horticulturae

MDPI

Article

Investigation of Fruit Quality and Biochemical Traits of Rosehip (*R. canina*) Ecotypes in the Aegean Region of Türkiye

Halil Ibrahim Sagbas

Department of Horticulture, Faculty of Agriculture, Ataturk University, 25240 Erzurum, Türkiye; hibrahimsagbas@gmail.com

Abstract: Rosehip is a valuable fruit species in particular for rural populations. In this study, fruit quality parameters of 15 wild grown rosehip ecotypes naturally obtained from seeds in the Aegean Region of Türkiye were determined. The fruit weight, fruit firmness, fruit flesh ratio, fruit shape index, fruit skin color (chroma), soluble solid content, vitamin C, total phenolic, total carotenoid, total anthocyanin, total flavonoid and antioxidant capacity were investigated. The results showed great diversity among ecotypes. The fruit weight, fruit firmness, fruit flesh ratio, fruit shape index, fruit skin color (chroma) and soluble solid content were between 2.28 and 3.29 g, 4.70 and 7.12 N, 69.34 and 81.67%, 0.97 and 1.07, 53.04 and 60.71 and 18.87 and 21.28%, respectively. The total antioxidant capacity was found to be 15.78–28.17 mg AAE/g in a DPPH assay. The vitamin C content of rosehip fruits was measured as 507–621 mg/100 g. Among ecotypes, A-15 gave the biggest fruits, A-1 had the highest soluble solid content and A-13 had the highest vitamin C content. These results suggested that some ecotypes showed more potent bioactive properties than other ecotypes, mainly related to the variations in the antioxidant capacity and bioactive content between ecotypes. Overall, this study provides additional insight into investigating the genotype exhibition of multifunctional bioactive properties.

Keywords: rosehip; diversity; pomology; biochemical compounds

check for updates

Citation: Sagbas, H.I. Investigation of Fruit Quality and Biochemical Traits of Rosehip (*R. canina*) Ecotypes in the Aegean Region of Türkiye. *Horticulturae* **2023**, *9*, 1292. https://doi.org/10.3390/horticulturae9121292

Received: 10 September 2023
Revised: 28 September 2023
Accepted: 29 September 2023
Published: 30 November 2023

1. Introduction

Türkiye is considered to be an important center for world plant diversity thanks to its geographical location and natural environment with high biodiversity. The ecological diversity of the country has not only supported a high level of genetic diversity, but also enabled the successful introduction and cultivation of numerous plant species. This means that Türkiye has a rich flora in terms of plant diversity and these plants have different uses. Many plants are used for food, pharmaceutical raw materials, wood and many other purposes. Wild and transitional forms of various cultivated plants form the basis of the genetic resources of the country concerned [1]. However, in contrast to these data, there are fruit species that are still unknown to a large part of the Turkish public and are being cultivated and researched, especially in Europe. These species, which grow locally in different regions of the country and have unique characteristics, cannot be utilized sufficiently. These fruit species are as valuable in terms of nutrients as other commonly grown fruits [2]. Rosehip (*Rosa* spp.) is one of the most important of these fruit species. Although rosehip is mostly widespread in the east of Türkiye, it has been stated that it is distributed in almost every region of the country [3]. Although it is not cultivated in Türkiye, significant amounts of rosehip are produced worldwide. As a matter of fact, *R. canina*, *R. moschata* and *R. rubiginosa* are widely cultivated rosehip species in Chile [4].

Rosehip is a plant species belonging to the order *Rosales* and is classified in the subfamily *Rosaoideae* of the family *Rosaceae*. Rosehip is a multi-stemmed fruit species with an upright shrub or climbing form, which can be 1.5 to 4.0 m high depending on the species. In adverse soil conditions where other fruit species cannot be grown, rosehip is a good erosion preventive, with a strong root structure up to 4 m. The trunk and branches are curved backwards and often covered with dense thorns. These thorns are usually strong and hook shaped. The fruit of the rosehip has an accessory fruit structure and can vary in shape from ovoid to round or spherical. Furthermore, the fruit color can vary from yellowish red (orange) to black. The fruit contains many seeds which, if not harvested, usually remain on the plant over the winter without falling off [5–8]. In addition, rosehip fruit is an excellent source of vitamins A, B_3, C, D and E, as well as bioflavonoids, citric acid, flavonoids, fructose, malic acid, tannins and zinc [9].

From the depths of history to the present day, people have used plants both as a food source and for medicinal purposes in order to maintain a healthy life and to treat various health problems. These plants provide an important wealth of vitamins, antioxidants and minerals essential for the body [2,10].

Rosehips have been used by various civilizations for thousands of years, and this long historical usage has been associated with the positive effects of rosehips on human health [11]. Rosehip is an important plant with a wide range of uses in nutrition and health. Unfortunately, for a long time, the Turkish people did not have the opportunity to understand rosehips sufficiently. However, intensive and comprehensive scientific research in recent years has revealed that rosehip has significant nutritional value and is rich in vitamins, minerals and phytochemical components [12]. This increasing interest in rosehips has started to be recognized worldwide and also in Türkiye, especially in recent years. Rosehip, which is used as a raw material in the pharmaceutical industry in some European countries, is also used in traditional folk medicine in the treatment of many diseases [13]. In parallel with this increasing demand for rosehip fruit, the number of industrial enterprises producing rosehip products in Türkiye has also increased [14]. It was stated that value-added products such as beverages [15], jam, jelly, tea, wine and marmalade are generally obtained from rosehip fruits [16]. The high commercial value of these products has created an important income source potential for low-income farmers who will gain from rosehip cultivation. However, it is necessary to provide suitable conditions for the production of rosehip in sufficient quantities and qualities. This requires alternative product evaluation and development studies.

The aim of this study was to determine the fruit quality characteristics and biochemical and physicochemical contents of seed-propagated rosehip ecotypes. Thus, the diversity of uncultivated rosehips in the Aegean Region of Türkiye was revealed.

2. Materials and Methods

2.1. Plant Material

The material of this study consisted of 15 wild seed-propagated rosehip ecotypes harvested from (Kabakli Village, Caglayan Village, Keklicek Village, Pinarli Village, Cerityaylasi Village) the Dinar district of Afyonkarahisar province (Figure 1) located in the Aegean Region of Türkiye.

Figure 1. The location of Afyonkarahisar province, where the study was conducted, on the map.

Rosehip ecotypes were named from A-1 to A-15, pre-selected according to high yield, health plant growth, and attractive fruit characteristics. The harvest date of the fruit samples is September 2022. The exocarp color of the rosehip fruits was red and different shades of red, the fruit stalk color started to turn from green to brown and the fruits started to be harvested by the people of the region where the study was carried out were effective in determining the harvest time. The tree and fruit forms of the A-3 and A-11 ecotypes are presented in Figure 2

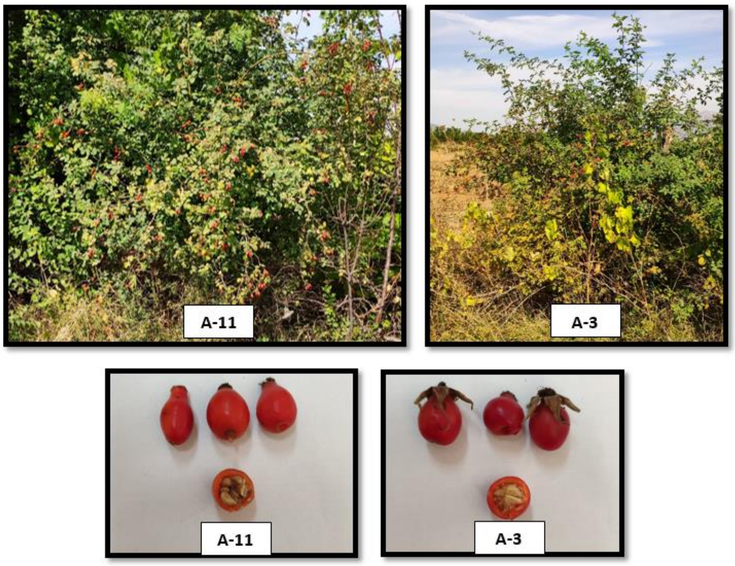

Figure 2. The tree and fruit forms of the A-3 and A-11 ecotypes.

