the tree. These fruits typically measure between 1 to 2 centimeters in length and display a wide spectrum of colors. Anthocyanins are a class of notable water-soluble pigments that belong to a larger group of compounds called flavonoidswhich are responsible for the vibrant red, purple, and blue colours seen in many fruits, flowers and vegetables (Ibrahim *et al.*, 2018).The diversity in color is indicative of the rich variety within the mulberry genus, each species possessing unique traits.

Mulberry, like other berry fruits, contains high amounts of anthocyanins, flavonoids and other phenolics. Extracts of mulberry fruit have potent antioxidant activity (Zhang *et al.*, 2008), hypolipidemic effect (Liu *et al.*, 2009), macrophage activating effect (Liu *et al*., 2012), neuroprotective activity (Kim *et al.*, 2010) and antitumor activity (Huang *et al.*, 2013). The presence of phenolics in mulberry fruit is linked to these bioactivities.

The levels of phytonutrients in mulberry fruits can vary significantly among cultivars. Several factors contribute to these variations, including the genetic makeup of the cultivar (genotype), the conditions in which it is grown and the stressors it encounters during its development. Phytonutrients encompass a range of bioactive compounds, such as anthocyanins, flavonoids, vitamins, minerals and dietary fiber, all of which play a vital role in determining the fruit's nutritional value and its potential health benefits. The presence and concentration of these compounds can differ substantially between different mulberry cultivars.

Given the significance of mulberry fruits in terms of their nutritional and health-promoting properties, the selection of cultivars that exhibit high fruit yield, excellent fruit quality and superior nutritional profiles becomes of paramount importance. Identifying mulberry genotypes that can optimize both fruit yield and nutritional content is a crucial objective in harnessing the full potential of this remarkable fruit. This study aims to assess the fruit attributes of selected elite mulberry genotypes in light of this background. By investigating these genotypes, the study sheds light on their potential for higher fruit yields, improved fruit quality and superior nutritional profiles.

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Material and Methods

The experimental material for the present study comprised eight elite mulberry genotypes for fruit purposes, which were selected from the germplasm unit maintained at the Department of Sericulture, UAS, GKVK, Bengaluru. The saplings of these genotypes were produced and planted on 90th day in the main field with a spacing of 5×3 feet in RCBD design with three replications. At 150th day plants were pruned at three feet height from the ground level. The performance of each elite genotype was evaluated by selecting five competitive plants in each replication for fruit traits.

The process began with hand-picking of mulberry fruits to ensure quality. These selected fruits were shielded in polythene covers to prevent external influences. However, fruit availability varied among different genotypes due to their unique growth and characteristics.To preserve sample integrity, the fruits were initially stored at -18°C until enough were collected for analysis. Subsequently, a two-fold categorization was done for further examination.

1. Wet basis analysis: The stored fruits were kept at a constant temperature of -18°C to preserve their natural state, important for assessing certain biochemical parameters.

2. Dry-powder analysis: This involved additional steps to prepare the samples. Initially, the stored fruits were air-dried, followed by further dehydration in a 60°C hot-air oven for 44 to 48 hours to remove remaining moisture. After drying, the fruits were transformed into a powdered form and stored in polythene covers for analysis.

The parameters were analyzed by randomized complete block design and completely random design (Sundarraj *et al.*, 1972). The mean values of the experiments were compared by using Duncan's Multiple Range Test (DMRT) (Duncan, 1955).

