

RESEARCH PAPER

Ripening-associated changes in physical and chemical quality parameters for determining optimum harvest time in 'Black Plum' (*Prunus domestica* L.)

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Abstract

The native 'Black Plum' (*Prunus domestica* L.), cultivated in Iğdır, Türkiye, is valued for its rich flavor, deep purple-black color, and size. This study aimed to determine the optimum harvest time of 'Black Plum' by integrating multiple physicochemical maturity parameters monitored throughout fruit development. In the study, color values, fruit firmness, soluble solids content (SSC), pH, organic acids, phenolic compounds, and physical properties (fruit weight, fruit width and length, sphericity) were analyzed weekly from the 2nd week of May to the 3rd week of July. The results showed that the fruit color parameters changed during the ripening process, which showed a gradual ripening from green to dark purple-black. Fruit weight increased from 1.75 g to 32.84 g, firmness peaked at week 6th (1224.08 g) and gradually decreased thereafter, while elasticity increased significantly after week 8. The SSC increased continuously from week 4 and reached 13.43% at week 11. Citric acid peaked at week 8 (304.61 mg 100 g⁻¹ f.w), whereas ascorbic acid reached its highest level at week 6 (592.86 mg 100 g⁻¹ f.w). Gallic acid and catechin fluctuated throughout the ripening process. Rather than relying on a single indicator, the combined evaluation of pomological and phytochemical traits provided a robust basis for maturity assessment. Based on pomological and phytochemical characteristics, the 10 and 11 weeks, when the fruit color changes from green to red and purple, were identified as the optimal harvest period. These findings offer practical guidance for growers and postharvest management and may contribute to optimizing fruit quality and market value through precise harvest timing.

Keywords

'Black Plum', fruit development, ripeness assessment, quality characteristics

Introduction

Plums (*Prunus domestica* L.), belonging to the family Rosaceae, the genus *Prunus*, and the subgenus *Prunophora*, are economically valuable stone fruits widely cultivated in temperate regions (Gull et al. 2022). Their extensive

adaptability to diverse agroclimatic conditions enables their cultivation in almost all parts of Türkiye, with the exception of high-altitude zones in Eastern Anatolia and the dry plains of Southeastern Anatolia (Özçağiran 2011; Yaman and Satmaz 2023). There are more than 200 recognized plum species worldwide; therefore, selecting suitable cultivars for

regional production is essential to meet market-driven fruit quality standards. Determining the optimum harvest time is a critical factor for maintaining fruit quality and minimizing postharvest losses. During ripening, plums undergo significant physicochemical changes, including a reduction in firmness, an increase in total soluble solids (TSS), conversion of starch to sugars, a decrease in organic acids, and pigmentation changes that contribute to flavor and color development (Kailaku et al. 2023; Rizzo et al. 2023). However, the expression of maturity indices and optimal harvest timing may vary significantly among cultivars and growing regions, which underscores the importance of cultivar-specific evaluation (Korićanac et al. 2025). In addition, the biosynthesis of volatile aromatic compounds intensifies, enhancing the sensory properties that directly affect consumer acceptance (García-Gómez et al. 2020; Chen and Quek 2023; Mieszczakowska-Frąć et al. 2025). These parameters are routinely used as maturity indices to define harvest guidelines for different plum cultivars (Gull et al. 2022).

Harvesting either too early or too late has a detrimental effect on fruit texture, flavor, storability, and market value. Early harvesting leads to underdeveloped fruit with inferior flavor, while late harvesting accelerates softening and reduces shelf life (Kunwar et al. 2024). Therefore, cultivar-specific studies focusing on harvest timing are essential to ensure optimal fruit quality, especially in regions such as Türkiye, where plums play an important role in local horticulture and export markets (Sonmete 2012; Bolat et al. 2017). In Iğdır Province, several plum cultivars are cultivated, including a local selection known as 'Black Plum', which is distinguished by its large fruit size and favorable organoleptic characteristics (Yaşar et al. 2022). However, scientific information regarding its ripening behavior and optimal harvest timing remains limited.

Accordingly, the objective of this study was to determine the optimum harvest time of the 'Black Plum' cultivar based on ripening-related physicochemical changes. The findings are expected to provide practical guidance for growers and consumers to optimize harvest timing and improve market value.