2.2. Pomological Parameters

Fruit and seed weight (for fruit flesh ratio) was measured with a balance sensitive to 0.01 g and fruit firmness was measured with a hand penetrometer with an 8 mm diameter probe (Nippon Optical Works Co., Tokyo, Japan). For this, the peel is first removed from the fruit using a fruit peeler [17]. For fruit shape index measurement, fruit length and fruit diameter were measured by digital caliper according to Ozkaplan and Balkaya [18].

2.3. Physicochemical and Biochemical Measures

Chroma value was measured with a (Chroma Meter CR-400 Chroma Portable, Konica Minolta Sensing, Inc., Osaka, Japan) color device [17]. Soluble solid content (SSC) was determined by digital refractometer (Kyoto Electronics Manufacturing Co., Ltd., Kyoto, Japan, Model RA-250HE) [19].

Antioxidant capacity was determined according to the method presented by Attar et al. [20] with DDPH assay (2,2-diphenyl-1-picrylhydrazyl). Firstly, fruit samples were extracted (70*v*/30*v*; methanol/water) for antioxidant capacity, and filtered 0.06 μM concentration of ethanolic DPPH solution was prepared. Then, 1950 μL of DPPH solution was added to 50 μL of rosehip extract. Then, this mixture was stirred for 60 s and kept in the dark at 25 °C for 30 min. The antioxidant activity of rosehip extracts was determined using Multiscan GO microplate spectrophotometer (Thermo Fisher Scientific, Waltham, MA, USA). The device was set to 515 nm wavelength and measurements were performed at 5 min intervals. The solvent was used as blank. Finally, values were expressed as milligram ascorbic acid equivalence (mg AAE/g).

Total anthocyanin content was determined using the pH differential method [21] and the value was calculated as cyanidin-3-glucoside. Samples were first digested and then diluted with distilled water and mixed with buffer solutions of pH 4.5 and pH 1.0. These mixtures were then filtered and the absorbance values at 520 nm and 700 nm wavelengths were measured using a spectrophotometer. Finally, the measured values were expressed in mg/kg using the following equation [22].

$$\text{Total monomeric anthocyanin content (mg/kg)} = \frac{\text{A} \times \text{MW} \times \text{Sf} \times 100}{\varepsilon \times \text{L}}$$

A (absorbance value): (A520 nm–A700 nm) pH 1.0- (A520 nm–A700 nm) pH 4.5.
MW: Molecular weight of anthocyanin to be taken as base (Cyanidin-3-glucoside molecular weight: 449.2 g/mol).
Sf: Dilution factor.
ε: Molar absorption coefficient (Molar absorbance value of cyanidin-3-glucoside: 26,900)
L: Layer thickness of the spectrophotometer cuvette (cm).

To measure the total carotenoid content, 1 g of fruit sample was homogenized with 5 mL acetone in a cold porcelain mortar in an ice bath. Then, 1 g of dehydrated sodium sulphate (Na_2SO_4) was added to the homogenized solution. The homogenous mixture was elutriated using a paper filter. The filtered solution was filled to 10 mL with acetone. This solution was then centrifuged (ROTINA 380/380R, Hettich, Tuttlingen, Germany) at 2600$\times$ *g* for 10 min. The supernatant was collected and the absorbance of the solution was measured at wavelengths of 662, 645 and 470 nm. Acetone was used as a control. Finally, the total carotenoid contents of rosehip ecotypes were calculated and expressed in mg/g [23,24].

Extraction procedure for total flavonoid content (TFC) analysis was performed according to Alirezalu et al. [25] Then, 1.5 mL methanol (80%, *v*/*v*), 100 µL aluminum chloride solution (10%, *w*/*v*), 100 µL potassium acetate solution (1 mol/L) and 4.78 mL deionized water were added to 15 µL fruit extract. After 15 min, the absorbance of the reaction mixture at 420 nm was read. TFC results were calculated using the quercetin standard and expressed as mg quercetin equivalent (QUE)/g [26].

Total phenolic content was determined using Folin–Ciocalteu reagent according to the method presented in Ebrahimzadeh et al. [27]. Firstly, methanolic extraction was performed [25]. Then, 180 µL of distilled water and 1.2 mL of Folin–Ciocalteu reagent were added to each 10 µL extract. After the mixture was kept for 5 min, 960 µL Na_2CO_3 (7%, *w*/*v*) was added and kept at 25 °C for about 45 min. The absorbance value of the final mixture was then measured at 760 nm wavelength. Total phenol contents of rosehip fruit samples were presented as gallic acid equivalent mg GAE/100 g fresh weight (FW) using gallic acid standard curve.

Vitamin C (ascorbic acid) was measured with the reflectometer set by using RQFlex reflectoquant ascorbic acid test strips (Merck Company, Darmstadt, Germany) and expressed as mg/100g [28].

2.4. Statistical Analyses

Different statistical analyses were performed in order to examine the differences and similarities of the ecotypes in terms of the parameters examined.

Analyses were conducted with three replications and the outcomes were assessed using SPSS software (Version 15.0; SPSS Inc., Chicago, IL, USA) to determine the statistically significant differences among ecotypes at the 0.05 significance level. One-way analysis of variance (ANOVA) and Duncan's multiple comparison tests were utilized in the software for data analysis.

Heatmap and principal component analyses were performed for hierarchical clustering of the rosehip ecotypes. Hierarchical cluster analysis with heatmap was conducted using R programming v. 4.1.1 (Boston, MA, USA). Principal component analysis (PCA) was performed and graphs were created using the Minitab-17 program.

3. Results

3.1. Pomological Parameters

Fruit weight, fruit firmness, fruit flesh ratio and fruit shape index are important fruit quality criteria for pomological characterization of fruits. Significant statistical differences were found between the analyzed parameters at $p < 0.05$ level (Table 1). The lowest fruit weight was 2.28 g in genotype A-5 and the highest was 3.29 g in genotype A-15. The average fruit weight of rosehip ecotypes is 2.78 g. The lowest flesh firmness was 4.70 N in genotype A-15, the highest was 7.12 N in genotype A-8 and the average value was 5.90 N. The fruit flesh ratio varied from the lowest in genotype A-4 (69.34%) to the highest in genotype A-2 (81.67%) and the average fruit flesh ratio was 73.50%. The fruit shape index was calculated to be in the range of (A-2 genotype) 0.97–1.07 (A-4 genotype) and the average fruit shape index was 1.03. Among ecotypes, A-15 gave the biggest fruits, indicating its importance for fresh fruit production.