Table 1: List of elite mulberry genotypes and their accession number used in the study

Treatments	Genotypes/scientific name	Accession number	National accession number
T_1	*Morus indica*	MI-0516	IC-314082
T_2	*M. cathayana*	ME-0018	EC-493775
T_3	*M. latifolia*	ME-0067	EC-493765
T_4	*M. macroura*	ME-0220	EC-493947
T_5	*M. alba*	ME-0086	EC-493843
T_6	*M. multicaulis*	ME-0006	EC-493763
T_7	*M. indica* (S-34)	MI-0160	IC-313779
T_8	*M. indica* (M-5)- Standard check	MI-0014	IC-313679

Result and discussion

Fruit length (cm)

The genotype ME-0006 recorded significantlylonger fruit length of 3.16cm followed by MI-0516 (3.12 cm) and theshorter fruit length was recorded by ME-0018 (1.55 cm) (Table 2).The results of the present study were consistent with the findings of Chikkalingaiah*et al.* (2009) evaluated 35 mulberry accessions for their fruit characteristics. The length of the fruit ranges from 0.90cm (Surat local) to 3.0cm (Karanahalli). Similarly, the fruit length of all three species *viz., Morus alba, M. nigra and M. rubra* have been studied by Erarslan*et al.* (2021) in the range of 1.5 to 2.5 cm.Genotypes like ME-0006and MI-0516 consistently displayed longer fruits, suggesting a genetic predisposition to

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enhanced fruit elongation. As a potential reason for the observed disparities, it's worth considering the connection between inflorescence length and subsequent fruit length.

Fruit width (cm)

Among the genotypes fruit width differed significantly, ME-0006 recordedhigher fruit width of 2.00cm followed by MI-0516 (1.84 cm) and the shorter fruit width was recorded by ME-0220 (0.98 cm) (Table 2).The consistent variation in fruit width across growing periods suggests a stable genetic foundation governing this trait. Genotypes like ME-0006 consistently displayed broader fruits of 24.05per centwider than the control genotype, indicating a genetic predisposition to enhanced fruit width. Considering the potential influence of inflorescence width on subsequent fruit width, it's possible that genotypes with broader inflorescences provide more space for fruit development, resulting in broader fruits.

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Fruit weight (g)

The genotype ME-0006 recorded significantly higher fruit weight of 3.02g followed by MI-0516 (2.72 g) and thelower fruit weight was recorded by ME-0018 (1.63 g) (Table 2).The present findings were confirmed by the earlier study by Iqbal*et al.* (2010)reported that four mulberry cultivars *viz*., *Morus nigra*,*M. alba*, *M. rubra*and Kabli Mulberry differed significantly inaverage fruit weight ranging from 2.54 to 3.02 g. Similarly, Chikanna*et al.* (2020) reported the fruit characteristics of five mulberry cultivars. Among all the cultivars MS- 9404 recorded a higher fruit weight (1.891 g).The variations in fruit weight among different mulberry genotypes, each genotype possesses its own genetic traits that influence fruit development, size, and weight. Additionally, environmental conditions, such as temperature, humidity, and nutrient availability, can substantially impact fruit growth.

Number of fruits per plant

Number of fruits per plant were significantly differed among the genotypes (Table 2),ME-0220 recorded higher number of fruits per plant (77.32), followed by ME-0018 (57.07) and lower number of fruits per plant was recorded by ME-0086 (40.90) for both growing periods.The results were supported by Chikanna*et al.* (2020) reported the fruit characteristics of five mulberry cultivars Among all the cultivars MS-9404 recorded a higher total number of fruits per tree (5902).

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4.4.6 Fruit yield per plant (g)

The examination of fruit yield per plant displayed different trends among the various genotypes, providing valuable insights into their productivity (Table 2). The genotype ME-0006 recorded higher fruit yield of 166.55g followed by MI-0516 (134.87 g) and lower fruit yield was recorded by ME-0018 (93.84 g).The present findings were consistent with the study by Singhal *et al.* (2010) conducted a study on a visualization of mulberry and the industrial exploitation of mulberry

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fruits for the global scenario. Among the selected varieties *Morus multicaulis*producesa higher fruit yieldof 10.85kg per tree under Indian climatic conditions.Chikanna*et al*. (2020)reported the fruit characteristics of five mulberry cultivars Among all the cultivars MS-9404 recorded a higher fruit yield per tree (11.021 kg).ME-0006's consistent top performance of 19.95 per cent over the control genotype MI-0014 across both growing periods might be attributed to its genetic predisposition for larger fruit size and optimal utilization of varying environmental conditions.