Materials and methods

The research was conducted in 2017 in a 'Black Plum' orchard belonging to a producer located in the city center of Iğdır, Eastern Türkiye. The orchard was planted at a spacing of 5 × 6 m between trees and rows and was managed under conventional cultivation practices common in the region. Sampling began in the second week of May, approximately two weeks after full bloom, and continued weekly until the third week of July (Fig. 1). Each week, 30 fruits were

randomly collected from the same three randomly selected, uniformly vigorous trees (10 fruits per tree) distributed throughout the orchard to represent orchard-level variability. The fruits were packed in plastic bags, immediately transported to the laboratory, and stored at -18 °C in a freezer until further chemical analyses.

Physical and pomological analyses

The dimensions of the fruit samples, including length and width, were determined using a digital caliper for precise measurements. The weight of each fruit was measured using a high-precision digital scale with an accuracy of 0.01 g. To further analyze the physical properties of the fruits, the geometric mean diameter (Dg) and sphericity (S) were calculated using specific mathematical formulas.

$$Dg = [(lwt)]^{1/3}$$

$$s = [((lwt)^{1/3})/I] \times 100$$

Where: Dg (mm) stands for the geometric mean diameter and s (%) for the sphericity. The terms l, w, and t denote the length, width, and thickness of the fruit in millimeters.

Fruit firmness measurement

Fruit firmness and elasticity were measured using a TA-XT2 texture analyzer (Stable Microsystems, Surrey, UK) with a 2 mm diameter cylindrical stainless-steel probe and a 30 kg load cell. Measurements were conducted at an initial and final speed of 5 mm/s, with a test speed of 1 mm/s and a penetration depth of 3 mm, following the method of Cui et al. (2008).

Color measurement

The skin color of the 'Black Plum' cultivar was determined using a Minolta CR-410 colorimeter (Osaka, Japan). Measurements were taken from three different points on each fruit and recorded according to the CIE L*, a*, and b* system. Additionally, chroma (C*) and hue angle (h°) parameters were calculated from these values to further characterize the color profile.

$$C^* = \sqrt{a^{*2} + b^{*2}}$$

$$h^{\circ} = \arctan b^*/a^*$$



Figure 1. The different development stages of the cv. "Black Plum".

Chemical properties

Soluble solids content (SSC) and pH measurements

The soluble solids content (SSC) of the plum juice was measured using a digital abbe refractometer with results expressed in °Brix. The acidity level of the extracted juice was measured with a pH electrode connected to a Consort C3040 multiparameter device (Belgium).

Sample extraction

The plum extraction process followed a modified protocol by Alwazeer and Örs (2019). A 5 g fruit sample was mixed with 10 mL of 50% methanol (v/v, 0.1% HCl). The mixture was homogenized using an IKA Ultra Turrax T18, homogenizer (Korea) at 1300 rpm for 1 min) and allowed to stand for 2 h at room temperature in the dark. After incubation, the extract was centrifuged (10,000 × g for 15 min, at 10 °C). The supernatant was then filtered with Whatman No. 4 paper and a 0.45 µm membrane filter for purification. Finally, the extract was stored at –80 °C for further analysis.

Organic acids analysis

The organic acids were analyzed isocratically according to a modified version described by Tan et al. (2023). An Agilent 1260 HPLC system with a diode array detector (DAD) and an ACE GENERIX 5 C18 column (5 µm, 4.6 mm × 250 mm) was used for the analysis. The separation was performed at 30 °C using 98% Na₂HPO₄ (pH adjusted to 2.4 with H₃PO₄) as the mobile phase. The flow rate was kept at 1 mL min^{–1}. The detection wavelengths were set to 210 nm for citric acid and 400 nm for ascorbic acid.

Phenolic compounds analysis

The separation of phenolic compounds was carried out according to a modified method by Hussain et al. (2013). An Agilent 1260 HPLC system with a diode array detector (DAD) and a Poroshell 120 EC-C18 column (2.7 µm, 4.6 mm × 150 mm) was used for the analysis. A gradient elution was performed with mobile phase B (83% phosphoric acid, 17% acetonitrile). The flow rate was 1 mL/min and the injection volume was 20 µL. The gradient program was set

as follows: 83% A (1 min), 70% A (2 min), 60% A (4 min), back to 83% A (10 min). The wavelengths for detection were 210 nm and 300 nm, with the column kept at 20 °C.