Table 1. Fruit quality criteria values of *Rosa canina* ecotypes.

Ecotypes	Fruit Weight (g)	Fruit Firmness (N)	Fruit Flesh Ratio (%)	Fruit Shape Index
A-1	2.83 ± 0.09 cd	5.71 ± 0.17 cde	77.69 ± 1.35 b	1.02 ± 0.03 abc
A-2	2.68 ± 0.20 d–g	5.56 ± 0.69 def	81.67 ± 1.82 a	0.97 ± 0.01 c
A-3	2.80 ± 0.10 de	6.93 ± 0.20 ab	71.78 ± 1.18 fg	1.05 ± 0.02 ab
A-4	2.94 ± 0.14 bcd	5.38 ± 0.19 efg	69.34 ± 0.52 g	1.07 ± 0.03 a
A-5	2.28 ± 0.08 h	5.39 ± 0.37 efg	75.34 ± 1.10 bcd	1.02 ± 0.01 abc
A-6	2.31 ± 0.05 h	6.41 ± 0.32 abc	71.67 ± 1.08 fg	1.01 ± 0.02 bc
A-7	2.74 ± 0.08 def	6.34 ± 0.17 bc	70.19 ± 0.47 g	1.05 ± 0.01 ab
A-8	3.00 ± 0.07 a–d	7.12 ± 0.17 a	75.56 ± 1.14 bc	1.05 ± 0.02 ab
A-9	2.50 ± 0.03 e–h	5.43 ± 0.18 d–g	74.19 ± 1.22 c	1.05 ± 0.01 ab
A-10	2.45 ± 0.23 fgh	6.44 ± 0.21 abc	70.23 ± 0.61 g	1.01 ± 0.02 bc
A-11	2.37 ± 0.10 gh	6.18 ± 0.24 bcd	75.03 ± 0.66 b–e	1.04 ± 0.01 ab
A-12	3.14 ± 0.05 abc	4.84 ± 0.09 fg	71.33 ± 0.65 fg	1.02 ± 0.01 abc
A-13	3.21 ± 0.08 ab	6.35 ± 0.11 abc	73.96 ± 1.10 c–f	1.05 ± 0.03 ab
A-14	3.15 ± 0.05 abc	5.74 ± 0.14 cde	72.10 ± 0.34 efg	1.04 ± 0.01 ab
A-15	3.29 ± 0.17 a	4.70 ± 0.15 g	72.37 ± 1.79 d–g	1.00 ± 0.02 bc

Different letters in each column indicate significant difference ($p < 0.05$) based on Duncan's multiple range test.

3.2. Physicochemical and Biochemical Mesasures

The physicochemical and biochemical values of *Rosa canina* ecotypes are presented in Table 2. It was determined that there were significant statistical differences between these parameters at $p < 0.05$ level. The chroma values of rosehip fruit samples were the lowest in genotype A-2 (53.04), highest in genotype A-5 (60.71) and the average value was 56.74. Soluble solid content (SSC) ratios were the lowest in genotype A-3 at 18.87% and the highest in genotype A-1 at 21.28%, while the average SSC value of the ecotypes was 20.28%. Among ecotypes, A-1 had the highest soluble solid content, indicating its significance as a fresh fruit, in particular for the processing industry.

In the determination of the total antioxidant capacity using a DPPH assay, the lowest value belongs to genotype A-12 (15.78 mg AAE/g) and the highest value belongs to genotype A-6 (28.17 mg AAE/g). The average antioxidant capacity of the ecotypes was 20.97 mg AAE/g. The lowest and highest total anthocyanin values were observed from the A-2 genotype (4.61 mg/kg) and the A-9 genotype (7.56 mg/kg), respectively. The mean anthocyanin value of the ecotypes was 6.01 mg/kg.

The total carotenoid in flesh was the highest in the A-5 genotype at 13.60 mg/g, followed by the A-1 genotype at 13.12 mg/g, while the lowest total carotenoid was found in the A-13 genotype at 6.59 mg/g. The total flavonoid was between 1.18 mg/QUE g (A-2) and 2.64 mg/QUE g (A-10) among the ecotypes. The average flavonoid content of the ecotypes was 1.74 mg/QUE g. The total phenolic content was quite variable among ecotypes; it was obtained between 470 mg/GAE 100 g FW (A-4) and 644mg/GAE 100 g FW (A-6) among the rosehip ecotypes (Table 3). The average total phenolic content was 559.44 mg/GAE 100 g. The concentration of vitamin C was the highest in A-13 at 621 mg/100 g, followed by A-4 at 597 mg/100 g, while the concentration of vitamin C was the lowest in A-15 at 507 mg/100 g, followed by A-8 at 511 mg/100 g.

Table 2. Physicochemical and biochemical values of *Rosa canina* ecotypes.

Ecotypes	Chroma	SSC (%)	DPPH (mg AAE/g)	Total Anthocyanin (mg/kg)
A-1	57.74 ± 1.46 a–d	21.28 ± 0.64 a	18.44 ± 0.14 ef	7.13 ± 0.17 ab
A-2	53.04 ± 1.63 f	19.79 ± 0.51 bcd	20.31 ± 0.15 b–f	4.61 ± 0.16 g
A-3	56.07 ± 1.33 b–f	18.87 ± 0.24 d	24.79 ± 0.42 ab	5.16 ± 0.09 f
A-4	55.19 ± 2.53 c–f	20.93 ± 0.26 ab	18.64 ± 0.16 def	5.71 ± 0.13 de
A-5	60.71 ± 0.27 a	20.41 ± 0.26 abc	24.44 ± 0.44 abc	7.15 ± 0.19 a
A-6	55.26 ± 0.91 c–f	19.59 ± 0.17 cd	28.17 ± 0.20 a	5.46 ± 0.26 ef
A-7	53.13 ± 1.93 ef	20.43 ± 0.20 abc	24.21 ± 0.08 abc	6.12 ± 0.08 cd
A-8	54.01 ± 0.92 def	20.82 ± 0.70 abc	17.81 ± 0.20 ef	5.47 ± 0.17 ef
A-9	56.97 ± 1.33 a–e	20.52 ± 0.25 abc	18.23 ± 0.85 ef	7.56 ± 0.19 a
A-10	56.09 ± 1.47 b–f	20.07 ± 0.37 a–d	19.31 ± 0.16 c–f	6.66 ± 0.16 b
A-11	57.46 ± 0.49 a–d	20.89 ± 0.12 ab	19.42 ± 0.14 c–f	5.47 ± 0.19 ef
A-12	59.28 ± 0.97 ab	20.11 ± 0.21 abc	15.78 ± 6.84 f	4.67 ± 0.13 g
A-13	58.86 ± 1.37 abc	19.77 ± 0.45 bcd	20.43 ± 0.19 b–f	5.54 ± 0.18 ef
A-14	56.89 ± 0.89 a–f	20.59 ± 0.82 abc	23.64 ± 0.15 a–d	6.19 ± 0.13 c
A-15	60.37 ± 0.58 a	20.08 ± 0.40 a–d	20.97 ± 0.18 b–e	7.24 ± 0.12 a

Different letters in each column indicate significant difference ($p < 0.05$) based on Duncan's multiple range test.

Table 3. Biochemical values of *R. canina* ecotypes.