Biochemical constituents of mulberry fruits of elite genotypes.

pH of the fruit

Among the genotypes examined, ME-0067 exhibited the highest pH value at 4.93 followed by ME-0086 at 4.74 and ME-0018 at 4.69. In contrast, the genotype MI-0516 displayed the lowest pH value at 4.12 (Table 3).These findings were supported by Lee and Hwang (2017) investigated the physiochemical changes in mulberry fruits during seven maturity stages of the ripening phase observing pH within the range of 3.9 to 5.5. Hosseini *et al*. (2018) explored 112 mulberry genotypes and reported pH values ranging from a minimum of 4.22 to a maximum of 5.87.

TSS (Brix)

Among the genotypes evaluated TSS significantly differed (Table 3), ME-0220 exhibited the highest TSS value with 19.71°Brix followed by ME-0018 with 19.47°Brix and MI-0014 with 17.47°Brix. Conversely, the genotype MI-0516 displayed the lowest TSS value with 12.03°Brix.The findings of this study were corroborated byA study on the physicochemical properties of *Morus nigra* (blackmulberry) fruits harvested in the Bitlis province of Turkey by Okatan*et al*. (2016) revealed TSS content varying between 15.65°Brix and 22.1°Brix. Additionally, Hosseini *et al*. (2018) examined 112 mulberry genotypes, observing TSS values ranging from a minimum of 11.20°Brix to a maximum of 24.80°Brix.

Carbohydrate (mg/g)

Among the examined genotypes, ME-0220 recorded notably elevated carbohydrate content at 166.49 mg/g, followed by ME-0006 at 155.43 mg/g and ME-0086 at 149.50 mg/g. Conversely, MI-0160 displayed the lowest carbohydrate content at 130.26 mg/g(Table 3).Genetic variability within mulberry genotypes is a key factor influencing carbohydrate accumulation. Sunlight availability profoundly influences photosynthesis, a pivotal process that drives carbohydrate production. Genotypes such as ME-0220 might have optimized photosynthetic mechanisms that enable them to harness more sunlight, resulting in increased carbohydrate synthesis.

Protein (mg/g)

Among the genotypes under examination, MI-0014 exhibited significantly higher protein content with 14.52 mg/g followed by ME-0086 with 13.94 mg/g and ME-0220 with 13.49 mg/g. In contrast, the genotype ME-0018 recorded lower protein content with 8.84 mg/g(Table 3).The results were consistent with the study by Gungor and Sengul (2008) reported the selected physiochemical properties and total phenolic content of three white mulberry genotypes (*Morus alba* L.) grown in Turkey. protein ranged from 8.21 to 8.94 mg/g fresh fruit basis. Similarly, Huang *et al.* (2013) reviewed the recent advances in mulberry extracts (ME's). The proximate composition of mulberry fruit protein ranged from 9.60 mg/g to 17.31 mg/g on dry weight basis. Genotypes with higher protein content, such as MI-0014 and ME-0086 could exhibit optimized pathways for amino acid synthesis and accumulation.

Anthocyanin (mg/g)

Within the examined genotypes, ME-0220 displayed the highest anthocyanin concentration in mulberry fruit at 38.41 mg/g followed by ME-0006 at 32.52 mg/g and ME-0006 at 25.65 mg/g. Conversely, ME-0086 exhibited a lower anthocyanin concentration of 4.49 mg/g on dry weight basis(Table 3).The results of the present findings supported by Koca *et al*. (2008) reported the chemical composition, anthocyanins and antioxidant activity of wild purple mulberry grown in Turkey. The fruit of mulberry had 193.85 mg/kg of total anthocyanins. The investigation by Abrol *et al.* (2015) on mulberry fruit wine for its physicochemical, antioxidant and sensory attributes was done. Where the total anthocyanins were 48.23-67.58 mg/100 ml. Similarly, Kim and Lee (2020) studied the anthocyanin profiles and antioxidant activity of mulberry fruits belonging to 12 genotypes and investigated their changes during processing conditions. The total anthocyanin content ranged from Isku28.61mg/g to Hasusang 0.95 mg /g on a dry weight basis.

