



SOIL SCIENCE

PROXIMATE ANALYSIS AND ANTIOXIDANT ACTIVITY OF DIFFERENT GENOTYPES OF BLACKBERRIES

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ABSTRACT

The experiment was conducted at Biochemistry Section, Post harvest Research Centre, AARI Faisalabad in collaboration with Barani Agriculture Research Institute, Chakwal during the year 2024-2025. Berries are becoming a larger part of our diet, not only because they're delicious but also due to their potent disease-fighting properties. There's growing interest in berries, particularly blackberries, thanks to recent studies highlighting their health benefits driven by high antioxidant. This study evaluated ten blackberry genotypes to identify superior traits, revealing significant differences among genotypes in fruit weight, length, width, TSS, titratable acidity, vitamin C and antioxidant activity. Genotypes G1 to G5, which produced the largest fruits, also exhibited favorable nutritional profiles. Notably, The TSS values ranged from 8.2% (G8) to 10.5% (G1), which is relatively higher compared to other genotypes. Antioxidant levels varied across genotypes, all the genotypes vary Non-significantly and ranging from 54.5 (G8) to 65.5% (G3). Vitamin C content ranged from 18.3mg /100g (G9) to 19.7mg /100g (G2), with G2 being statistically comparable to G3, G4, G5 and G6. The total sugar contents were higher in G1 (8.2%) and lowest in G9 (7.29%) which is significantly higher than other genotypes. These compositional variations likely stem from factors like species, variety, growing conditions and harvest timing and season key influencers of consumer demand in the food industry. In conclusion, this study highlights the G₁ to G₅ genotypes as standout genotypes with superior traits, indicating strong potential for enhancing fruit production

KEYWORDS: Antioxidants; blackberry; genotypes; total sugars; vitamin C; Pakistan

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INTRODUCTION

Blackberries have gained considerable attention recently owing to their exceptionally high antioxidant content and promising health benefits, sparking growing research interest in their nutritional and medicinal potential. Their reputation as a nutrient-dense fruit stems from rich phenolic compounds, including anthocyanins, flavan-3-ols and phenolic acids (Kaume *et al.*, 2012).

The global production of blackberries is substantial, with an estimated annual production of approximately 154,578 tons across various regions, including North America, Europe, Asia and Africa (Strik *et al.*, 2008). The rapid growth in blackberry cultivation can be attributed to several factors, including introduction of new and improved cultivars (Clark and Finn, 2014; Wu *et al.*, 2022). Advances in agricultural technology and breeding programs have led to the development of new and improved blackberry genotypes, which has contributed to the increase in production. Customers are becoming responsive to the nutritive and medicinal

benefits of blackberries, which has driven up demand and led to an expansion in cultivation. This fruit is a opulent source of phenolic compounds, powerful antioxidants responsible for the fruit's deep purple color, Flavan-3-ols (A type of flavonoid that has been linked to various health benefits) and Phenolic acids (Kaume *et al.*, 2012).

Blackberries have been found to possess higher antioxidant capacity compared to other fruits, including, Blueberries, Raspberries, Cherries (Heinonen *et al.*, 1988). Additionally, blackberries exhibit stronger obstructing action against oxidants than other berry fruits such as can berry and straw berry (Wang and Jiao, 2000). The growing need for better-quality berries has directed to the progress of plentiful varieties with capricious levels of biologically active amalgams and antioxidant capabilities. Understanding the nutritional profiles of different blackberry cultivars is crucial for consumers: to make informed choices about the best cultivars for their needs food processors: to select cultivars that meet specific requirements and

health professionals: to recommend cultivars with optimal nutritional benefits. Comparing the metabolite profiles and biological activities of different blackberry cultivars can also help Breeders to develop new genotypes with required characteristics and enhancing the formation of blackberry cultivars that satisfy both customer priorities and industry requirement.