Ecotypes	Total Carotenoid (mg/g)	Total Flavonoid (mg/QUE g)	Total Phenolics (mg GAE/100 g)	Vitamin C (mg/100 g)
A-1	13.12 ± 0.23 a	1.67 ± 0.17 c–f	536 ± 18.85 de	547 ± 21.42 b–f
A-2	7.55 ± 0.28 hi	1.18 ± 0.08 f	551 ± 30.07 de	530 ± 36.07 c–f
A-3	8.58 ± 0.09 f	1.41 ± 0.10 ef	628 ± 8.51 ab	565 ± 22.41 a–f
A-4	7.71 ± 0.13 gh	2.05 ± 0.10 bcd	470 ± 18.58 f	597 ± 31.82 ab
A-5	13.60 ± 0.27 a	2.17 ± 0.11 abc	564 ± 19.78 cde	594 ± 7.45 ab
A-6	9.84 ± 0.11 e	2.39 ± 0.35 ab	644 ± 17.85 a	589 ± 11.46 abc
A-7	7.08 ± 0.07 ij	1.44 ± 0.10 ef	570 ± 13.86 b–e	553 ± 37.56 b–f
A-8	8.20 ± 0.43 fg	1.54 ± 0.12 def	523 ± 16.95 ef	511 ± 11.59 ef
A-9	11.10 ± 0.17 c	1.32 ± 0.16 ef	585 ± 17.14 a–d	527 ± 12.47 def
A-10	8.17 ± 0.08 fg	2.64 ± 0.37 a	622 ± 27.23 abc	570 ± 21.62 a–e
A-11	8.30 ± 0.13 f	1.48 ± 0.12 ef	541 ± 32.45 de	564 ± 20.87 a–f
A-12	6.94 ± 0.22 j	1.76 ± 0.07 cde	537 ± 18.82 de	587 ± 10.74 a–d
A-13	6.59 ± 0.21 j	1.45 ± 0.06 ef	550 ± 33.29 de	621 ± 9.70 a
A-14	10.43 ± 0.20 d	1.78 ± 0.30 cde	550 ± 5.29 de	561 ± 16.46 a–f
A-15	12.39 ± 0.10 b	1.82 ± 0.16 cde	516 ± 9.02 ef	507 ± 18.01 f

Different letters in each column indicate significant difference ($p < 0.05$) based on Duncan's multiple range test.

3.3. Clustering Analysis

A heatmap analysis was performed to reveal the effects of *R. canina* ecotypes on some quality criteria and biochemical properties. In the heatmap analysis, the color change towards red on the color scale shows that the level of statistical significance has increased. In a hierarchical cluster analysis, the ecotypes were divided into four different clusters. According to the heat mapping analysis method, the A-1, A-9, A-5 and A-15 ecotypes formed a separate cluster with high fruit weight, chroma, SSC (%), total carotenoid, total anthocyanin and fruit shape index. The A-2 genotype was less significant (blue color) with all other quality criteria and biochemical contents except the fruit flesh ratio. The vitamin C content was significant in the A-13 genotype (red color). The A-3, A-6 and A-10 ecotypes formed a separate cluster with high fruit firmness, total phenolics, DPPH and total flavonoid content (Figure 3). Red indicates an increase and blue a decrease in the variables in color key.

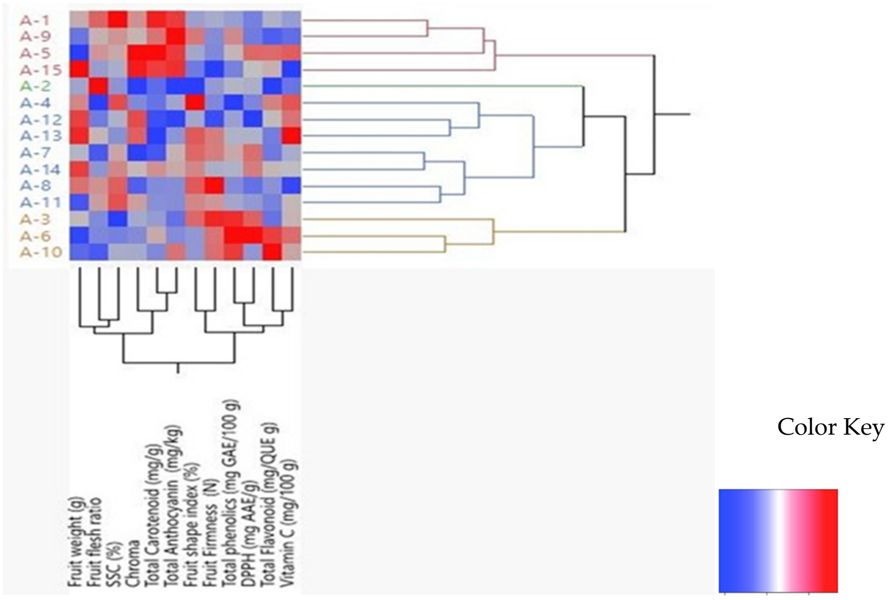

Figure 3. Grouping of *Rosa canina* ecotypes according to fruit quality criteria and biochemical content.

The distributions of correlation between fruit quality criteria and biochemical contents of *R. canina* ecotypes in the basic coordinate plane defined by PCA are given in Figure 4. As a result of the PCA analysis, it was seen that the total variation consisted of the first two basic components. As a result of the PCA analysis, it was seen that the total variation consisted of the first two main component axes, and the variation between fruit quality criteria and biochemical contents and ecotypes was 39.9%. The first principal component axis constitutes 21.9% of the total variation, and the second principal component axis constitutes 18.0% of the total variation. Therefore, it has been seen that these axes are important in the evaluation of the analysis. It was observed that the total carotenoid, total anthocyanin and chroma values of the parameters defined by PCA were parallel to each other. Similarly, the fruit weight, fruit flesh ratio and SSC (%) values were found to be parallel to each other. However, its values were negatively correlated with the vitamin C values (Figure 4).

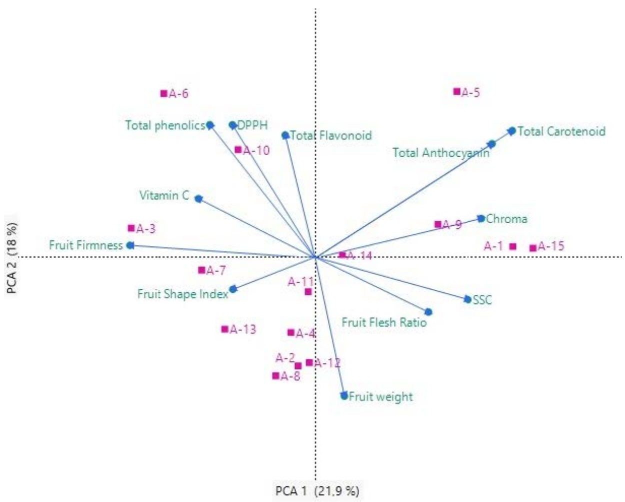

Figure 4. Principal component analysis (PCA) in a biplot of physio-biochemical traits (12 variables) of 15 *Rosa canina* ecotypes at harvest.

4. Discussion

Post harvest fruit quality characteristics are influenced by many factors. Some properties such as flesh firmness, soluble solid content (SSC) and total acidity (TA) are important parameters affecting post harvest quality and the shelf life of fruits [29] Fruit weight is one of the leading fruit quality criteria which is associated with fruit size and directly affects the market value of the fruit. Therefore, the selection and determination of ecotypes with high fruit weight is one of the most important issues for researchers studying fruit breeding.