Vitamin C (mg/100g)

Among the elite genotypes examined, ME-0086 exhibited the highest levels of vitamin C at 34.17 mg/100g followed by ME-0006 at 32.46 mg/100g and MI-0014 at 31.56 mg/100g. On the other hand, the genotype ME-0018 displayed lower vitamin concentrations at 26.77 mg/100g(Table 3).The results of the present findings were supported byErcisli and Orhan (2008) who assessed some selected physicochemical characteristics of black mulberry (*Morus nigra* L.) genotypes grown in the Northeast Anatolia region of Turkey. The vitamin C content of black mulberry ranged from 14.9 and 18.7 mg/100 ml. Similarly, Gungor and Sengul (2008) reported the selected physiochemical properties and total phenolic content of three white mulberry genotypes (*Morus alba* L.) grown in Turkey. 10.15 to 21.50 mg/100 g ff of vitamin C content was recorded in the white mulberry fruits. Koca *et al*(2008) studied the chemical composition, anthocyanins and antioxidant activity of wild purple mulberry grown in Turkey. The mulberry has 28.42mg/kg ascorbic acid content. Various genotypes may exhibit unique metabolic pathways influencing vitamin C production, potentially resulting in differing content. Furthermore, the stage of fruit ripening, which can impact vitamin C accumulation, may lead to variations among genotypes with varying ripening rates.

Phosphorous (mg/100g)

The phosphorus content in various mulberry genotypes was analyzed in this study, revealing intriguing variations that could be attributed to multiple factors. The genotypes MI-0014, ME-0086 and ME-0006 exhibited the highest phosphorus levels at 241.89 mg/100 g, 238.32 mg/100 g and 224.18 mg/100 g, respectively. In contrast, the genotype ME-0018 displayed a lower phosphorus content of 198.25 mg/100 g(Table 4).Comparative studies conducted by Ercisli and Orhan (2007) on black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberry varieties in Turkey unveiled phosphorus content ranging from 226.13 mg/100 g to 247.83 mg/100 g. Similarly, Yigit *et al*. (2010) explored the elemental composition of various mulberry species including *Morus alba*, *M. rubra* and *M. nigra*, reporting phosphorus levels spanning from 198.71 mg/100 g to 229.28 mg/100 g. Koyuncu *et al*. (2014) delved into the chemical properties of fully ripe fruits from black mulberry (*Morus nigra* L.) genotypes cultivated in Mahmatlar, Turkey, revealing phosphorus content fluctuations from 150.85 mg/100 g to 228.48 mg/100 g.

Potassium (mg/100g)

Among the genotypes examined, MI-0014 exhibited the highest concentration of potassium at 1193 mg/100 g followed by ME-0086 at 1155.63 mg/100 g and MI-0160 at 1104.17 mg/100 g. In contrast, the genotype ME-0220 displayed a lower potassium level of 681.48 mg/100 g(Table 4).The findings of our study align with the research conducted by Ercisli and Orhan (2007), who explored the chemical composition of three mulberry types-black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) grown in Turkey. They reported potassium concentrations in mulberry fruits ranging from 834.65 mg/100 g to 1668.01 mg/100 g.Similarly, Yigit *et al*. (2010) examined the elemental composition of *Morus alba*, *M. rubra*, and *M. nigra* fruits, highlighting potassium levels varying from 1180.67 mg/100 g to 1420.57 mg/100 g. Koyuncu *et al*. (2014) investigated chemical traits in fully ripe fruits ofblack mulberry (*Morus nigra* L.) genotypes in Mahmatlar, Turkey, observing potassium content ranging between 599.34 mg/100 g and 1254.85 mg/100 g.