Various environmental and physiological stressors cause the production of oxidants (ROS) that can be produced naturally in the body as a result of normal body functioning. The accumulation of ROS can lead to oxidative stress, which is linked to the growth of several chronic and deteriorating diseases (Uttara *et al.*, 2009). In near past, there was a rising appreciation of the significance of a good diet in stopping and handling oxidative stress-related diseases (Kristo *et al.*, 2016). An organic food containing fresh vegetables and fruits has been shown to provide essential nutrients and antioxidants that can help neutralize ROS and mitigate oxidative stress. Fruits and vegetables are abundant in antioxidants, which have been shown to exhibit strong antioxidant capacity. Berries, in particular, are a promising group of fruits having high levels of phenolic compounds, Flavonoids, Anthocyanins, Strong antioxidant capacity. It has been extensively studied for their chemical composition and antioxidant properties, with research focusing on their potential health benefits in both fresh and processed forms (Diaconeasa *et al.*, 2017; Diaconeasa *et al.*, 2015). One of the challenges associated with berries is their perishable nature, which can limit their availability and shelf-life. To address this issue, berries are often processed into various products, such as Jams, Jellies, Juices, Frozen berries. Processing can help extend the shelf-life of berries and make them more accessible to consumers. However, it is essential to understand the effects of processing on the nutritional value and antioxidant properties of berries (Donno *et al.*, 2019; Rabie *et al.*, 2015).

This study aims to compare the nutritional profiles of ten genotypes of blackberry and investigate their proximate make up by further exploring the potential benefits of this nutritious fruit. By understanding the nutritional and medicinal properties of blackberries, researchers can reveal further prospects for promoting fitness and health.

MATERIALS AND METHODS

The experiment was conducted at Biochemistry Section, Post Harvest Research Centre, AARI Faisalabad in collaboration with Barani Agriculture Research Institute, Chakwal during the year 2024-2025. The blackberry fruits were harvested at the optimal stage of ripeness, characterized by their black color and slightly

brown fruit stalks. The fruits were carefully picked when they might be detached from the bunch easily. The experiment had been conducted in a controlled manner, with three replications, each consisting of 10 fruits from pooled harvest of the same plant. A series of data collection and analyses were then carried out on the harvested berries to get detailed information about their characteristics.

To determine the physical characteristics of the blackberry fruits, the following measurements were taken:

Fruit weight: Fruits of ten genotypes were haphazardly taken and weighed using an Electric balance with precision of 0.01 g exactitude. The weight of 10 fruits/genotype was taken and average weight was determined by the formula

$$\text{Wt of a fruit (g)} = \frac{\text{wt of ten fruits}}{10}$$

Fruit width and length: Fruits of ten genotypes were taken for measurements of length and width by means of a digital Vernier caliper having 0.01 mm precision. Equatorial part of the fruit at maximum wide point was used to measure the width while distance between the stem end and the opposite end of the fruit was measured to take the length of the fruit. Both length and width were noted in mm.

Total soluble solids: Fruit of all the ten genotypes were squeezed separately with the help of an electric juicer to get sufficient juice. The juice was sieved via cheesecloth. Total Soluble Solids (TSS) of sieved juice was recorded using a refractometer with digital display. The results were expressed in percentage.

Titrateable acidity: The sieved juice was used to determine the acidity. One mL juice was diluted to 50 mL with distilled water took the reading thrice using digital refractometer. The results were expressed in percentage (Berezin *et al.*, 1995).

Antioxidant activity: A modified method based on Blois (1958) was used to measure the total antioxidants activity. Briefly 0.5 mL juice was mixed with 5 mL of extraction mixture. Mixture was consist of Methanol, Acetone and HCl. The mixture was vortexed and incubated in darkness for 30 minutes. After incubation, mixture was centrifuged. Then 0.5 mL of supernatant was mixed with DPPH (0.04% DPPH was dissolved in methanol). Absorbance was measured at 517 nm, with results expressed as %DPPH activity using formula;