Red fruits are abundant in phytochemicals like phenolic compounds, flavonoids, anthocyanins and carotenoids. Rosehips are distinguished by their abundance and diversity of phytochemicals, surpassing many other fruit species. They encompass a spectrum of valuable components including minerals, high-capacity antioxidants, carotenoids, phenolic compounds, tocopherol, bioflavonoids, tannins, pectins, organic acids, amino acids, ascorbic acids and fatty acids [16,30–33]. Antioxidants and total phenolic contents protect cells and cell components against oxidative damages [34,35] Also, sugar compounds are phytochemicals that provide the fruit's sweetness, enhance the occurrence of sensory connections between sweetness and flavor perceptions and constitute the majority of soluble solid content [36,37]. Although the thought of consuming citrus fruits as a daily source of vitamin C is dominant among the public, rosehip fruit contains 20–30 times more vitamin C than oranges [38,39]. Rosehip is consumed in processed products rather than fresh fruit and this is known to cause a decrease in the vitamin and bioactive content in the fruit. Although there are losses after drying compared to fresh fruit [40] (especially in terms of vitamin C [41]), rosehip has been proven to be very nutritious compared to other fruit types, as stated by Paunovic et al. [42]. Carotenoids play a crucial role as antioxidants and valuable bioactive compounds that contribute to the health-promoting qualities of various foods. Rosehips, in particular, are recognized for their high bioactive content. Carotenoids represent one of the most widespread classes of pigments and are naturally found in substantial quantities in many horticultural crops. They are renowned for their structural diversity and multifaceted functions, including their role in imparting the vibrant red, orange and yellow hues to edible fruits. Additionally, carotenoids are the primary pigments responsible for determining the coloration of fruits, a highly significant aspect of their external quality [43,44].

Gunes et al. [45] measured the fruit weight of ripe rosehip (*R. canina*) fruits as 3.02–3.70 g, the fruit flesh ratio was 69.64–73.52%, SSC was 20.67–21.67% and fruit flesh hardness was 2.40–4.80 N. Dogan and Kazankaya [46] conducted a study on rosehip species and the fruit weights were between 1.50 and 3.74 g. The fruit shape index was between 1.06 and 2.12. The SSC of the rosehip samples had a range of 11–25%. Celik et al. [47] conducted a study to select promising ecotypes of different rosehip species in the Eastern Anatolia region of Türkiye. They determined the fruit weight of the ecotypes as 1.79–4.95 g, the fruit flesh ratio was 66.42–100%, SSC ratio was 17.73–28.45% and vitamin C content was 517.18–1031.46 mg/100 g. Uggla et al. [48] investigated the biochemical and pomological characteristics of four different rosehip species and found that the fruit weight, fruit flesh ratio and vitamin C content of *R. dumalis* subsp. *coriifolia* species were 2–2.3 g, 73.2–77.7% and 535 mg/100g, respectively. The fruit weight, fruit flesh ratio and vitamin C content of *R. dumalis* subsp. *dumalis*, *R. rubiginosa*, *R. villosa* subsp. *mollis* species were 2.1–2.8 g/1.5–1.9 g/2.1–2.5 g, 76.8–80%/64.3–71.7%/73–76.4% and 525 mg per 100 g/500 mg per 100 g/330 mg per 100 g, respectively. Kovacs et al. [38] examined the pomological characteristics of ecotypes of different rosehip species and they found that the fruit flesh ratios of *R. pimpinellifolia*, *R. blanda*, *R. rugosa*, *R. canina*, *R.* × *vetvickae*, *R. sancti-andreae* and *R. canina* var. *blondeana* were 81.5%, 76.3%, 75.0%, 74.2%, 74.2%, 72.6% and 72.2%, respectively. Ersoy [49] conducted a study to determine the fruit characteristics of different ecotypes of *R. pimpinellifolia*. The fruit weights were 1.56–2.01 g, fruit flesh ratios were 80.60–91.44%, vitamin C were 21.12–29.44 mg/100 g, total anthocyanins were 3.45–4.31 mg/100 g, total phenolics were 971–1138 mg GAE/100 g, antioxidant activity (with FRAP assay) were 9.23–12.17 µmol Fe (II)/g. Murathan et al. [50] carried out a study on different rosehip species and found the average fruit weight was 3.45 g, The soluble solid content (SSC) was 14–22%, total anthocyanin was 2.43–3.72 mg/100 g, total phenolics was 1081–6298 mg GAE/100 g, antioxidant capacity by FRAP method was 10.04–97.95 mmol Trolox equivalent/g and vitamin C was 24.93–754.48 mg/100 g. Guerrero et al. [51] stated that the anthocyanin component has antioxidant activities and therapeutic effects, besides giving color to fruits. The researchers analyzed the bioactive components of different berry fruits, and they found that the average anthocyanin content of rosehip fruits was 0.38 mg/100 g, and the average total phenolic content was 145.7 mg/100 g. Nojavan et al. [39] performed a study to investigate the effect of the ripening level of the fruit on the ascorbic acid level. According to the results of the study, the vitamin C content of ripe rosehip fruits was 417 mg per 100 g. Demir et al. [52] found the antioxidant activity as 39.510–72.673 mmol/kg, total flavonoids as 287.80–1686.20 mg QUE/kg and total phenolics as 38,519–79,080 mg GAE/kg in the characterization study (with DPPH assay) of 25 seed-propagated rosehip ecotypes. Ercisli [53] analyzed the biochemical content of six different rosehip species, and he found the highest total phenolic content in *R. canina* (96 mg GAE/g dry weight). The SSC and vitamin C varied between species as 29.42–37.33% and 727–943 mg/100 mL, respectively. Paunovic et al. [42] determined the vitamin C content of rosehip fruits as 429.55 mg/100 g, total phenolics as 90.51 mg GAE/g DW, total flavonoids as 38.52 mg QE/g and antioxidant activity as 0.32 mM TE/g DW. Koca et al. [40] reported total carotenoids 0.38 mg/g, vitamin C 24.96 mg/g, total phenolics 79.88 mg/g and antioxidant activity (with FRAP assay) 9.22 mmol/g in fresh rosehip fruit samples. Beyhan et al. [44] conducted a study on *R. canina* biotypes in Türkiye and the average fruit mass, flesh ratio and SSC values were determined between 2.95 and 4.02 g, 59.3 and 78.4% and 17.3 and 22.3, respectively. The vitamin C of the ecotypes ranged from 360 to 482 mg/100 g. The total phenolic content varied from 340 to 464 mg/100 g. The total flavonoids varied in the range of 241–151 mg QUE/100 g, and the antioxidant activity was between 14.2 and 30.7 μg Trolox/mL. In addition, the total carotenoid content of rosehip samples varied from 58 to 92 β-carotene equivalents per 100 g. Machmudah et al. [54] reported that total carotenoids varied between 10.35 and 20.88 mg/g in their study on *R. canina* species. The total carotenoids of the *R. canina* and *R. rugosa* were 224 mg/kg and 106.1 mg/kg in another study conducted on rosehip species [55]. According to Hodisan et al. [56], the quantity of total carotenoids in *R. canina* fruits, evaluated by visible spectroscopy of the total extract, was 78.5 mg/g DW.