Calcium (mg/100g)

Among the genotypes analyzed, ME-0006 exhibited significantly elevated calcium levels at 153.80 mg/100g followed by MI-0014 at 143.34 mg/100g, and ME-0086 at 141.97 mg/100g. Conversely, the genotype ME-0067 displayed comparatively lower calcium content at 105.62 mg/100g(Table 4).The findings of our study align with the research conducted by Ercisli and Orhan (2007), who explored the chemical composition of three mulberry types-black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) cultivated in Turkey. They reported calcium concentrations ranging between 132 mg/100g and 152 mg/100g.

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Magnesium (mg/100g)

Among the genotypes examined, MI-0014 exhibited significantly higher magnesium concentrations at 103.79 mg/100g followed by ME-0067 at 100.35 mg/100g and ME-0086 at 99.23 mg/100g. In contrast, the genotype MI-0516 displayed lower magnesium levels at 76.99 mg/100g(Table 4).Similar trends were identified in related research. Ercisli and Orhan (2007) examined the chemical composition of black *(Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberries grown in Turkey, reporting magnesium levels between 106 mg/100g and 115 mg/100g. Yigit *et al*. (2010) explored the elemental composition of *Morus alba*, *M. rubra* and *M. nigra* fruits, revealing magnesium content ranging from 95.04 mg/100g to 117.09 mg/100g. Koyuncu *et al*. (2014) delved into the chemical properties of fully ripe black mulberry (*Morus nigra* L.) genotypes in Mahmatlar, Turkey, identifying magnesium concentrations within the range of 92 mg/100g to 152 mg/100g.\

Iron (mg/100g)

Among the genotypes evaluated for the iron content in mulberry fruit, genotype ME-0086 displayed the highest iron content at 4.26 mg/100g followed closely by ME-0067 at 4.14 mg/100g and MI-0014 at 4.05 mg/100g. In contrast, the genotype MI-0516 exhibited lower iron levels at 3.06 mg/100g(Table 4).These findings are consistent with the research of Ercisli and Orhan (2007), who studied the chemical composition of black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberries cultivated in Turkey. They reported iron levels ranging between 4.2 mg/100g and 4.5 mg/100g. Similarly, Yigit *et al*. (2010) explored the elemental composition of *Morus alba*, *M. rubra*, and *M. nigra* fruits, revealing mineral iron content .rangingfrom 3.47 mg/100g to 4.45 mg/100g. Koyuncu *et al*. (2014) investigated various chemical traits in fully ripe black mulberry (*Morus nigra* L.) genotypes in Mahmatlar, Turkey, identifying iron concentrations ranging from 4.47 mg/100g to 10.59 mg/100g.

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Zinc (mg/100g)

Among the genotypes examined, ME-0220 exhibited significantly higher zinc levels at 3.08 mg/100g followed by ME-0006 at 2.64 mg/100g and MI-0014 at 2.58 mg/100g.Conversely, the genotype ME-0067 displayed lower zinc content at 1.91 mg/100g(Table 4). These findings are consistent with the research conducted by Ercisli and Orhan (2007), who explored the chemical composition of black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberries grown in Turkey. They reported zinc concentrations varying from 2.8 mg/100g to 3.2 mg/100g. Similarly, Yigit *et al*. (2010) investigated the elemental composition of *Morus alba*, *M. rubra* and *M. nigra* fruits, revealing zinc levels ranging from 1.8 mg/100g to 3.6 mg/100g. Koyuncu *et al*. (2014) examined several chemical traits in fully ripe black mulberry (*Morus nigra* L.) genotypes in Mahmatlar, Turkey, reporting zinc content ranging between 2.07 mg/100g and 4.36 mg/100g.