Statistical analysis

Statistical evaluation was conducted using SPSS software (v.18, SPSS Inc., Armonk, NY, USA). The experiment was arranged in a completely randomized design (CRD). Data were subjected to one-way ANOVA, followed by Duncan's multiple range test to assess significant differences ($P < 0.05$). Results are presented as mean ± standard deviation.

Results and discussion

Color evaluation

Color is an important indicator of the ripeness and harvest time of certain fruits. The color of the fruit reflects the chemical changes that occur during the ripening process and helps to determine the degree of ripeness and the optimal harvest time (Köksal and Büyükkartal 2011). The color values (L^* : lightness, a^* : red–green coordinate, b^* : yellow–blue coordinate, C^* : chroma, and hue angle) of cv. “Black Plum” during eleven-week harvest periods from the 2nd week of May to the 3rd week of July are presented in Table 1.

The L^* value increased continuously from the first week to the seventh week, reaching a peak value of 56.79. A gradual decline in the L^* value was observed in the following weeks, reaching a reduced value of 29.93 in the 11th week. This reduction in lightness during the final ripening stages indicates increased pigment accumulation and reduced surface reflectance, which are characteristic features of advanced fruit maturity (Xiao et al. 2024). The sharp decline observed, particularly in the last two weeks, suggests the onset of full ripening and the development of the characteristic dark purple-black skin color.

The a^* value remained negative from the 1st to the 8th week (–7.30 to –16.10), indicating the dominance of green tones due to high chlorophyll content. From the 9th week onwards, a^* values increased sharply and reached 27.83 in the

Table 1. Color parameters (L^* , a^* , b^* , C^* , and h^*) of cv. “Black Plum”.

No.	Harvesting Date	L^*	a^*	b^*	h^*	C^*
1	09.05.2017	26.36 ± 0.54g	–7.30 ± 0.38c	11.27 ± 0.53f	122.94 ± 0.52a	13.42 ± 0.64f
2	16.05.2017	43.79 ± 1.02de	–16.52 ± 0.56c	26.17 ± 1.14d	122.26 ± 0.31a	30.95 ± 1.26cd
3	23.05.2017	46.24 ± 1.25cd	–18.11 ± 0.55c	29.93 ± 1.10cd	121.18 ± 0.24a	34.98 ± 1.21bc
4	30.05.2017	42.75 ± 0.65e	–16.43 ± 0.22c	26.23 ± 0.54d	122.06 ± 0.22a	30.95 ± 0.57a
5	06.06.2017	50.84 ± 0.98b	–18.60 ± 0.50c	31.02 ± 1.13bc	120.95 ± 0.25a	36.17 ± 1.23b
6	13.06.2017	49.01 ± 0.34bc	–17.44 ± 0.18c	29.98 ± 0.26cd	120.19 ± 0.25a	34.68 ± 0.27bc
7	20.06.2017	56.79 ± 1.00a	–15.65 ± 1.55c	34.91 ± 2.00ab	114.15 ± 2.45a	38.26 ± 1.95ab
8	27.06.2017	55.63 ± 0.43a	–16.10 ± 0.30c	37.38 ± 0.48a	113.30 ± 0.45a	40.70 ± 0.47a
9	04.07.2017	40.56 ± 1.85e	22.52 ± 2.05b	19.39 ± 3.02e	40.73 ± 5.63b	29.71 ± 2.12cd
10	11.07.2017	32.61 ± 1.98f	27.83 ± 1.94a	8.59 ± 0.92f	17.16 ± 3.36b	29.12 ± 2.12de
11	18.07.2017	29.93 ± 1.24f	23.89 ± 1.79b	9.36 ± 1.89f	21.39 ± 3.05b	25.65 ± 2.24e
Significance ⁺⁺		0.000	0.000	0.000	0.000	0.000

Color values represent the mean of two independent experiments, with three samples per replicate (n = 6). ++ $P < 0.001$.

10th week, reflecting the transition from green to red–purple coloration associated with anthocyanin accumulation. A similar pattern of chlorophyll degradation followed by anthocyanin-driven redness increase has been reported in plums by Long et al. (2025) and Usenik et al. (2009).

