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# Comparative Assessment of Pomological and Biochemical Traits in Apricot Genotypes from Gilgit Baltistan

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**Abstract**
Apricot is a drupe fruit that belongs to the family "Rosaceae" and is rich in antioxidants, vitamins, minerals, and bioactive compounds. Gilgit Baltistan is Pakistan's central apricot-producing region with numerous local and wild genotypes. However, the genotypes of this area are unexplored. This study aims to assess morphological and biochemical traits of local genotypes ('Shakanda,' 'Shakarfo,' 'Ali Sha Kaka,' and 'Habi') grown in Gilgit Baltistan for future breeding programs and cultivar improvement. This research revealed significant differences among these genotypes in fruit pomological and biochemical traits. The results narrated that genotype "Shakarfo" was maximum in fruit size (28.8 cm²), fruit weight (45.1g), leaf area (40.3 cm²) and stone weight (4.7 g), while these traits were observed minimum in 'Ali sha kaka.' Likewise, these genotypes were also diverse in biochemical attributes and the highest total soluble solids were observed in 'Shakanda' (23.4 °Brix), while minimum TSS was determined in 'Shakarfo' (12.5 °Brix). However, 'Shakarfo' was riched with ascorbic acid (15.4 mg) and total phenolic contents (75.18 mg GAE/100g). Meanwhile, the titratable acidity was maximum in 'Shakrfo' (1.28%) and minimum in 'Shakanda' (0.29%). The results concluded a considerable variation in apricot genotypes in Gilgit Baltistan and that they may be used for crop improvement.
**Keywords:** Morphological, Unexplored, Phenolics, Diversity, Assessment

## Highlight:

- The apricot genotypes of Gilgit Baltistan were diverse in fruit pomological traits, including fruit size, shape, colour, and firmness.
- Fruit quality traits such as total soluble solids (TSS), titratable acidity (TA), and pH exhibited considerable variation among these genotypes.
- The apricot genotypes growing in Gilgit Baltistan are rich in antioxidants and polyphenols contributing to human health.

## 1.0 Introduction

Apricot (*Prunus armeniaca* L.), is a drupe fruit that belongs to the family "Rosaceae" and has significant nutritional and antioxidant value, containing a rich array of antioxidants, essential nutrients, and organic acids (Jaafar, 2021). It contains diverse polyphenols, flavonoids, carotenoids, sugars, organic acids like ascorbic, citric, and malic acid, and vitamins A, C, K, and the B-complex (Fatima et al., 2018). Apricots are exceptionally high in sugars, comprising over 60% in a 100g sample, which enhances their energy content. Due to their antioxidant properties, apricots exhibit anti-inflammatory and cardiovascular benefits and play a role in preventing degenerative diseases, including cancer (Rai et al., 2016).
It is grown globally, in temperate zones, and is a primary crop of Mediterranean and Middle East regions (Aradhya et al., 2022). Pakistan is at 6$^{th}$ rank in world apricot production, produces 174.54 metric tons annually, and is being grown in Gilgit Baltistan (GB), Baluchistan, and Khyber Pakhtunkhwa (FAO STAT, 2022; Waseem et al., 2021). Gilgit-Baltistan GB is renowned for its apricot production and diverse germplasm resources. Estimates suggest that GB hosts around 1.8 million apricot trees, occupying 62% of the region's cultivated land (Ullah et al., 2017).
The apricot genotypes grown in GB exhibit extensive morphological and biochemical diversity, with variations in traits such as flavour, aroma, skin colour, fruit size, length, weight, total soluble solids, titratable acidity (TA), pH, and sugar content (Ali et al., 2014). However, this diversity supports evaluating, identifying, and characterizing apricot genotypes, contributing to varietal improvement and promoting local varieties (Mennone, 2016). Such genetic resources facilitate breeding programs to enhance stress resistance, improve fruit quality, and extend the harvest period, which benefits local

growers by prolonging the marketing season (Biscotti et al., 2022). The availability of diverse germplasm is crucial for developing new cultivars and boosting crop productivity (Corrado et al., 2021).

Recently, there has been a growing global concern over the extinction of local apricot genotypes and the loss of genetic diversity within apricot germplasms (Herrera et al., 2021). This reduction in diversity impacts breeding programs, as homogeneity within apricot populations hinders genetic improvement and increases vulnerability to biotic and abiotic stresses (Martín et al., 2011). Additionally, foreign apricot genotypes are often incompatible with local rootstocks, presenting further challenges in cultivation (Campoy et al., 2020).