This study aligns with the findings of some researchers while also revealing discrepancies compared to others. It is widely acknowledged that several factors, including the plant species under investigation, genotype variations, agricultural applications, fruit maturity during harvest, post harvest storage conditions, the local climate and geographical factors, can influence the biochemical composition of horticultural crops including rosehip [57–71]. Kayahan et al., 2023 [71] used *Rosa corymbifera*, *Rosa rugosa* (Thunb.), *Rosa alba* L. and *Rosa canina* L. fruits grown in the rose germplasm of Ataturk Horticultural Central Research Institute, Yalova, Türkiye, and reported great variability on total phenol, vitamin C, carotenoid content and the ability to scavenge the DPPH radical.

5. Conclusions

Over the past decade, there has been a growing demand for less-known crops, driven by various factors including the pursuit of enhanced food security, healthier nutrition, preservation of cultural heritage, income generation, and more. The findings of this investigation make it evident that the bioactive content within *R. canina* ecotypes exhibits variation. Such variations in bioactive content hold potential implications for food production, the health industry and future breeding programs. Finally, it is necessary to state that in a possible future breeding program, genotype A-15 can be used for obtaining large-fruited rosehip cultivars, genotype A-1 can be used for breeding rosehip cultivars with a high sugar content since the majority of the SSC is composed of sugar components, and genotype A-13, which has the highest vitamin C content, can be used in breeding programs for obtaining plant-based vitamin C supplements derived from rosehip.

Funding: This research received no external funding.

Data Availability Statement: The data used in the manuscript can be provided by the author upon request. The data presented in this study are available in supplementary file.xlsx and supplementary figures.docx.

Acknowledgments: I would like to thank the people of Kabakli Village, Caglayan Village, Keklicek Village, Pinarli Village and Cerityaylasi Village of the Dinar district for their help in accessing the ecotypes used in the study.

Conflicts of Interest: The author declare no conflict of interest.

References

1. Davis, P.H. *Flora of Türkiye and the East Aegean Islands*; Edinburgh University Press: Edinburgh, UK, 1997; Volume 1–9.
2. Encu, T. Determination of Pomological and Some Biochemical Properties of Rosehip (*Rosa canina* L.) fruit Taken from Different Locations (Van-Hakkari-Şırnak) of Eastern Anatolia Region. Master's Thesis, Institute of Science Department of Horticulture, Yuzuncu Yıl University, Van, Turkey, 2015.
3. Yildiz, U.; Celik, F. Physico-chemical characteristics of native rosehip (*Rosa* spp.) genetic resources grown in Muradiye (Van) District. *Yuz. Yil Univ. J. Inst. Nat. Appl. Sci.* **2011**, *16*, 45–53.
4. Joublan, J.P.; Rios, D. Rose Culture and industry in Chile. In Proceedings of the I International Rose Hip Conference, Gümüşhane, Turkey, 7–10 September 2004; pp. 65–70. [CrossRef]
5. Akkus, E. Morphological description of wild rosehips (*Rosa* spp.) genotypes growing in Hamur (Agri). Master's Thesis, Institute of Science Department of Horticulture, Ordu University, Ordu, Turkey, 2016.
6. Karakus, S.; Bostan, S.Z. Breeding by selection of wild rose hip genotypes (*Rosa* spp.) grown in Akincilar county (Sivas Province, Turkey). *J. Nevsehir Sci. Technol.* **2017**, *6*, 215–225. [CrossRef]
7. Ozcelik, H.; Ozcelik, D.S. Botanical characteristics of fruit roses/rosehips *Rosa* L. spp. *Biol. Divers. Conserv.* **2018**, *11*, 68–79. [CrossRef]
8. Ozturk, A.; Bastas, K.K. A potential threat for blackberry, raspberry and rosehip growing in Konya Province: Fire blight disease. *Turk. J. Agric.—Food Sci. Technol.* **2021**, *9*, 2663–2669.
9. Ercisli, S. Rose (*Rosa* spp.) germplasm resources of Turkey. *Genet. Resour. Crop Evol.* **2005**, *52*, 787–795. [CrossRef]
10. Tumbas, V.T.; Canadanovic-Brunet, J.M. Effect of rosehip (*Rosa canina* L.) phytochemicals on stable free radicals and human cancer cells. *J. Sci. Food Agric.* **2012**, *92*, 1273–1281. [CrossRef]
11. Sar, S. The analysis of the use of certain berries from the perspective of pharmacy and history of medicine. *Mersin Univ. Sch. Med. Lokman Hekim. J. Hist. Med. Folk. Med.* **2011**, *1*, 1–6.
12. Smanalieva, J.; Iskakova, J.; Oskonbaeva, Z.; Wichern, F.; Darr, D. Investigation of nutritional characteristics and free radical scavenging activity of wild apple, pear, rosehip, and barberry from the walnut-fruit forests of Kyrgyzstan. *Eur. Food Res. Technol.* **2020**, *246*, 1095–1104. [CrossRef]
13. Jimenez-Lopez, J.; Ruiz-Medina, A.; Ortega-Barrales, P.; Llorent-Martínez, E.J. *Rosa rubiginosa* and *Fraxinus oxycarpa* herbal teas: Characterization of phytochemical profiles by liquid chromatography-mass spectrometry, and evaluation of the antioxidant activity. *New J. Chem.* **2017**, *41*, 7681–7688. [CrossRef]
14. Unalan, O. Rose hip in Turkish beliefs and practices. *Ordu Univ. Inst. Soci. Sci. J. Soci. Sci. Res.* **2021**, *11*, 745–762. [CrossRef]
15. Tomar, O. Determination of some quality properties and antimicrobial activities of kombucha tea prepared with different berries. *Turk. J. Agric. For.* **2023**, *47*, 252–262. [CrossRef]
16. Murathan, Z.T.; Zarifikhosroshahi, M.; Kafkas, N.E. Determination of fatty acids and volatile compounds in fruits of rosehip (*Rosa* L.) species by HS-SPME/GC-MS and Im-SPME/GC-MS techniques. *Turk. J. Agric. For.* **2016**, *40*, 269–279. [CrossRef]
17. Cetinbas, M.; Butar, S.; Koyuncu, F. Effects of Aminoethoxyvinylglycine (AVG) on fruit quality of 0900-ziraat sweet cherry. *J. Agric. Fac. Ege Univ.* **2012**, *49*, 103–106.
18. Ozkaplan, M.; Balkaya, A. The effects of light and temperature on the fruit quality parameters of cluster tomatoes growing in soilless culture. *J. Agric. Sci.* **2019**, *34*, 227–238. [CrossRef]
19. Yilmaz, K.U.; Ercisli, S.; Zengin, Y.; Sengul, M.; Kafkas, E.Y. Preliminary characterisation of cornelian cherry (*Cornus mas* L.) genotypes for their physico-chemical properties. *Food Chem.* **2009**, *114*, 408–412. [CrossRef]
20. Attar, S.H.; Gundesli, M.A.; Urun, I.; Kafkas, S.; Kafkas, N.E.; Ercisli, S.; Ge, C.; Mlcek, J.; Adamkova, A. Nutritional analy-sis of red-purple and white-fleshed pitaya (*Hylocereus*) species. *Molecules* **2022**, *27*, 808. [CrossRef]
21. Wrolstad, R.E. *Color and Pigment Analyses in Fruit Products*; Agricultural Communications, Oregon State University: Corvallis, OR, USA, 1993.