The b^* value represents the blue and yellow color axis, with $-b^*$ indicating a shift to blue tones and $+b^*$ indicating a shift to yellow tones (Durmus 2020). The b^* value (yellow–blue axis) showed a general increase between the 2nd and 8th weeks, reaching its maximum in the 8th week (37.38), which may be attributed to carotenoid prominence during early ripening stages. However, the subsequent decline after the 9th week suggests that increasing anthocyanin synthesis masked yellow tones as ripening progressed. These coordinated changes in a^* and b^* values indicate a strong relationship between color parameters and pigment dynamics during fruit maturation.

Chroma (C^*), which reflects color saturation and vividness, increased steadily from the 1st week (13.42) to peak values in the 7th and 8th weeks (38.26 and 40.70, respectively), before declining in the final three weeks. This pattern indicates that color intensity reaches its maximum slightly before full ripening, after which darker pigmentation reduces perceived saturation, a phenomenon commonly associated with advanced anthocyanin accumulation (Usenik et al. 2009; Xiao et al. 2024).

The hue angle (h^*) measures the position of a color on the color wheel in degrees, corresponding to specific wavelengths that define certain colors such as 0° (red), 60° (yellow), 120° (green), 180° (cyan), 240° (blue), and 300° (magenta) and thus determines the dominant

wavelength or type of color (Kasajima 2019). In ‘Black Plum’, the lowest and highest hue values were recorded at week 10th (17.16) and 1st (122.94), respectively. The hue value, which remained relatively constant in the first eight weeks, showed a clear decrease in the last three weeks. This means that the fruit color changed from green to red during the ripening period.

Plum fruit coloration is mainly attributed to chlorophylls, carotenoids, and anthocyanins. During ripening, chlorophyll degrades, while carotenoids (e.g., β -carotene) contribute yellow–orange hues and anthocyanins (e.g., cyanidin-3-glucoside) promote red–purple pigmentation. Dynamic changes in these pigments ultimately determine the final fruit color (Long et al. 2025). Consistent with previous studies (Usenik et al. 2009; Long et al. 2025), pigment dynamics especially anthocyanin accumulation and chlorophyll degradation drive color development in plums. However, unlike Usenik et al. (2009), this study found a stronger correlation between anthocyanin levels and color parameters, particularly at the final ripening stage, indicating cultivar-specific differences in pigment regulation.

Physical and pomological properties

The weight and dimensions of fruit are important quality indicators that strongly influence consumer preferences. These attributes have a direct impact on the marketability and acceptability of fruit (Kelley et al. 2016). The physical properties of ‘Black Plum’ cultivar during the ripening process are presented in Fig. 2. Statistically significant