Copper (mg/100g)

The copper concentrations exhibited significant variation among the different genotypes, with ME-0086 displaying the highest copper content at 0.48 mg/100g, followed by MI-0014 at 0.43 mg/100g and ME-0006 at 0.41 mg/100g. Conversely, ME-0018 exhibited the lowest copper concentration at 0.35 mg/100g(Table 4).In a similar study conducted by Ercisli and Orhan (2007) in Turkey, the chemical composition of black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberry varieties were investigated. The reported copper content ranged from 0.4 to 0.5 mg/100g. Additionally, Koyuncu *et al*. (2014) explored the chemical properties of fully ripe fruits from black mulberry (*Morus nigra* L.) genotypes grown in Mahmatlar, Turkey. This study found copper composition to vary from 0.22 to 0.58 mg/100g.The genotype ME-0086 exhibited a positive increment of 10.41 per cent over the control genotype MI-0014. It might be due to the genetic diversity within different mulberry genotypes likely contributing to the observed differences in copper content. Variations in genes responsible for copper uptake, transportation, and storage can lead to differences in copper accumulation.

4.5.14 Manganese (mg/100g)

Among the genotypes examined, ME-0086 exhibited the highest manganese concentration at 4.09 mg/100g followed by ME-0220 at 3.99 mg/100g and ME-0006 at 3.54 mg/100g. In contrast, the genotype ME-0067 displayed lower manganese content at 2.81 mg/100g(Table 4).These findings find validation in the research of Ercisli and Orhan (2007), who studied the chemical composition of black (*Morus nigra*), white (*Morus alba*) and red (*Morus rubra*) mulberries cultivated in Turkey. They reported manganese levels varying between 3.8 mg/100g and 4.2 mg/100g. Similarly, Yigit *et al*. (2010) investigated the elemental composition of *Morus alba*, *M. rubra*, and *M. nigra* fruits, revealing manganese content ranging from 1.8 mg/100g to 2.6 mg/100g. Koyuncu *et al.* (2014) examined various chemical attributes in fully ripe black mulberry (*Morus nigra* L.) genotypes in Mahmatlar, Turkey, identifying manganese concentrations ranging between 3.8 mg/100g and 5.9 mg/100g.

These differences may be due to ecological factors, growing conditions and genetic factors. Mineral nutrition is controlled by environment, soil and plant factors. Since the uptake of nutrients from the soil is genetically controlled, plant species and varieties show different responses to nutrients even when they are grown in the same conditions (Koyuncu *et al.*, 2014). The black mulberry genotypes showed valuable phytochemical properties and have the potential to be used in food and healthcare industries. The results on the phenolic and phytochemical properties of the mulberry genotypes may be of use to both consumers and agricultural companies that supply important genetic sources for breeding studies (Okatan*et al*., 2018).

The levels of essential minerals such as Calcium (Ca), Potassium (K), Phosphorus (P) and Magnesium (Mg) in mulberry fruits were observed to surpass the standard reference values. On the other hand, the concentrations of various other elements present in the fruits remained within the expected normal ranges. It is noteworthy that the recommended dietary allowance (RDA) values for the major macro-elements, namely Calcium, Potassium, Magnesium and Phosphorus, are set at 1200, 4700, 420 and 700 milligrams, respectively on a daily basis. Interestingly, the concentrations of these elements in mulberry fruits suggest their potential significance as a valuable dietary source.

In summary, mulberry fruits exhibited elevated levels of Ca, K, P and Mg compared to established standards, while the concentrations of other elemental components fall within the expected ranges. Given that the RDA values for these essential macro-elements are well met by consuming mulberry fruits, they hold promising nutritional importance as a favourable and abundant source of these essential minerals.