To address these challenges, researchers are increasingly focused on improving local apricot genotypes, which have demonstrated strong adaptability to biotic and abiotic stresses (Engels et al., 2020). Evaluating Indigenous genotypes also aids in conserving and preserving existing germplasm, leveraging the genetic diversity found within these cultivars (Zhang et al., 2021). This diversity is expressed mainly through pomological and biochemical variations existing in the germplasm (Wang et al., 2024). Numerous studies have explored the use of these variations in the classification, characterization, and evaluation of genotypes (Akram et al., 2019). Therefore, this study aimed to evaluate indigenous apricot genotypes based on their pomological and biochemical traits for crop improvement.

## 2.0. Materials and Methods

### 2.1. Experimental site and sample collection

This experiment was conducted at Chamograh, Gilgit, during 2023, situated at 35.80861°N latitude and 74.56°E longitude, at an elevation of 1500 m (4900 ft) above sea level. The research site experiences an annual rainfall of 193.6 mm, with average temperatures ranging from -5.9°C in winter to 30°C in summer (PMD, 2023). For this experiment, healthy, disease-free apricot trees of 7-8 years were selected. Indigenous cultivars 'Shakanda,' 'Shakarfo,' 'Ali Sha Kaka,' and 'Habi' were chosen to assess morpho-physiochemical attributes. Each cultivar was considered a treatment, with three trees of the same variety serving as replicates. Thirty fruits were collected from each selected genotype and transported to the Vegetable Physiology and Precision Horticulture Lab at PMAS-Arid Agriculture University, Rawalpindi.

### 2.2 Morphological analysis

Morphological analyses, including qualitative and quantitative traits, were conducted on the selected fruits in the Vegetable Physiology and Precision Horticulture Laboratory at PMAS-Arid Agriculture University, Rawalpindi. Morphological attributes were evaluated using standardized apricot descriptors (UPOV, 2021) available at www.upov.int/edocs/tgdocs/en/tg070_04_rev.pdf. Qualitative traits assessed were fruit size, shape, ground colour, over-colour, and harvesting maturity, as outlined in the apricot descriptors (UPOV, 2021). For quantitative analysis, fruit size and leaf area were measured using vernier caliper and recorded in square centimetres ($cm^2$) (Rana et al., 2024; Yaman & Turna, 2021). A digital weighing balance was employed to determine fruit and stone weights, with values expressed in grams (g). Fruit firmness was measured using a digital firmness tester, and the results were expressed in kilograms per square centimeter ($kg/cm^2$).

### 2.3. Biochemical analysis

In the biochemical analysis, fruits from each sample were crushed, and the juice was extracted using muslin cloth. The extracted juice was then stored in an ultra-freezer for subsequent testing. This study analysed quality parameters, including total soluble solids (TSS), pH, titratable acidity (TA), ascorbic acid, and total phenolic content. Total soluble solids were measured with a digital refractometer and recorded in °Brix (Popova et al., 2024). Titratable acidity was determined following the method described by Cirillo et al. (2024). In this method, 10 mL of juice was homogenized with 40 mL of distilled water and filtered into a conical flask. A 10 mL aliquot of the filtrate, with 2–3 drops of phenolphthalein as an indicator, was titrated against 0.1N NaOH until a light pink colour persisted for 15 seconds, and the results were expressed as a percentage (%).

The pH of the fruit juice from each sample was measured using a digital pH meter, following the method outlined by Bashir et al. (2021). Total phenolic content was determined using the procedure described by Domínguez-Rodríguez et al. (2021). For the ascorbic acid content, 10 mL of juice was mixed with 5 mL of 1% HCl and centrifuged at 10,000 rpm for 10 minutes. The absorbance was measured at 510 nm, and the results were expressed in mg/100 g fresh weight (FW).

### 2.4. Statistical analysis

This study utilized a Completely Randomized Design (CRD) for statistical analysis. The means of the samples were compared using the Least Significant Difference (LSD) test at a 5% confidence level ($\alpha = 0.05$) with Statistics 8.1 software. Four apricot varieties were used as treatments, with three plants of each variety serving as replications, resulting in 12 non-infected apricot plants selected for the experiment.

## 3.0 Results and Discussion

### 3.1 Assessment of morphological qualitative variation in apricot genotypes

The fruit shape of these genotypes was also varied from elliptic to circular. 'Shakanda' was elliptic-shaped, 'Shakarfo' had circular-shaped fruits, 'Habi' had ovate-shaped fruits, and 'Ali Sha Kaka' had oblong-shaped fruits. A diversity in overcolor was also noted: 'Shakanda' and 'Ali Sha Kaka' had no overcolor. At the same time, 'Shakarfo' exhibited greenish/brownish spots, and 'Habi' had small pinkish splashes on the fruits. Additionally, the harvesting maturity varied across the genotypes, with 'Ali Sha Kaka' being an early-mid season variety, 'Shakanda' a red (early) season variety, and 'Habi' a mid-season variety. Meanwhile, the genotype 'Shakarfo' matured in the late season. The variation in fruit traits, including fruit size, colour, overcolor, and fruit shape, has been depicted in Fig. (1).