22. Inacio, M.R.C.; de Lima, K.M.G.; Lopes, V.G.; Pessoa, J.D.C.; de Almeida Teixeira, G.H. Total anthocyanin content determination in intact açaí (*Euterpe oleracea* Mart.) and palmitero-juçara (*Euterpe edulis* Mart.) fruit using near infrared spectroscopy (NIR) and multivariate calibration. *Food Chem.* **2013**, *136*, 1160–1164. [CrossRef]
23. Shameh, S.; Alirezalu, A.; Hosseini, B.; Maleki, R. Fruit phytochemical composition and color parameters of 21 accessions of five Rosa species grown in North West Iran. *J. Sci. Food Agric.* **2019**, *99*, 5740–5751. [CrossRef]
24. Lichtenthaler, H.K. Chlorophylls and carotenoids: Pigments of photosynthetic biomembranes. *Methods Enzymol.* **1987**, *148*, 350–382. [CrossRef]
25. Alirezalu, A.; Salehi, P.; Ahmadi, N.; Sonboli, A.; Aceto, S.; Hatami Maleki, H.; Ayyari, M. Flavonoids profile and antioxidant activity in flowers and leaves of hawthorn species (*Crataegus* spp.) from different regions of Iran. *Int. J. Food Prop.* **2018**, *21*, 452–470. [CrossRef]
26. Chang, Q.; Zuo, Z.; Harrison, F.; Chow, M.S.S. Hawthorn. *J. Clin. Pharmacol.* **2002**, *42*, 605–612. [CrossRef] [PubMed]
27. Ebrahimzadeh, M.A.; Hosseinimehr, S.J.; Hamidinia, A.; Jafari, M. Antioxidant and free radical scavenging activity of Feijoa sellowiana fruitspeel and leaves. *Pharmacologyonline* **2008**, *1*, 7–14.
28. Koukounaras, A.; Siomos, A.S. Changes in antıoxidant activity of radicchio during storage. *Acta Hortic.* **2010**, *877*, 1281–1285. [CrossRef]
29. Paladines, D.; Valero, D.; Valverde, J.M.; Diaz-Mula, H.; Serrano, M.; Martínez-Romero, D. The addition of rosehip oil improves the beneficial effect of Aloe vera gel on delaying ripening and maintaining postharvest quality of several stone fruit. *Postharvest Biol. Technol.* **2014**, *92*, 23–28. [CrossRef]
30. Qian, J.Y.; Liu, D.; Huang, A.G. The efficiency of flavonoids in polar extracts of *Lycium chinense* Mill fruits as free radical scavenger. *Food Chem.* **2004**, *87*, 283–288. [CrossRef]
31. Trappey II, A.; Bawadi, H.A.; Bansode, R.R.; Losso, J.N. Anthocyanin profile of mayhaw (*Cretaegus opaca*). *Food Chem.* **2005**, *91*, 665–671. [CrossRef]
32. Su, L.; Yin, J.J.; Charles, D.; Zhou, K.; Moore, J.; Yu, L.L. Total phenolic contents, chelating capacities, and radical-scavenging properties of black peppercorn, nutmeg, rosehip, cinnamon and oregano leaf. *Food Chem.* **2007**, *100*, 990–997. [CrossRef]
33. Barros, L.; Carvalho, A.M.; Morais, J.S.; Ferreira, I.C. Strawberry-tree, blackthorn and rose fruits: Detailed characterisation in nutrients and phytochemicals with antioxidant properties. *Food Chem.* **2010**, *120*, 247–254. [CrossRef]
34. Colak, A.M.; Okatan, V.; Polat, M.; Guclu, S.F. Different harvest times affect market quality of *Lycium barbarum* L. berries. *Turk. J. Agric. For.* **2019**, *43*, 326–333. [CrossRef]
35. Korkmaz, N.; Askin, M.A.; Altunlu, H.; Polat, M.; Okatan, V.; Kahramanoglu, I. The effects of melatonin application on the drought stress of different citrus rootstocks. *Turk. J. Agric. For.* **2022**, *46*, 585–600. [CrossRef]
36. Sun, Y.F.; Liang, Z.S.; Shan, C.J.; Viernstein, H.; Unger, F. Comprehensive evaluation of natural antioxidants and antioxidant potentials in *Ziziphus jujuba* Mill. var. *spinosa* (Bunge) Hu ex HF Chou fruits based on geographical origin by TOPSIS method. *Food Chem.* **2011**, *124*, 1612–1619. [CrossRef]
37. Saint-Eve, A.; Deleris, I.; Aubin, E.; Rabillier, J.M.; Ibarra, D.; Souchon, I. Influence of Composition (CO_2 and Sugar) on aroma release and perception of mint-flavored carbonated beverages. *J. Agric. Food Chem.* **2014**, *57*, 5891–5898. [CrossRef] [PubMed]
38. Kovacs, S.; Facsar, G.; Udvardy, L.; Toth, M. Phenological, morphological and pomological characteristics of some rose species found in Hungary. *Acta Hortic.* **2005**, *690*, 71–76. [CrossRef]
39. Nojavan, S.; Khalilian, F.; Kiaie, F.M.; Rahimi, A.; Arabanian, A.; Chalavi, S. Extraction and quantitative determination of ascorbic acid during different maturity stages of *Rosa canina* L. fruit. *J. Food Compos. Anal.* **2008**, *21*, 300–305. [CrossRef]
40. Koca, I.; Ustun, N.S.; Koyuncu, T. Effect of drying conditions on antioxidant properties of rosehip fruits (*Rosa canina* sp.). *Asian J. Chem.* **2009**, *21*, 1061.
41. Pirone, B.N.; Ochoa, M.R.; Kesseler, A.G.; De Michelis, A. Chemical characterization and evolution of ascorbic acid concentration during dehydration of rosehip (*Rosa eglanteria*) fruits. *Am. J. Food Technol.* **2007**, *2*, 377–387. [CrossRef]
42. Paunovic, D.; Kalusevic, A.; Petrovic, T.; Urosevic, T.; Djinovic, D.; Nedovic, V.; Popovic-Djordjevic, J. Assessment of chemical and antioxidant properties of fresh and dried rosehip (*Rosa canina* L.). *Not. Bot. Horti Agrobo Cluj Napoca* **2019**, *47*, 108–113. [CrossRef]
43. Socaciu, C. (Ed.) *Food Colorants: Chemical and Functional Properties*; CRC Press: Boca Raton, FL, USA, 2007.
44. Beyhan, O.; Koc, A.; Ercisli, S.; Jurikova, T.; Cakir, O. Bioactive Content of Rosa canina Biotypes from Turkey. *Oxid. Commun.* **2017**, *40*, 178–185.
45. Gunes, M.; Dolek, U.; Elmastas, M. Pomological changes in some rosehip species during ripening. *J. Agric. Fac. Gaziosmanpaşa Univ. JAFAG* **2016**, *33*, 214–222. [CrossRef]
46. Dogan, A.; Kazankaya, A. Fruit properties of rose hip species grown in Lake Van Basin (Eastern Anatolia Region). *Asian J. Plant Sci.* **2006**, *5*, 120–122.
47. Celik, F.; Kazankaya, A.; Ercisli, S. Fruit characteristics of some selected promising rose hip (*Rosa* spp.) genotypes from Van region of Turkey. *Afr. J. Agric. Res.* **2009**, *4*, 236–240.
48. Uggla, M.; Gao, X.; Werlemark, G. Variation among and within dogrose taxa (Rosa sect. caninae) in fruit weight, percentages of fruit flesh and dry matter, and vitamin C content. *Acta Agric. Scand. Sect. B Plant Soil. Sci.* **2003**, *53*, 147–155. [CrossRef]
49. Ersoy, B. Determination of fruit properties of different genotypes of *Rosa pimpinellifolia*. Master's Thesis, Institute of Science Department of Horticulture, Ataturk University, Erzurum, Turkey, 2019.