$$(\text{DPPH activity}\%) = \frac{B-S}{B} \times 100$$

Where

B: stands for blank reading

S stands for sample reading

Total sugar: Took 20 g sample (20 ml pulp or juice) in volumetric flask (250 ml). Added distilled water, 25 ml 15 ml lead acetate and potassium oxalate solution respectively. Volume of 250 ml was made using distilled water and sieved. Took 25 ml filtrate, 5 ml HCl and some water. Left for 24 hours for complete hydrolysis. Then exactly neutralized it with about 5N NaOH using phenolphthalein indicators and made the volume. Took Fehling's solutions (10 ml) in a beaker and added some water and heated to boiling. Took sample in titrating burette and allow the solution to flow drop wise into the Fehling's solution containing conical flask continuing slow boiling till end point (brick red color). Add some drops of methylene blue for clear end point (Casterline Jr *et al.*, 1999).

Vitamin C (Ascorbic Acid): Using the reagents Oxalic acid solution (0.4%), Dye (di-chlorophenol indophenol) was prepared and store in cool dark place use within three days) and Ascorbic acid solution (0.1%). vitamin C was find out by the protocol mentioned by (Pegg *et al.*, 2010). Briefly dye was standardize with ascorbic acid (0.1%) of known concentration to know the mL of dye need for 1 mL dye for ascorbic acid. Mixture of Ascorbic acid (1mL) and oxalic acid (1.5 mL) was titrated against dye to pink end point. Samples were analyzed by taking 30, 50 g pulp and make volume 100 mL with oxalic acid and filter through cheese cloth. Then 5 mL of filtered samples were titrated against dye and calculated by formula,

$$\text{Ascorbic acid (Vit. C mg/100 g)} = \frac{1 \times R1 \times V \times 100}{R \times W \times G1}$$

Crude fat: It was find out by extracting fat with ether. Boiling and subsequently condensing of Ether after passing through sample. Sample of weight 2.5 g was taken into oven dried previously extracted filter paper sheet (3 x 4 inches). Placed the sample, enclosed in filter paper sheet into the thimble and fixed in the Soxtec extraction apparatus under the condenser. Then poured 40 mL of ether in the metallic beaker and sited on the hot plate of the apparatus. Tap water was turned on and started the extraction for 1 hour. After one hour the extraction will be completed, removed the thimbles along with samples. Allowed the samples to become dry at room temperature. Weighed the samples and calculated via formula as described by Thiex (Thiex *et al.*, 2012).

$$\text{Crude Fat} = \frac{\text{Wt of ether extract}}{\text{Wt of samples}} \times 100$$

Crude fiber: After extraction of fat moisture and fat free sample was oven dried. The samples were then digested with 1.25% H₂SO₄ (200 mL) volume in a glass

container and boiling for 30 minute on hot plate. The heated material then strained by cheese cloth and splashed thrice with deionized water. The residues were collected from the cheese cloth and mixed in 200 mL of 1.25% NaOH solution. The mixture was placed on hot plate again and boiled for half an hour. The mixture after boiling was filtered, gave washing with distilled water thrice and 1 with acetone. Collected the residues from the cheese cloth and transferred in pre weighed crucible. Crucible were placed in hot air oven at temperature of 105 °C for 24 hours till there was no change in weight. Noted the dry weight of sample along with crucible, ignited the sample along with crucible by placing at 595 °C in a muffle furnace for 4 hours. White ash was obtained (Thiex *et al.*, 2012). Weight was recorded again and calculated the crude fiber by following formula

$$\text{Crude fiber(\%)} = \frac{\text{wt.of oven dried sample} - \text{wt.of ash}}{\text{wt.of fat free sample}} \times 100$$