The morphological assessment revealed significant variations among the apricot genotypes across various attributes, as summarized in Table 1 (LSD test, $p \leq 0.05$). Most genotypes exhibited small-sized fruits with ground colours ranging from yellow to orange. Notably, 'Shakanda' displayed a white-orange ground colour, 'Habi' showed an orange ground colour, 'Ali Sha Kaka' presented a whitish-yellow ground, and 'Shakarfo' exhibited a dark orange ground. Fruit shapes also varied considerably among the genotypes. 'Shakanda' had elliptic-shaped fruits, 'Shakarfo' produced circular-shaped fruits, 'Habi' had ovate-shaped fruits, while 'Ali Sha Kaka' exhibited oblong-shaped fruits. In the over-colour fruit trait, a diversity in overcolor was also noted in these genotypes. 'Shakanda' and 'Ali Sha Kaka' had no overcolor, while 'Shakarfo' exhibited greenish/brownish tiny spots and 'Habi' had small pinkish splashes on the fruits. Harvesting maturity also differed among the genotypes. Based on fruit maturity, 'Ali Sha Kaka' was classified as an early-mid-season variety, 'Shakanda' as an early-season variety, 'Habi' as a mid-season variety, and 'Shakarfo' matured during the late season. The variations among fruit pomological traits, including fruit size, ground colour, over colour and fruit shape, are illustrated in Fig. (1).

| Genotypes | Fruit color | Fruit size | Fruit shape | Over color | Harvesting maturity |
|---|---|---|---|---|---|
| **Shakanda** | White orange | Small | Elliptic | Absence | Mid-season |
| **Shakarfo** | Orange greenish | Medium | Circular | Greenish/brownish spots | Mid-late |
| **Habi** | Dark orange | Small | Ovate | Pinkish | Early-mid |
| **Ali sha kaka** | Whitish-Yellow | Small | Elliptic | Absent | Mid-season |

**Table. 1:** Morphological qualitative variation in four apricot genotypes of Gilgit Baltistan


**Figure 1:** Morphological variation observed in (a) fruit , (b) leaf and (c) stone traits of apricot genotypes of Gilgit Baltistan

### 3.2 Comparative assessment of morphological quantitative traits in apricot genotypes of Gilgit Baltistan

#### 3.2.1 Fruit size (cm$^2$), Fruit weight (g), Fruit firmness (kg/cm$^2$), Leaf area (cm$^2$) and Stone weight (g)

The quantitative morphological assessment revealed significant diversity among the selected apricot genotypes in various parameters, as presented in Table 2. The results indicated notable differences in fruit size among the genotypes. 'Shakarfo' exhibited the largest fruit size (28.8 cm²), followed by 'Shakanda Red' (19.8 cm²) and 'Habi' (17.2 cm²), while 'Ali Sha Kaka' had the smallest fruit size (10.1 cm²). Similarly, fruit weight varied significantly among the genotypes. 'Shakarfo' produced the heaviest fruits, with an average weight of 45.1 g, followed by 'Shakanda' (38.2 g) and 'Habi' (33.7 g). In contrast, 'Ali Sha Kaka' exhibited the lightest fruits, with an average weight of 25.3 g. Fruit firmness also differed among the genotypes. 'Habi' demonstrated the highest firmness (3.10 kg/cm²), followed by 'Shakanda' (2.61 kg/cm²) and 'Ali Sha Kaka' (2.17 kg/cm²), whereas 'Shakarfo' had the softest fruits (1.52 kg/cm²). The leaf area varied significantly depending on the genotype. 'Shakarfo' displayed the largest leaf area (40.3 cm²), followed by 'Habi' (29.6 cm²), 'Shakanda' (19.0 cm²), and 'Ali Sha Kaka' (17.2 cm²). Stone weight also exhibited considerable variation among the genotypes. 'Shakarfo' had the heaviest stones (4.7 g), while 'Ali Sha Kaka' had the lightest stones (2.4 g). The mean stone weights were 3.4 g for 'Shakanda', 3.2 g for 'Habi', and 4.7 g for 'Shakarfo'. These findings highlight significant diversity in the quantitative morphological traits of the selected apricot genotypes, underscoring their potential for breeding and selection in horticultural programs.

| Genotypes | Fruit size (cm$^2$) | Fruit weight (g) | Firmness (Kg/cm$^2$) | Leaf area (cm$^2$) | Stone weight (g) |
|---|---|---|---|---|---|
| **Shakanda** | 19.8$^b$ | 38.2$^b$ | 2.6$^b$ | 19.0$^c$ | 3.4$^b$ |
| **Shakarfo** | 28.8$^a$ | 45.1$^a$ | 1.5$^d$ | 40.3$^a$ | 4.7$^a$ |
| **Habi** | 17.2$^b$ | 33.7$^c$ | 3.9$^a$ | 29.6$^b$ | 3.2$^b$ |

| | | | | | |
|---|---|---|---|---|---|
| **Ali sha kaka** | 10.1$^{c}$ | 25.3$^{d}$ | 2.17$^{c}$ | 17.2$^{c}$ | 2.3$^{c}$ |

*Means with same letters do not differ significantly at p 0.05 by LSD test (P≤ 0.05).