50. Murathan, Z.T.; Zarifikhosroshahi, M.; Kafkas, E.; Sevindik, E. Characterization of bioactive compounds in rosehip species from East Anatolia region of Turkey. *Ital. J. Food Sci.* **2016**, *28*, 314–325. [CrossRef]
51. Guerrero, J.; Ciampi, L.; Castilla, A.; Medel, F.; Schalchli, H.; Hormazabal, E.; Bensch, E.; Alberdi, M. Antioxidant capacity, anthocyanins, and total phenols of wild and cultivated berries in Chile. *Chil. J. Agric. Res.* **2010**, *70*, 537–544. [CrossRef]
52. Demir, B.; Sayinci, B.; Yaman, M.; Sumbul, A.; Yildiz, E.; Karakaya, O.; Alkaya, G.B.; Ercisli, S. Biochemical composition and shape-dimensional traits of rosehip genotypes. *Folia Hortic.* **2021**, *33*, 293–308. [CrossRef]
53. Ercisli, S. Chemical composition of fruits in some rose (*Rosa* spp.) species. *Food Chem.* **2007**, *104*, 1379–1384. [CrossRef]
54. Machmudah, S.; Kawahito, Y.; Sasaki, M.; Goto, M. Process optimization and extraction rate analysis of carotenoids extraction from rosehip fruit using supercritical CO_2. *J. Supercrit. Fluids* **2008**, *44*, 308–314. [CrossRef]
55. Razungles, A.; Oszmianski, J.; Sapis, J.-C. Determination of carotenoids in fruits of Rosa sp. (*Rosa canina* and *Rosa rugosa*) and of chokeberry (*Aronia melanocarpa*). *J. Food Sci.* **1989**, *54*, 774–775. [CrossRef]
56. Hodisan, T.; Socaciu, C.; Ropan, I.; Neamtu, G. Carotenoid composition of Rosa canina fruits determined by thin-layer chromatography and high-performance liquid chromatography. *J. Pharm. Biomed. Anal.* **1997**, *16*, 521–528. [CrossRef]
57. Kostic, D.A.; Dimitrijevic, D.S.; Mitic, S.S.; Mitic, M.N.; Stojanovic, G.S.; Zivanovic, A.V. A survey on macro-and micro-elements, phenolic compounds, biological activity and use of *Morus* spp. (*Moraceae*). *Fruits* **2013**, *68*, 333–347. [CrossRef]
58. Dogan, H.; Ercisli, S.; Temim, E.; Hadziabulic, A.; Tosun, M.; Yilmaz, S.O.; Zia-Ul-Haq, M. Diversity of chemical content and biological activity in flower buds of a wide number of wild grown caper (*Capparis ovate* Desf.) genotypes from Turkey. *Comptes Rendus Acad. Bulg. Sci.* **2014**, *67*, 1593–1600.
59. Cavusoglu, S.; Yilmaz, N.; Islek, F.; Tekin, O.; Sagbas, H.I.; Ercisli, S.; Rampáčková, E.; Nečas, T. Effect of Methyl Jasmonate, Cytokinin, and Lavender Oil on Antioxidant Enzyme System of Apricot Fruit (*Prunus armeniaca* L.). *Sustainability* **2021**, *13*, 8565. [CrossRef]
60. Skrovankova, S.; Ercisli, S.; Ozkan, G.; Ilhan, G.; Sagbas, H.I.; Karatas, N.; Jurikova, T.; Mlcek, J. Diversity of phytochemical and antioxidant characteristics of black mulberry (*Morus nigra* L.) fruits from Turkey. *Antioxidants* **2022**, *11*, 1339. [CrossRef]
61. Jaćimović, V.; Adakalić, M.; Ercisli, S.; Božović, D.; Bujdosó, G. Fruit Quality Properties of Walnut (*Juglans regia* L.) Genetic Resources in Montenegro. *Sustainability* **2020**, *12*, 9963. [CrossRef]
62. Bolaric, S.; Müller, I.D.; Vokurka, A.; Cepo, D.V.; Ruscic, M.; Srecec, S.; Kremer, D. Morphological and molecular characterization of Croatian carob tree (*Ceratonia siliqua* L.) germplasm. *Turk. J. Agric. For.* **2021**, *45*, 807–818. [CrossRef]
63. Grygorieva, O.; Klymenko, S.; Kuklina, A.; Vinogradova, Y.; Vergun, O.; Sedlackova, V.H.; Brindza, J. Evaluation of *Lonicera caerulea* L. genotypes based on morphological characteristics of fruits germplasm collection. *Turk. J. Agric. For.* **2021**, *45*, 850–860. [CrossRef]
64. Ozkan, G.; Ercıslı, S.; Zeb, A.; Agar, G.; Sagbas, H.I.; Ilhan, G. Some morphological and biochemical characteristics of wild grown caucasian whortleberry (*Vaccinium arctostaphylos* L.) genotypes from northeastern Turkey. *Not Bot Horti Agrobo* **2018**, *47*, 378–383.
65. Abanoz, Y.Y.; Okcu, Z. Biochemical content of cherry laurel (*Prunus laurocerasus* L.) fruits with edible coatings based on caseinat, Semperfresh and lecithin. *Turk. J. Agric. For.* **2022**, *46*, 908–918. [CrossRef]
66. Daler, S.; Cangi, R. Characterization of grapevine (*V. vinifera* L.) varieties grown in Yozgat province (Turkey) by simple sequence repeat (SSR) markers. *Turk. J. Agric. For.* **2022**, *46*, 38–48.
67. Dawadi, P.; Shrestha, R.; Mishra, S.; Bista, S.; Raut, J.K.; Joshi, T.P.; Bhatt, L.R. Nutritional Value and Antioxidant Properties of *Viburnum mullaha* Buch.-Ham. Ex D. Don fruit from Central Nepal. *Turk. J. Agric. For.* **2022**, *46*, 781–789. [CrossRef]
68. Delialioglu, R.A.; Dumanoglu, H.; Erdogan, V.; Dost, S.E.; Kesik, A.; Kocabas, Z. Multidimensional scaling analysis of sensory characteristics and quantitative traits in wild apricots. *Turk. J. Agric. For.* **2022**, *46*, 160–172. [CrossRef]
69. Ozer, G.; Makineci, E. Fruit characteristics, defoliation, forest floor and soil properties of sweet chestnut (*Castanea sativa* Mill.) forests in Istanbul-Turkey. *Turk. J. Agric. For.* **2022**, *46*, 703–716. [CrossRef]
70. Kotsou, K.; Stoikou, M.; Athanasiadis, V.; Chatzimitakos, T.; Mantiniotou, M.; Sfougaris, A.I.; Lalas, S.I. Enhancing Antioxidant Properties of *Prunus spinosa* Fruit Extracts via Extraction Optimization. *Horticulturae* **2023**, *9*, 942. [CrossRef]
71. Kayahan, S.; Ozdemir, Y.; Gulbag, F. Functional Compounds and Antioxidant Activity of *Rosa* Species Grown in Turkey. *Erwerbs Obstbau* **2023**, *65*, 1079–1086. [CrossRef]