Crude protein: The Kjeldahl procedure, described by Thiex (Thiex *et al.*, 2012) was followed to measure the given parameter of sample. The protein proportion are the measure of protein: nitrogen for the specific food. For determination of crude protein the samples were boiled with sulfuric acid to transform nitrogen of protein and other compounds into NH₄SO₄. Selenium was used as catalyst along with K₂SO₄ and CuSO₄ at 370°C on hot plate. The digested samples were cooled. The distillation apparatus was used to distillate the samples, using NaOH and distilled water where boric acid was used as carrier. The nitrogen as ammonia released and captured in boric acid solution which was then titrated against N/10 H₂SO₄. A blank sample was run to compare the samples. The quantity of H₂SO₄ used for titration of blank was deducted from each reading.

$$\text{Nitrogen (\%)} = \frac{\text{Acid Used} \times \text{Normality of acid} \times 0.014 \times 100}{\text{wt.of sample in g}}$$

$$\text{Crude protein (dry wt. basis)} = N \times 6.25$$

(Equation 2.7)

Ash (Mineral matter): For mineral matter determination the weight of oven dry crucible were noted. Tared the weight of crucible and weighed 4g sample in crucible. The samples contained in the crucibles were heated at 600 °C in the furnace for 4 hours. Samples were converted into white ash after ignition (Thiex *et al.*, 2012). Samples (Ash) along with crucible were weighed and mineral matter content was determined as under:-

$$\text{Mineral matter (\%)} = \frac{\text{Ash weight}}{\text{wt. of sample}}$$

Statistical analysis: Mean of data taken for two years was statistically analyzed through standard procedures (Steel *et al.*, 2013) using Statistics.8.1. Least significant difference test (LSD) at $p < 5\%$, were applied to evaluate treatment means differences.

RESULTS AND DISCUSSION

Fruits are rich source vitamins, minerals, antioxidants and fiber. Daily use of fruits add considerable nutrition in the diet. Fruit weight of berries are given in Table 1, showed statistically significant differences in their weight ranging from 1.04 to 2.21 g. Fruit width ranging

from 10.08 to 12.63 mm and fruit length ranging from 12.25 to 14.33 mm (Finn and Clark, 2011). The fruits of genotype G₂ were observed the largest, compared to the smallest fruits of G₆. According to similar studies, the fruits in this study were smaller than cultivars, study in the laboratory comparable to wild species. The size of fruit matters a lot for both raw form of consumption as well as processing, with a desired fruit weight of 8-10 g in blackberries.

The variation in fruit size can be attributed to genotype. Previous studies have reported varying fruit weights in blackberries, ranging from as 1.2 to 5.4 g in cultivated

Table: 1 Physical analysis of berries

Genotypes	Fruit width (mm)	Fruit length (mm)	Fruit weight (g)
G1	12.5 ab	13.90 a	1.98 c
G2	12.0 b	14.03 a	2.08 bc
G3	12.1 b	13.53 abc	2.05 bc
G4	12.8 a	13.60 abc	2.21 a
G5	12.1 b	13.70 ab	2.11 ab
G6	10.0 d	12.67 cde	1.14 ef
G7	10.2 cd	12.03 de	1.19 e
G8	10.6 c	13.27 abc	1.04 f
G9	10.1 cd	11.80 e	1.18 e
G10	10.2 cd	12.93 bcd	1.33 d
LSD	0.5168	0.9646	0.1147

*Values sharing the same letters are statistically similar at given LSD

Table: 2 Biochemical analysis of berries

Genotypes	pH	TSS (%)	Acidity (%)	Total antioxidants (%)
G1	3.86 ab	10.5 a	0.50 b	65.40
G2	4.06 a	10.0 b	0.54 ab	62.70
G3	3.66 bc	10.4 a	0.55 a	60.50
G4	3.86 ab	10.3 ab	0.56 a	64.43
G5	4.16 a	10.2 ab	0.54 ab	55.43
G6	3.26 d	8.3 cd	0.33 c	56.60
G7	3.36 cd	8.6 c	0.33 c	55.43
G8	3.40 cd	8.2 d	0.34 c	54.47
G9	3.80 ab	8.6 c	0.34 c	54.60
G10	3.30 cd	8.3 cd	0.33 c	56.70
LSD	0.3912	0.3745	0.0440	NS

*Values sharing the same letters are statistically similar at given LSD, TSS=?

genotypes (Yilmaz *et al.*, 2009), 1.50 to 2.11 g in wild blackberries in Türkiye (Celik *et al.*, 2003) and 2.00 to 6.82 g in cultivated genotypes in Türkiye (Cangi and Islam, 2003, Agaoglu *et al.*, 2007). The differences in fruit size highlight the importance of considering genotype and ecological factors in blackberry cultivation (Aglar *et al.*, 2021).