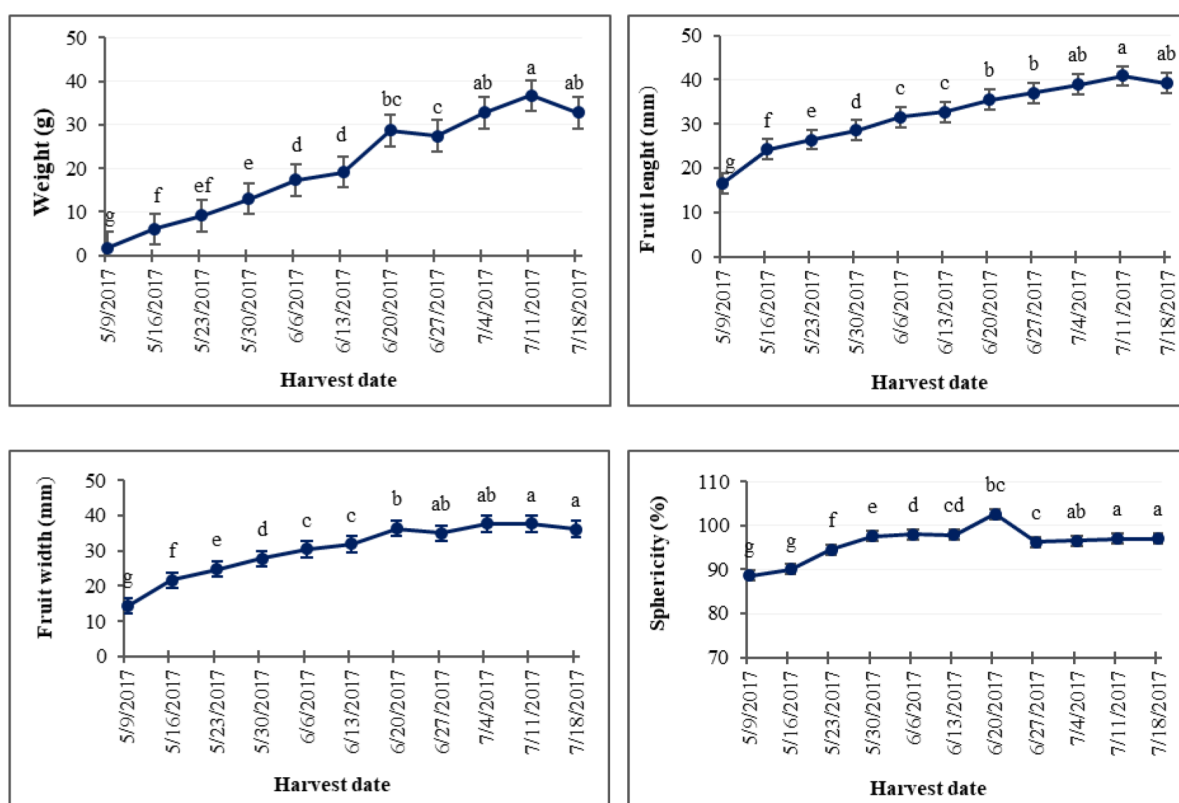


Figure 2. Variations in weight, length, width, and sphericity of cv. “Black Plum” during ripening. The ANOVA results showed that changes in these parameters were statistically significant ($P < 0.001$).

variations ($p < 0.05$) were observed in the physical properties of 'Black Plum' samples at collected two weeks interval.

Fruit weight, width, and length increased steadily throughout ripening. While fruit weight, width, and length in the 1st week were 1.75 g, 14.37 mm, and 16.59 mm, respectively, these values reached 32.84 g, 36.16 mm, and 39.26 mm in the 11th week. The continuous and statistically significant increase in these parameters indicates active cell expansion and dry matter accumulation during fruit development, which are characteristic of advanced ripening stages (Li et al. 2025; Ortuño-Hernández et al. 2025). The highest values were recorded in the 9th and 10th weeks, coinciding with the period when color parameters also showed rapid transitions, suggesting coordinated physical and biochemical maturation.

The sphericity generally increased during the ripening process and reached its highest value of 102.58% in the 7th week, then fluctuated slightly and leveled off at 97.06% in the 11th week. The observed changes in sphericity reflect that fruit development included both dimensional expansion and shape modification, particularly during the mid-ripening phase.

In earlier studies, Usenik et al. (2008) reported that the fruit weight of four plum cultivars increased during different periods from the 1st to the 5th week as follows: in the 'Jojo' cultivar from 25.2 g to 33.2 g, in 'Čačanska rodna' from 16.5 g to 19.7 g, in 'Čačanska najbolja' from 23.1 g to 25.7 g, and in 'Valor' from 27.5 g to 28.5 g. Sezer and Çetin (2021) found that the fruit weight of the 'Papaz' plum cultivar ranged between 5.49 and 20.02 g, with fruit length between 22.92 and 30.01 mm, width between 20.84 and 28.88 mm, and thickness between 20.28 and 27.54 mm across three harvest periods. These variations can be attributed to genetic factors, cultivar-specific characteristics, orchard management practices, and local climate and soil conditions. Harvesting stage and fruit maturity are also critical determinants of fruit quality, as physical growth during ripening is closely linked to biochemical changes that affect taste and consumer acceptance. As fruits approach optimum maturity, higher soluble solids content (SSC), sugars, organic acids, and greater anthocyanin accumulation, all of which contribute to improved flavour and visual quality generally accompany increases in size and weight. Alniak

and Çetin (2021) similarly reported significant differences in the physical traits of plums at different harvest stages in the Aydın province of Türkiye. Compared to previous studies, the present study more clearly demonstrates that ripening stage and regional growing conditions together influence fruit size, colour development, and chemical quality, highlighting the importance of precise harvest timing for optimal fruit quality.