**Table. 2: Morphological quantitative characteristics of four apricot genotypes of Gilgit Baltistan**

### 3.3 Biochemical assessment of apricot genotypes

#### 3.3.1 pH

The pH analysis revealed significant variability among the observed apricot genotypes ($p \leq 0.05$), as illustrated in Figure 2. The pH values ranged from 3.2 to 6.3. The highest mean pH was recorded in 'Shakanda' (6.3), followed by 'Habi' (5.1) and 'Shakarfo' (4.2). In contrast, 'Ali Sha Kaka' exhibited the lowest pH value (3.2).

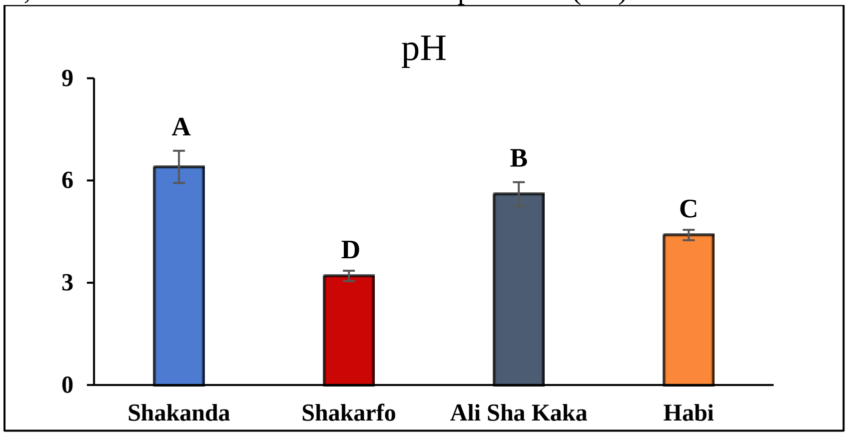


**Figure. 2**: Comparison of pH level among apricot genotypes grown in Gilgit Baltistan

#### 3.3.2 Total soluble solids (°Brix)

The results of this experiment revealed significant diversity in the total soluble solid (TSS) content among the assessed apricot genotypes ($p \leq 0.05$), as shown in Figure 3. 'Shakanda' exhibited the highest TSS value (23.4°B), followed by 'Habi' (19.66°B) and 'Ali Sha Kaka' (16.7°B). However, the genotype, 'Shakarfo' demonstrated the lowest TSS content (12.5°B).

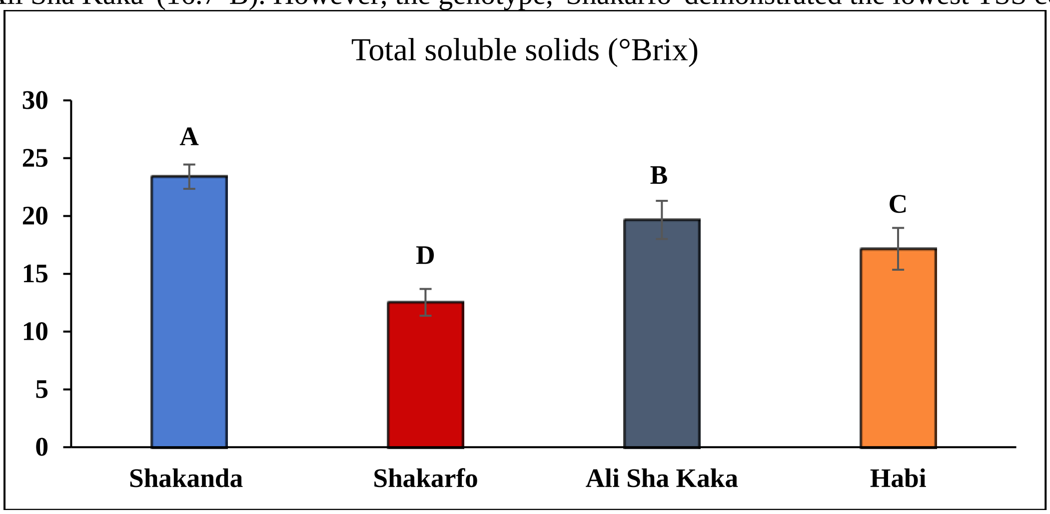


**Figure. 3: Comparison of total soluble solids among apricot genotypes grown in Gilgit Baltistan**

#### 3.3.3 Titratable Acidity (%)

The data revealed significant variation in titratable acidity among the apricot genotypes ($p \leq 0.05$), as depicted in Figure 4. 'Shakarfo' exhibited the highest titratable acidity (1.28%), followed by 'Ali Sha Kaka' (0.96%) and 'Habi' (0.64%). In contrast, 'Shakanda' recorded the lowest titratable acidity (0.49%).