The chemical composition of the blackberry genotypes showed significantly different values regarding vitamin C content, total soluble solids (TSS) and titratable acidity (Table 2). The TSS values ranged from 8.2% (G8) to 10.5% (G₁), which is relatively higher compared to other studies. For example, Sánchez-Betancourt *et al.* (2020) reported TSS levels between 5.68% and 7.55% in 10 blackberry genotypes, while Eskimez *et al.* (2019) found TSS levels between 7.1% and 9.5%. Moraes *et al.* (2020) also reported varying TSS levels across different blackberry genotypes.

In Türkiye, TSS levels in cultivated blackberries have been reported to range from 8.98% to 20.2%, while wild blackberries had TSS levels between 11.3% and 13.1% (Agaoglu *et al.*, 2007). Additionally, wild species generally have higher TSS levels than cultivated genotypes (Yilmaz *et al.*, 2009). Moreover, Aglar *et al.* (2021) conduct experiment on wild blackberries, collected from Kelkit Valley, concluded the TSS (9.2%) on an average. While another scientist Mikulic-Petkovsek *et al.* (2019) record this value ranging from 8.42% to 12.21% in different blackberry genotypes.

Results revealed that pH value (Table 2) ranged from highly acidic 3.3 (G₁₀) to acidic 4.16 (G₅). However the titratable acidity values in this study ranged from 0.33% (G₆-G₁₀) to be the lowest acidity to the highest value of

0.56% (G₄). In comparison, acidity levels in cultivated blackberries in Türkiye have been reported to vary between 1.0% and 3.1%, while wild blackberries had acidity levels between 0.7% and 1.0% (Agaoglu *et al.*, 2007).

Considering antioxidants (Table2) all the genotypes vary significantly and ranging from 54.5 (G8) to 65.5% (G₃). The antioxidant potential of blackberry and accentuated the part of these complexes in deactivating free radicals (Acosta-Montoya *et al.*, 2010). High amino benzoic acid levels in the berries suggest the cause to have greater antioxidant capacities. These outcomes are in line with the conclusions of Kaume *et al.* (2012) as he observed greater antioxidant activity in blackberry cultivars. Blackberries contain procatechin flavonoid having strong antioxidant activity (Lee *et al.* 2012). This finding confirms that berries, particularly blackberries, could serve as a potent antioxidant source, with their efficacy likely influenced by varying levels of bioactive compounds. Lower antioxidant levels may translate to reduced activity, though this can fluctuate due to interactions with other phenolic compounds. These results align with Gil-Martínez *et al.* (2023), who highlighted the antioxidant, anti-inflammatory and anticancer properties of such compounds. Phenolics, critical for mitigating oxidative stress in fruits, are backed by studies like Castañeda-Ovando *et al.* (2009), underscoring their role in promoting fruit health. Beyond antioxidant potential, berries may support metabolic health, aiding weight management and improving insulin sensitivity, as corroborated by Gowd *et al.* (2018). Blackberries, especially rich in these compounds, are linked to reduced cardiovascular risks and exhibit a robust antioxidant profile (Turan *et al.*,