Fruit firmness and elasticity

The texture of a fruit refers to its physical properties that can be perceived in the mouth and is influenced by factors such as cell structure, water content, pectin and fiber composition, ripeness, and genetic characteristics (Lahaye et al. 2020). In black plum, firmness increased during the first six weeks and reached its highest value in the 6th week (1224.08 g), followed by a gradual decrease from the 7th to the 11th week (Fig. 3). Elasticity, on the other hand, remained low during the early stages of fruit development, increased significantly from the 8th week, and reached its maximum value in the 10th week, followed by a slight decline in the final weeks. The increase in elasticity during ripening is associated with progressive structural changes that enhance tissue flexibility. However, at advanced or over-ripening stages, elasticity may decrease due to excessive softening and degradation of cell wall components. Fruit softening is a key process during ripening and is mainly caused by changes in cell wall structure and composition, which directly affect texture, shelf life, and market quality (Zhou et al. 2021; Li et al. 2025).

Soluble solids content (SSC) and pH

The pH value ranged from 2.76 to 3.20, with a pH value of 3.15 in the 1st week. In the 2nd week, it dropped to 2.76 and remained stable at a similar level in weeks 3rd to 9th. In the last two weeks, the pH increased and reached 3.08 and 3.20 respectively (Fig. 4). pH changes during fruit development are closely related to organic acid metabolism. In early stages, pH decreases due to the accumulation of organic acids such as malic and citric acids. As ripening advances, pH increases as

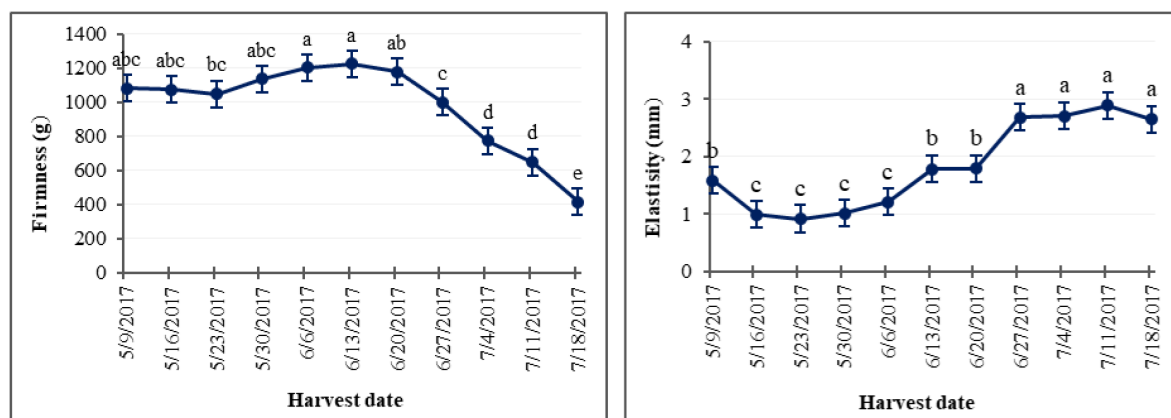


Figure 3. Variations in firmness (g) and elasticity (mm) of cv. 'Black Plum' during ripening. ANOVA results indicated that these changes were statistically significant ($P < 0.001$).

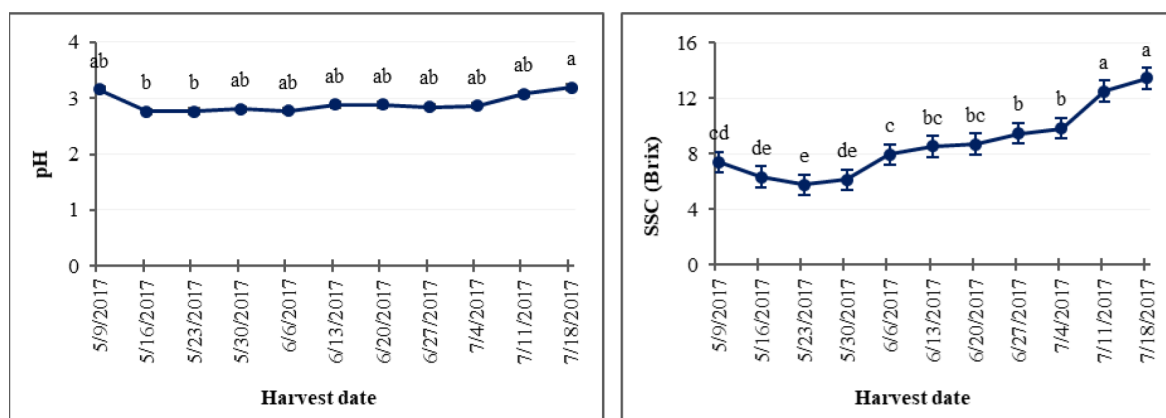


Figure 4. Variations in soluble solids content (SSC) and pH of cv. 'Black Plum' during ripening. ANOVA results showed that changes in SSC were statistically significant ($P < 0.001$), whereas pH variations were not significant.