Plate 1. Phenotypic variations in the fruit size among elite mulberrygenotypes

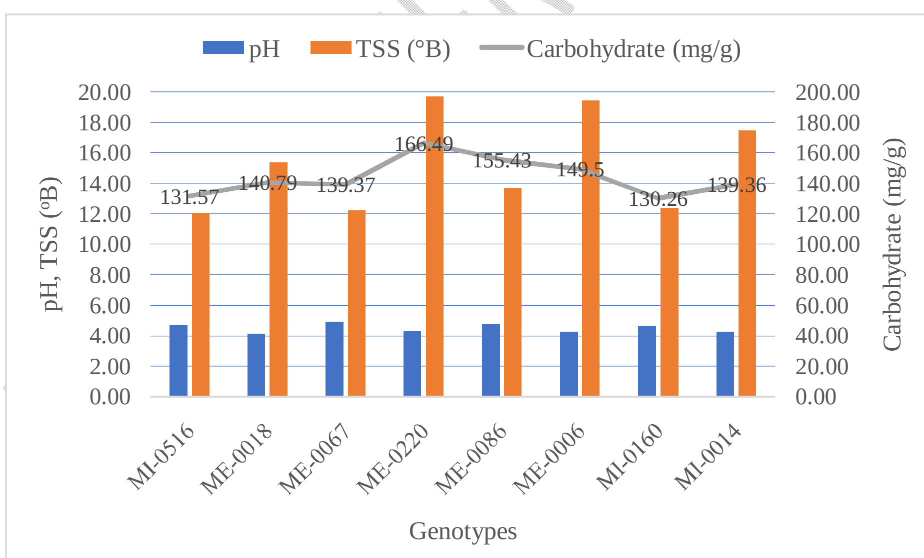

Fig. 1. pH, TSS and carbohydrate composition of fruits in elite mulberry genotypes

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Table 2. Performance of elite mulberry genotypes for fruit traits

Genotypes	Fruit length (cm)	Fruit width (cm)	Fruit weight (g)	No. of fruits per plant	Fruit yield (g)
MI-0516	3.12^{a}	1.84^{ab}	2.72^{b}	48.68^{d}	134.87^{b}
ME-0018	1.55^{e}	1.10^{d}	1.63^{f}	57.07^{b}	93.84^{e}
ME-0067	2.83^{b}	1.33^{cd}	2.43^{c}	49.07^{d}	121.48^{c}
ME-0220	1.60^{e}	0.98^{d}	1.70^{f}	77.32^{a}	135.06^{b}
ME-0086	1.84^{d}	1.20^{cd}	2.09^{e}	40.90^{e}	87.40^{e}
ME-0006	3.16^{a}	2.00^{a}	3.02^{a}	54.40^{bc}	166.55^{a}
MI-0160	2.49^{c}	1.00^{d}	2.09^{e}	51.07^{cd}	109.13^{d}
MI-0014	2.83^{b}	1.52^{bc}	2.25^{d}	54.67^{bc}	125.38^{c}
F test	*	*	*	*	*
S.Em±	0.041	0.035	0.032	1.445	2.264
CD @ 5%	0.125	0.106	0.097	4.384	6.869
CV (%)	2.950	4.439	2.474	4.623	3.223

* Significant at 5%; Figures with the same superscript are statistically on par

Table 3. Biochemical composition of fruits in elitemulberry genotypes

Genotypes	pH	TSS (^{o}Brix)	Carbohydrate (mg/g)	Protein (mg/g)	Anthocyanin (mg/g)	Vitamin C (mg/100g)
MI-0516	4.69^{ab}	12.03^{c}	131.57^{cd}	10.61^{d}	25.65^{c}	29.57^{bcd}
ME-0018	4.12^{c}	15.40^{bc}	140.79^{c}	8.84^{e}	18.52^{e}	26.77^{d}
ME-0067	4.93^{a}	12.25^{c}	139.37^{cd}	12.11^{c}	32.52^{b}	28.61^{cd}
ME-0220	4.27^{c}	19.71^{a}	166.49^{a}	13.49^{b}	38.41^{a}	31.51^{abc}
ME-0086	4.74^{ab}	13.70^{c}	149.50^{b}	13.94^{ab}	4.49^{f}	34.17^{a}
ME-0006	4.24^{c}	19.47^{a}	155.43^{b}	11.85^{c}	23.31^{cd}	32.46^{ab}
MI-0160	4.61^{b}	12.40^{c}	130.26^{d}	12.39^{c}	20.99^{de}	30.25^{bcd}
MI-0014	4.23^{c}	17.47^{ab}	139.36^{cd}	14.52^{a}	20.27^{de}	31.56^{abc}
F test	*	*	*	*	*	*
S.Em±	0.091	0.994	2.820	0.220	1.066	1.124
CD @ 5%	0.275	2.982	8.456	0.660	3.197	3.371
CV (%)	3.547	11.260	3.390	3.123	8.024	6.363