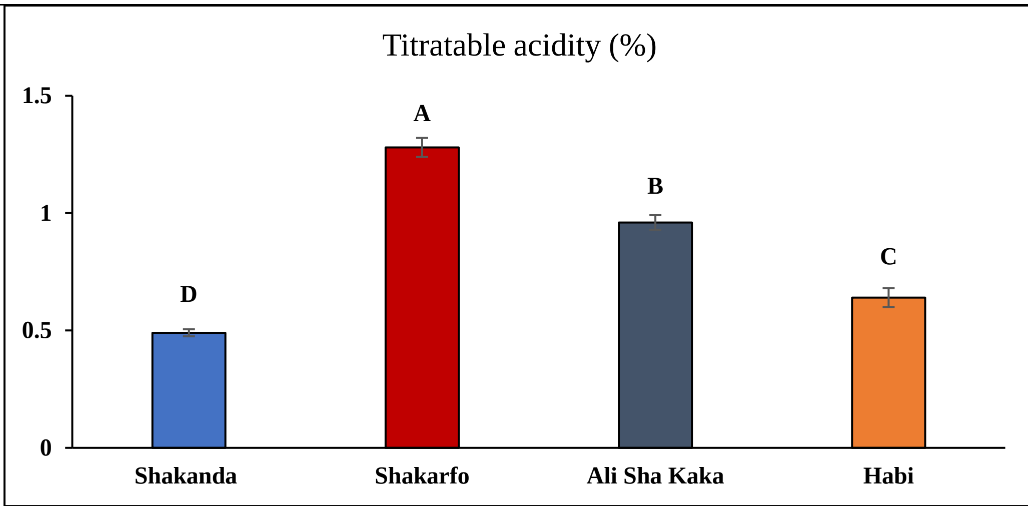


**Figure. 4: Comparison of titratable acidity among apricot genotypes grown in Gilgit Baltistan**

### 3.3.4 Ascorbic acid (mg/100g FW)

The findings of this study revealed significant variation in ascorbic acid content among the assessed apricot genotypes ($p \leq 0.05$), as shown in Figure 5. 'Shakarfo' exhibited the highest ascorbic acid content, followed by 'Shakanda' and 'Ali Sha Kaka'. In contrast, 'Habi' had the lowest ascorbic acid content. The mean ascorbic acid values were 15.4 mg, 11.6 mg, 9.6 mg, and 5.9 mg per 100 g of fresh sample for 'Shakarfo', 'Shakanda', 'Ali Sha Kaka', and 'Habi', respectively.