these acids are metabolized through respiration and partially converted into sugars and other neutral compounds. Similar pH trends during ripening have been reported in plums and other climacteric fruits (Xiao et al. 2024; He et al. 2025). Soluble solids content (SSC) refers to the concentration of soluble sugars in a fruit, which consists mainly of sucrose, glucose, and fructose (Xu et al. 2019). In cv. 'Black Plum', SSC decreased between the 1st and 3rd week but increased continuously from the 4th to the 11th week, reaching its highest value (13.43%) in the 11th week (Fig. 4). This increase in SSC is mainly associated with the enzymatic breakdown of starch and complex carbohydrates into soluble sugars during ripening. In climacteric fruits, this process is promoted by ethylene-regulated enzymes such as amylases and glucosidases, leading to the accumulation of glucose, fructose, and sucrose. Similar increases in SSC during ripening have been reported in plums and other climacteric fruits (Xiao et al. 2024; Huang et al. 2025). Usenik et al. (2008) picked fruit samples from four plum cultivars at six different stages and reported that SSC increased in all cultivars from the first to the last week.

Organic and phenolic contents

The changes in organic acids (ascorbic and citric acid) and phenolic compounds (gallic acid and catechin) in cv. 'Black Plum' during fruit development are presented in Fig. 5. Citric acid increased steadily during the first seven weeks, reaching 304.61 mg 100 g⁻¹ f.w. in the 8th week, followed by a marked decline to 136.87 mg 100 g⁻¹ f.w. by the 11th week. This decline during late ripening may be associated with increased respiratory activity and the utilization of organic acids as substrates in metabolic processes. A similar decreasing trend in citric acid during advanced ripening stages has been reported in plum and other stone fruits (He et al. 2025).

Ascorbic acid increased during the first six weeks and reached 592.86 mg 100 g⁻¹ f.w., then slightly decreased in the 7th week (528.15 mg 100 g⁻¹ f.w.), increased again in the 8th week (573.08 mg 100 g⁻¹ f.w.), and subsequently declined gradually until the 11th week (395.05 mg 100 g⁻¹ f.w.). The reduction observed at advanced ripening stages may be associated with enhanced oxidative metabolism and the involvement

of ascorbic acid in antioxidant defense systems during fruit maturation, as also reported for plum cultivars by Mieszcza-kowska-Fraç et al. (2025) and Korićanac et al. (2025).

Citric acid showed a marked decline during late ripening, which may reflect its utilization as a respiratory substrate within the tricarboxylic acid (TCA) cycle (He et al. 2025). Similar decreases in organic acid content during plum maturation have been documented by Xiao et al. (2024) and Fotirić Akšić et al. (2023), indicating that organic acid metabolism is closely linked to fruit development and flavor formation.

Celik et al. (2017) reported that citric acid content in three plum species ranged from 5.45 mg 100 g⁻¹ f.w. (*P. domestica*) to 27.61 mg 100 g⁻¹ f.w. (*P. spinosa*), while ascorbic acid content varied between 18.75 and 25.49 mg 100 g⁻¹ f.w. Similarly, Çatak et al. (2022) indicated that citric and ascorbic acid contents in different plum cultivars and genotypes ranged from 5.13 to 24.85 mg 100 g⁻¹ f.w. and 11.07 to 29.44 mg 100 g⁻¹ f.w., respectively. In contrast, the values obtained in the present study were markedly higher. These differences may be attributed to cultivar-specific metabolic characteristics, ecological conditions, maturity stage at sampling, and possible variations in analytical methods, all of which are known to significantly influence organic acid and vitamin C accumulation in plums.