Table: 3 Biochemical analysis of berries

Genotypes	Reducing sugar (%)	Total sugar (%)	Vitamin C (mg/100g)	Crude protein (%)
G1	4.56 a	8.20 a	18.2 b	0.95 ab
G2	4.43 b	8.04 c	19.7 a	0.91 cd
G3	4.53 a	8.14 b	19.4 a	0.93 bc
G4	4.26 c	8.03 c	18.4 b	0.97 a
G5	4.15 d	8.01 c	19.4 a	0.88 d
G6	3.94 f	7.57 d	19.5 a	0.93 bc
G7	3.84 g	7.46 e	18.6 b	0.94 abc
G8	3.94 f	7.31 f	18.5 b	0.95 abc
G9	4.02 e	7.29 f	18.3 b	0.94 abc
G10	3.96 f	7.44 e	19.3 a	0.96 ab
LSD	0.0503	0.0545	0.4465	0.0383

Values sharing the same letters are statistically similar at given LSD

2023). Conversely, varieties with low antioxidant levels may offer diminished protection against oxidative stress, as noted by Blando *et al.* (2018), emphasizing the importance of genotype selection for optimal health benefits.

The vitamin C content (Table 3) in the varieties under study were ranged from 18.3 mg/100g (G₉) to 19.7 mg/100g (G₂). It is statistically at par with G₃, G₄, G₅ and G₆. These variations in chemical composition can be attributed to factors such as species, variety, growing conditions, harvest season and timing, which can influence consumer preferences in the food industry (Abiodun and Akinoso, 2014).

The total sugar content varied among genotypes, with G₁ exhibiting the highest level (8.2%) and G₉ the lowest (7.29%), both significantly differing from other genotypes (Table 3). Glucose and fructose, present in an approximate 1:1 ratio, constituted 90–96% of total sugars, while sucrose and maltose were minor components (0.01–0.16 mg/g). As fructose is sweeter than glucose and sucrose, its prevalence enhances the fruit's sweetness, a trait favored by most consumers. Comparable sugar profiles have been reported (Veberič *et al.*, 2014), though some studies (Milivojević *et al.*, 2011) noted slightly higher glucose and fructose levels in blackberries, likely due to cultivation sites and production practices. Blackberries' signature sour taste stems from a low sugar-to-acid ratio.

The protein-to-carbohydrate ratio is ecologically, physiologically and nutritionally significant, influencing plant growth, metabolism, nutrient allocation, stress resilience and agricultural value. In blackberries, this balance affects growth, adaptability and nutritional quality, serving as a vital indicator in both natural and managed systems. Protein, a source of amino acids (carbon, hydrogen, oxygen, nitrogen), is absorbed as amino acids in humans. Food processing can alter proximate composition, impacting nutritional value (Parmenter *et al.*, 2020).

Results showed varying percentage of cold treatment, ranging from 0.91 (G₂) to 0.95 (G₁) given in table 3. In all the genotypes crude protein is less than one percent hence it is not of worth discussion consistent with reported literature (Wasagu *et al.*, 2013; Tayyeb *et al.*, 2017; Kookal and Thimmaiah, 2018; Oyeyinka and Afolayan, 2019). However proteins, essential as life's building blocks, are predominantly associated with animal sources, although certain fruits contain proteins, albeit not as abundantly as animal products. A diet rich in proteins aids in muscle building, metabolism enhancement and bolstering immunity. Fruits are recommended as one of the sources of protein intake. Concerns regarding protein's impact on

acid production underscore the importance of higher fruit and vegetable intake rather than reduced protein intake due to the alkalizing effect these foods provide (Heaney and Layman, 2008).

The lipid/crude fat content among the fruits ranged from 0.63% (G₁) to 0.66% (G₆) (Table 4), showing non-significant variation ($P \leq 0.05$) across different genotypes, consistent with previous literature findings (Tayyeb *et al.*, 2017; Oyeyinka & Afolayan, 2019). Lipids serve as crucial energy sources, holding twice the energy value of carbohydrates. They also play fundamental roles in the structure and function of biological membranes and act as precursors for various hormones (Berdanier, 1995).