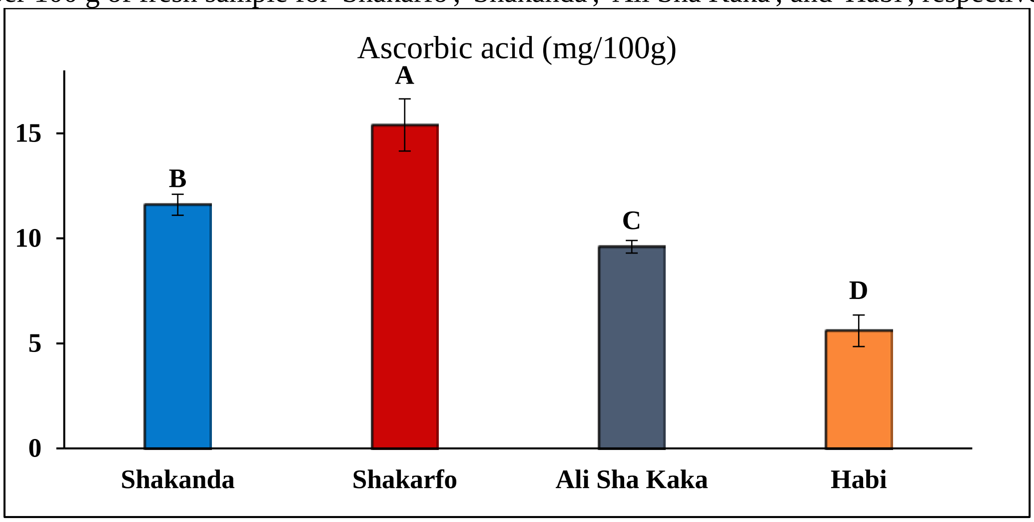


**Figure. 5: Comparison of ascorbic acid contents among apricot genotypes grown in Gilgit Baltistan**

### 3.3.5 Total phenolic contents (mg GAE/100g)

The results of this study revealed significant varietal diversity in total phenolic content ($p \leq 0.05$), as illustrated in Figure 6. The highest total phenolic content was observed in 'Shakarfo' (42.12 mg GAE/100g), followed by 'Shakanda' (27.54 mg GAE/100g) and 'Ali Sha Kaka' (19.31 mg GAE/100g). In contrast, 'Habi' exhibited the lowest total phenolic content (14.55 mg GAE/100g).

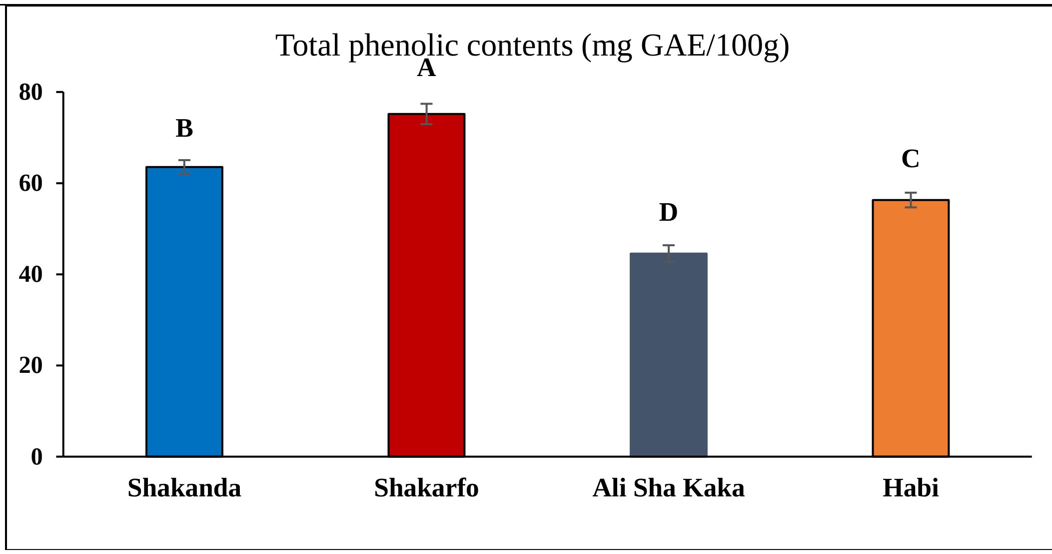


**Figure. 6: Comparison of total phenolic contents among apricot genotypes grown in Gilgit Baltistan**

### 3.3.6. Pomological assessment of apricot genotypes of Gilgit Baltistan

Morphological evaluation is crucial in scientific studies, particularly in assessing germplasm diversity (Urrestarazu et al., 2018). This method can also be used to determine genetic diversity through techniques such as Inter Simple Sequence Repeats (ISSR) and Random Amplified Polymorphic DNA (RAPD) (Sümbül et al., 2024). Its simplicity and effectiveness make it one of the most widely accepted methods for genetic evaluation. For centuries, phenotypic characteristics of fruits have been used in horticulture to characterize and identify genotypes. Traits such as fruit size, shape, skin colour, and overcolor are essential because they contribute significantly to consumer appeal (Maeda et al., 2018). In this study, fruit shape, skin colour, and overcolor were beneficial for characterizing the apricot genotypes.

In the morphological qualitative assessment, five apricot genotypes were compared using the apricot descriptor (UPOV, 2021). The results revealed significant diversity among the genotypes in terms of morphological traits. Variations were observed in fruit colour, shape, overcolor, harvesting maturity, and size. All genotypes exhibited small-sized fruits, except for 'Shakarfo,' which had medium-sized fruits. The fruit colours ranged from light orange in 'Shakanda' to yellow in 'Ali Sha Kaka,' with varying shapes from circular in 'Shakarfo' to elliptic in 'Ali Sha Kaka.' The harvesting maturity for 'Shakanda' was early-mid season, while 'Shakarfo' was a late-season variety. Overcolor was absent in 'Shakanda' and 'Ali Sha Kaka,' while 'Habi' exhibited pinkish overcolor.