* Significant at 5%; Figures with the same superscript are statistically on par

Table 4. Nutritional composition of fruits in elitemulberry genotypes

Genotypes	Phosphorous (mg/100g)	Potassium (mg/100g)	Calcium (mg/100g)	Magnesium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)	Copper (mg/100g)	Manganese (mg/100g)
MI-0516	205.87^{cd}	847.10^{f}	107.73^{c}	76.99^{d}	3.06^{f}	2.14^{c}	0.39^{c}	3.05^{c}
ME-0018	198.25^{d}	982.39^{de}	124.47^{b}	94.19^{bc}	3.85^{bc}	2.04^{c}	0.35^{d}	2.94^{c}
ME-0067	203.81^{cd}	934.11^{e}	105.62^{c}	100.35^{ab}	4.14^{a}	1.91^{c}	0.40^{c}	2.81^{c}
ME-0220	214.64^{bc}	681.48^{g}	112.73^{bc}	88.95^{c}	3.33^{e}	3.08^{a}	0.35^{d}	3.99^{a}
ME-0086	238.32^{a}	1155.63^{ab}	141.97^{a}	99.23^{ab}	4.26^{a}	2.45^{b}	0.48^{a}	4.09^{a}
ME-0006	224.18^{b}	1050.43^{cd}	153.80^{a}	90.85^{c}	3.56^{d}	2.64^{b}	0.41^{bc}	3.54^{b}
MI-0160	221.78^{b}	1104.17^{bc}	126.11^{b}	88.16^{c}	3.71^{cd}	1.99^{c}	0.40^{c}	2.89^{c}
MI-0014	241.89^{a}	1193.93^{a}	143.34^{a}	103.79^{a}	4.05^{ab}	2.58^{b}	0.43^{b}	3.48^{b}
F test	*	*	*	*	*	*	*	*
S.Em±	4.525	24.557	4.571	2.361	0.074	0.088	0.007	0.106
CD @ 5%	13.567	73.623	13.704	7.080	0.224	0.264	0.021	0.319
CV (%)	3.585	4.280	6.235	4.407	3.464	6.494	3.069	5.505

* Significant at 5%; Figures with the same superscript are statistically on par

SUMMARY AND CONCLUSION

This study highlights the mulberry genotypes, chosen for fruit purpose such as quality and production.Mulberry fruits provide significant health advantages due to high essential mineral and bioactive compound levels. Concentrations of key macro-elements exceed recommended dietary values, suggesting mulberries as a valuable source of essential minerals for overall health.Theelite genotype ME-0006 emerged as a standout performer, demonstrating superior fruit length, width, weight, and overall yield per plant. ME-0220 also exhibited notable performance, particularly in terms of the number of fruits per plant. These findings suggest that certain genotypes possess genetic predispositions that contribute to their exceptional fruit characteristics.The biochemical analysis revealed significant variations in the composition of mulberry fruits among the genotypes. ME-0220 stood out with higher total soluble solids (TSS), carbohydrate, anthocyanin, and zinc content. ME-0006 displayed elevated calcium levels, while MI-0014 exhibited higher concentrations of phosphorus, potassium, magnesium, and protein. ME-0086 recorded a higher content of micronutrients and vitamin C.

Comment [ms15]: health. The

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