Based on tables 4, the crude fiber content in berry genotypes was decreased from 4.39% (G₅) to 4.22% (G₁) and 4.24% (G₂). The results showed significant difference ($P > 0.05$) in the proximate value of different genotypes of berries consistent with previous results that there was a significant difference. Dietary fiber plays a pivotal role in digestion, facilitating the breakdown of food through enzymatic and microbial action, ultimately yielding glucose (Moser *et al.*, 2011). One of its key functions is its ability to bind water, thereby promoting the formation of bulky, regular digestive waste and ensuring smooth passage through the gastrointestinal tract. Additionally, fiber's water-binding capacity increases fecal mass, accelerating transit time and enabling it to sequester and eliminate carcinogenic and toxic compounds (Tao *et al.*, 2013), thereby supporting gut health. The crude fiber content analyzed in this study serves as a proxy for the broader dietary fiber composition of blackberries, focusing exclusively on the edible portions. Since fiber is a critical component in mitigating digestive disorders and influencing satiety, understanding its profile is vital for assessing the fruit's nutritional value.

Fruits are recognized for their fiber provision, associated with reduced cardiovascular diseases and obesity (Slavin and Lloyd, 2012). Dietary fiber, an indigestible food component, adds bulk to gastrointestinal content, stimulating peristalsis and maintaining normal bowel function, among other health benefits (Berdanier, 1995). The variations in these results are likely due to genotypic factors.

According to Table 4, ash content varied significantly among genotypes, ranging from 0.45% (G₄) to 0.65% (G₄ and G₇), indicating genotypic differences. Elevated ash levels may reflect inherent mineral concentration. (Retterstol *et al.*, 2001) Additionally, higher processing temperatures can exacerbate ash content by evaporating water, concentrating residual minerals and increasing measured ash levels (Krikorian *et al.*, 2010) Regarding ash content/mineral matter, our findings

Table: 4 Biochemical analysis of berries

Genotypes	Crude fat (%)	Crude fiber (%)	Ash (%)
G1	0.63	4.22 c	0.49 cd
G2	0.65	4.24 c	0.65 a
G3	0.64	4.34 ab	0.50 cd
G4	0.64	4.38 ab	0.45 d
G5	0.64	4.39 a	0.54 bc
G6	0.66	4.33 b	0.58 b
G7	0.65	4.26 c	0.65 a
G8	0.65	4.26 c	0.55 b
G9	0.64	4.36 ab	0.65 a
G10	0.64	4.34 b	0.50 cd
LSD	NS	0.0545	0.04430

Values sharing the same letters are statistically similar at given LSD

aligned with reported literature (Tayyeb *et al.*, 2017; Garuba *et al.*, 2018; Oyeyinka and Afolayan, 2019). Ash, the inorganic residue after complete oxidation of organic food components, represents the total mineral content in food. High ash content in samples indicates a rich source of minerals, a trait well established in numerous studies confirming fruits as significant mineral sources.

CONCLUSION

The current experiment was conducted to determine the nutritional characteristics of ten blackberry genotypes. This study evaluates ten blackberry genotypes for superior traits, revealing significant differences in fruit quality and nutritional profiles. Key findings include, G1-G5 genotypes produced larger fruits with favorable nutritional profiles. High variability in TSS (8.2-10.5%), antioxidant activity (54.5-65.5%) and vitamin C content (18.3-19.7 mg/100g) G₁ and G₃ stood out for high TSS and antioxidant levels, respectively. Compositional variations attributed to species, variety, growing conditions and harvest timing. This study identifies G₁-G₅ genotypes as promising candidates for meeting consumer demand for nutritious and high-quality berries. It is concluded, that genotypes from G₁ to G₅ showed better results for nutritional parameters so these may be good to consume fresh and for production of by-products in industries.

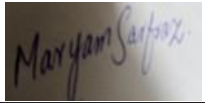
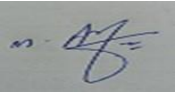
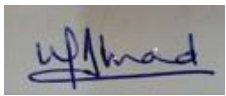
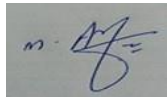
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