Our findings are consistent with those of Gecer et al. (2020), who observed variation in fruit shape, color, firmness, weight, and harvesting maturity among 26 apricot genotypes. Similarly, Rezaei et al. (2020) noted variations in fruit shape, colour, and harvesting maturity in 98 apricot genotypes Rakida (2023) also reported variation in skin colour among apricot genotypes, while Wani et al. (2017) documented considerable variation in fruit skin colour, overcolour, fruit size, and shape across different apricot genotypes. These morphological traits are influenced by a combination of climatic factors, soil types, ecological conditions, and the genetic makeup of the genotype (Akram et al., 2020). Therefore, the observed variation in morphological characteristics can be attributed to differences in genomic composition, environmental factors, and soil types (Akram et al., 2021).

Fruit size and weight are closely linked traits that significantly influence crop market acceptance and yield, including apricot (Cantore et al., 2016). These pomological attributes are crucial in determining quality and consumer preference (Rodrigues et al., 2018). Additionally, fruit size influences marketing strategies, determining whether the fruit is to be processed or sold as table fruit. Customers typically prefer larger fruits to smaller ones (Pashova et al., 2024). However, intermediate-sized fruits are generally recommended for breeding programs (Lachkar et al., 2021). Fruit maturity is often assessed based on fruit weight and size (Kumar et al., 2023).

In this study, we observed fruit size and weight variation among the four apricot genotypes, ranging from 10.13 $mm^2$ to 28.8 $mm^2$ and fruit weight ranging from 25 g to 45.1 g. Similar results were reported by Karatas et al. (2021) in Turkey, who identified variations in apricot fruit size and weight. These findings are consistent with those of Rakida (2023), who observed fruit weight variations ranging from 12.3 g to 53.1 g. The fruit weight range in this study was lower than that reported by Milošević et al. (2014), who examined 13 apricot genotypes in Serbia and recorded fruit weight variations from 37.06 g to 81.60 g.

Fruit firmness is a critical factor influencing transportation and postharvest storage life, directly affecting fruit quality and shelf life. Fruits with reduced firmness typically have a shorter market duration (Riva et al., 2020). This study observed notable differences in fruit firmness across the four genotypes, with values ranging from 1.9 kg/cm² to 5.1 kg/cm². Our findings are consistent with those of Awad et al. (2016), who reported fruit firmness ranging from 1.66 kg/cm² to 3.8 kg/cm². Similarly, Karatas (2022) observed fruit firmness values between 4.05 kg/cm² and 6.03 kg/cm². The fruit firmness range in this study was higher than that reported by Ayour et al. (2021), who examined three apricot genotypes in Morocco and found a maximum fruit firmness value of approximately 3.4 kg/cm², which might be due to genetic difference of the cultivars.

Leaves are the primary site for nutrient production in plants and are essential for regulating photosynthesis and other metabolic processes (Baird et al., 2021). Leaf area is directly related to plant health and nutrient translocation, and any biotic or abiotic stress can negatively affect fruit size, weight, and leaf area (Tao et al., 2023). The results of this study demonstrated significant variation in leaf area and pit/stone size among the four apricot genotypes. The leaf area ranged from 17.2 cm² to 40.3 cm², while the pit/stone weight ranged from 2.3 g to 4.7 g. These findings align with Salari et al. (2020) and Rezaei et al. (2020), who also reported variations in stone weight and leaf area.

The observed variations in fruit size, leaf area, fruit weight, and stone size are likely attributed to factors such as genomic differences, nutrient availability, the nutrient uptake capacity of each genotype, plant density, and plant age (Kumar et al., 2013). Additionally, fruit firmness is heavily influenced by genotype, the plant's water retention capacity, storage temperature, and the maturity and ripening stages of the fruit (Brüggenwirth et al., 2016).

**3.3. 7. Biochemical assessment of apricot genotypes of Gilgit Baltistan**

Currently, breeders are focusing on developing new fruit cultivars with health-promoting biochemical characteristics (Akram et al., 2024). Factors such as titratable acidity, pH, and total soluble solids (TSS) determine fruit taste and flavour. TSS is directly proportional to fruit sweetness, while titratable acidity is associated with sourness (Lee et al., 2013). These characteristics, TSS, titratable acidity (TA), and pH, are also used as maturity indices for horticultural produce (Ghanghas et al., 2024). Several studies have shown that consumers prefer fruits with higher TSS values, low titratable acidity, and high antioxidant content (Velardo-Micharet et al., 2021). A titratable acidity of approximately 0.60% is generally preferred by customers (Zargar et al., 2023).