Gallic acid reached its highest value in the 1st week (1840.84 mg 100 g⁻¹ f.w.) and showed fluctuations in the following weeks. Apart from temporary increases in the 5th and 7th weeks, a general decreasing trend was observed, reaching 352.12 mg 100 g⁻¹ f.w. in the 11th week. Catechin exhibited its highest levels during the first two weeks and declined sharply by the 5th week, followed by moderate fluctuations toward the end of ripening. Previous studies reported considerably lower concentrations of gallic acid and catechin in different plum cultivars (Çatak et al. 2022; Xiao et al. 2024). The substantially higher phenolic values observed in the present study may be associated with early harvest sampling, as phenolic compounds particularly hydrolysable tannins and flavan-3-ols are known to be more abundant in immature fruits and decline during ripening due to oxidative degradation, polymerization, and metabolic conversion processes (Zhao et al. 2022; Fotirić Akšić et al. 2023).

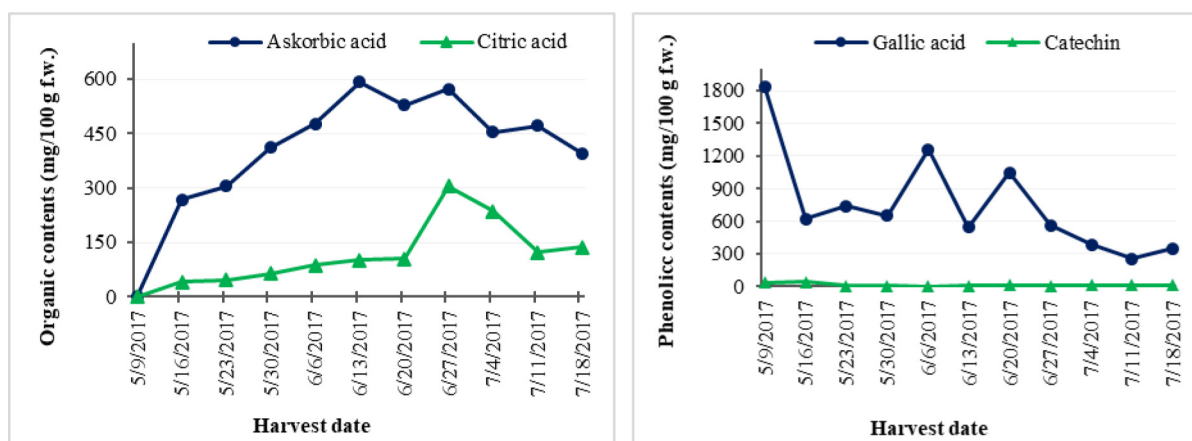


Figure 5. Changes in phenolic content and organic acids of cv. 'Black Plum' during ripening period.

The marked decrease in gallic acid during ripening may also reflect its involvement in esterification reactions and its role as a precursor in complex phenolic biosynthesis pathways. In addition, environmental conditions such as high solar radiation and temperature in the Iğdır region may have contributed to enhanced phenolic accumulation during early developmental stages.

Overall, the results indicate that phenolic metabolism in 'Black Plum' is strongly stage-dependent, with the highest concentrations detected in early developmental phases and progressive decline toward physiological maturity.

mum at the 8th week, whereas ascorbic acid content was highest at the 6th week before declining. Among the phenolic compounds, gallic acid and catechin varied across developmental stages without a consistent trend.

Based on statistically significant differences ($p < 0.05$) observed in color parameters (a^* , b^*), firmness, elasticity, and SSC values throughout fruit development, weeks 10 and 11 were identified as the optimal harvest period for 'Black Plum'. At this stage, fruits were characterized by fully developed red–purple coloration, maximum soluble solids accumulation, and significantly reduced firmness compared to earlier developmental stages.

Conclusions

In this study, the physicochemical changes occurring during the 11-week ripening process of 'Black Plum' (*Prunus domestica* L.) grown in the Iğdır region were investigated. Fruit weight and dimensions increased continuously from the first week to harvest, while color parameters showed a clear transition from green to red–purple tones between the 8th and 9th weeks. Fruit firmness reached its maximum at the 6th week and gradually decreased thereafter, whereas elasticity increased significantly from the 8th week onward ($p < 0.05$). SSC values increased continuously throughout ripening, while pH values fluctuated. Citric acid content reached its maxi-

Authors contributions

Ersin Gülsoy and Emrah Kuş experiment idea designed the study, field analysis, data collection analysis and wrote manuscript. Betül Tan and Kadir Tan performed chemical analyses. Dured Alwazeer revised the manuscript. The final version was approved by all authors.

Artificial Intelligence (AI) use

The authors accept full responsibility for the content of the manuscript, including the disclosure of any use of AI.

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