This study examined the total soluble solids (TSS), titratable acidity (TA), and pH in four apricot genotypes. The results revealed significant variation in these attributes ($P \leq 0.05$). The highest TSS values were recorded in 'Shakanda' (23.3°Brix), while the lowest was found in 'Shakarfo' (12.3°Brix). 'Shakanda' also exhibited the highest pH values, whereas 'Shakarfo' displayed the lowest pH. Regarding titratable acidity, 'Shakarfo' showed the highest values, while 'Shakanda' had the lowest. These findings are consistent with those of Yilmaz et al. (2009) and Asma (2012), who observed TSS ranges of 17.6–26.2°Brix and 17–24°Brix, respectively. Our results also align with those of Waseem et al. (2021), who reported similar levels of variation in titratable acidity (0.026%–1.54%) among 26 apricot genotypes from northern Pakistan. Additionally, Sartaj Ali et al. (2014) observed a comparable range of titratable acidity (0.45–0.86%) in apricots from Gilgit-Baltistan. However, the TA range in this study was lower than that of Alajil et al. (2021), who recorded a TA range of 1.88% to 2.5% among six apricot genotypes in India. Furthermore, the TA findings in this study were higher than those of Su et al. (2022), who reported titratable acidity values between 0.52% and 0.80% in apricot genotypes from China.

Apricot fruits are rich in antioxidants and polyphenols, contributing to human health by reducing the risk factors associated with various diseases (Rampáčková et al., 2021). In addition, apricots contain a range of secondary metabolites, including ascorbic acid and phenolic compounds, which provide significant health benefits (Gómez-Martínez et al., 2021). The antioxidants, notably polyphenols, exhibit anti-inflammatory and antioxidant properties by enhancing the functionality of endogenous antioxidant enzymes such as superoxide dismutase, peroxidase, catalase, and proline (Sorrent et al., 2023). Furthermore, vitamins, including vitamin C, are crucial in regulating numerous physiological processes and boosting the immune system by inhibiting redox reactions (Baviskar et al., 2024). Vitamin C also supports the body's healing process, helps prevent regenerative diseases, and mitigates heavy metal toxicity (Kitic et al., 2022).

In this study, the four apricot genotypes exhibited varying levels of ascorbic acid (5.6 to 15.4 mg/100g fresh weight) and total phenolic content (14.55 to 42.18 mg GAE/100g dry weight). These findings align with those of Fratianni et al. (2022), who reported ascorbic acid content ranging from 2.65 to 10.65 mg/100g of fresh weight in apricot. Similarly, Alajil et al. (2023) observed a comparable range of ascorbic acid (4.35 to 15.71 mg/100g) in six apricot genotypes. The ascorbic acid levels in this study were lower than those reported by Pfeiffer et al. (2014), who examined apricot genotypes in Turkey and found ascorbic acid content ranging from 27.9 mg to 37.7 mg per 100g of fresh weight. Additionally, our results are consistent with those of Keçe et al. (2024), who recorded phenolic contents ranging from 33.47 to 59.4 mg GAE/100g fresh weight in 31 apricot genotypes. Our findings on phenolic content also agree with the work of Imrak et al. (2017), who found similar levels of phenolic compounds in six apricot genotypes. However, the total phenolic contents in this study were lower than those reported by Karatas (2022), who found phenolic levels ranging from 68.3 to 81.4 mg GAE/100g in fourteen apricot genotypes in Turkey.

The observed differences in biochemical parameters among the apricot genotypes in this study may be attributed to various factors, including genotype, soil conditions, environmental influences, and nutritional imbalances (Nawazish et al., 2015). The genetic variability of the genotypes plays a crucial role in these differences (Martínez-Esplá et al., 2014). Additionally, the maturity level of the fruit at harvest can influence the concentrations of these biochemical compounds (Wani et al., 2016; Usenik et al., 2014).

The assessed apricot genotypes exhibited differences in their pomological and phytochemical characteristics, highlighting the diversity that could benefit future breeding programs. 'Shakarfo' demonstrated superiority in phenolic content, ascorbic acid, and most pomological attributes, except for fruit firmness, making it suitable for the processing industry. These antioxidants and vitamins help prevent the spoilage of fruit by-products (Poljsak et al., 2021). On the other hand, the 'Habi' and 'Shakanda' genotypes, with their sweet, firm fruit and attractive colour, are more suitable for table use. In contrast, the pomological attributes of 'Ali Sha Kaka' pose challenges for marketing, making it more appropriate for drying purposes. Ochmian et al. (2013) observed similar pomological and biochemical attribute patterns among three grape varieties, categorizing them for table use or processing.

**Conclusion**

The study findings concluded significant morphological and biochemical diversity among the apricot genotypes 'Shakanda', 'Shakarfo', 'Ali Sha Kaka', and 'Habi' grown in Gilgit Baltistan. 'Shakarfo' excelled in fruit size, weight, leaf area, and stone weight, while 'Ali Sha Kaka' showed the lowest values. Biochemically, 'Shakanda' exhibited the highest total soluble solids, whereas 'Shakarfo' stood out for its ascorbic acid and total phenolic content. These findings underscore the substantial variation in apricot genotypes within the region, providing a valuable resource for breeding programs and cultivar improvement efforts

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