https://doi.org/10.31015/jaefs.2026.1.9 https://izlik.org/JA54KE27BK

# Evaluation of physico-mechanical properties of Rosehip (*Rosa canina* L.) fruits

**Mehmet Emin Gökduman**

Isparta University of Applied Sciences, Faculty of Agriculture, Department of Agricultural Machinery and Technologies Engineering, Isparta, Türkiye

**Corresponding author:** Mehmet Emin Gökduman, **E-mail:** mehmetgokduman@isparta.edu.tr

**Received:** January 7, 2026 | **Accepted:** February 20, 2026 | **Published Online:** March 11, 2026 | **Final Version:** March 22, 2026

**Abstract**

Rosehip (*Rosa canina* L.*)* is a widely distributed wild fruit species in Türkiye that is increasingly important for food, pharmaceutical, and industrial applications. While many studies have examined its chemical composition and nutritional value, information on its physical and mechanical properties relevant to harvesting, handling, and processing remains limited. Thus, the objective of this study was to evaluate the physico-mechanical properties of rosehip fruits collected from natural populations in Isparta Province. The physical and mechanical characteristics were determined: fruit dimensions, mass, projected area, moisture content, fruit-to-seed ratio, flesh thickness, firmness, friction coefficient, angle of repose, color parameters, and mechanical behavior under detachment and puncture loading. All measurements were performed on 50 randomly selected fruit samples. The moisture content of the fruits and seeds was measured using the oven-drying method at 105 °C. The mechanical properties were evaluated using detachment, puncture, and firmness tests. The flow properties were characterized by determining the friction behavior and angle of repose. The average moisture content of fruits and seeds (wet basis, w.b.) was 32.46% and 18.90%, respectively, and the fruit-seed ratio was 58.75% fruit and 41.25% seed. Mean detachment and puncture forces were 8.19 N and 2.84 N, respectively. The angle of repose (12.3°) and friction coefficient values indicated favorable flow behavior, while color measurements showed moderate brightness with predominant red (a*) and yellow (b*) components. Overall, the results provide baseline engineering data that can support the design and optimization of harvesting, handling, and processing systems for rosehip fruits.

**Keywords:** Angle of repose, Detachment force, Friction coefficient, Physico-mechanical properties, Puncture force, Rosehip

## INTRODUCTION

The rosehip (*Rosa canina* L. and other Rosa spp.) is an important wild fruit that grows naturally in various regions of Türkiye. It is valued for its nutritional composition and potential for industrial use. Several studies have reported that rosehip fruits are particularly rich in vitamin C, phenolic compounds, organic acids, and minerals (Demir and Özcan, 2001). The high antioxidant capacity of rosehip fruits is mainly attributed to considerable levels of ascorbic acid, flavonoids, and various phenolic acids (Demir and Özcan, 2001; Macit, 2018). Rosehip is classified as a non-wood forest product with considerable socio-cultural and economic value, and its wide range of uses has led to an increasing demand and growing interest in cultivation practices (Ertaş, 2023).

The rosehip species is well adapted to harsh environmental conditions and is widely distributed in the Central Anatolia, Mediterranean, and Eastern Anatolia regions of Turkey (Demir and Özcan, 2001). Natural populations exhibit wide variation in pomological characteristics such as fruit size, shape, flesh thickness, color, and internal composition, resulting in significant differences among genotypes (Yılmaz et al., 2016; Medveckienė et al., 2023). Recent studies on naturally grown rosehip ecotypes in Turkey have demonstrated significant variability in fruit quality traits, such as weight, firmness, flesh-to-seed ratio, color parameters, and soluble solids, among different genotypes (Sagbaş, 2023).

**Citation:** Gokduman, M.E. (2026). Evaluation of physico-mechanical properties of Rosehip (*Rosa canina* L.) fruits. International Journal of Agriculture, Environment and Food Sciences, 10 (1): 77–85. https://doi.org/10.31015/jaefs.2026.1.9

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 International License (CC BY 4.0). https://creativecommons.org/licenses/by/4.0/
**Copyright © 2026 by the authors.**

Globally, the use of rosehip fruits and their derivatives in functional foods, nutraceutical formulations, and cosmetics is increasing, reflecting growing market demand (Negrean et al., 2024). According to official national statistics from the Republic of Turkey Ministry of Agriculture and Forestry (2020), rosehip cultivation and utilization in Turkey has increased significantly over the last decade. The registered cultivation area grew from 999 da in 2010 to 27,053 da in 2019. Certified organic production reached approximately 1,000 tons in 2019, and an additional 113 tons were collected from natural stands. The species is distributed over more than 102,000 hectares of forest, with an annual utilization amount exceeding 8,000 tons. Producer prices are reported to be around 10 TL/kg, and feasibility analyses indicate favorable economic indicators, including a benefit-cost ratio of 3.44 and an internal rate of return exceeding 40%.

The physical and mechanical properties of rosehip fruits are critical for reducing postharvest losses, assessing the feasibility of mechanical harvesting, developing grading and sorting systems, and designing processing lines. Previous studies have shown that structural changes such as volume and surface area shrinkage occurring during drying processes must be characterized not only for evaluating final product quality but also for the design and simulation of processing equipment (Ochoa et al., 2002).

Physical properties are fundamental indicators used to evaluate the suitability of agricultural and biological materials for engineering, handling, and processing applications. These properties directly affect the structural stability, flow behavior, and system performance of agricultural systems (Alhassan et al., 2018). Studies on different fruit species have shown that physical properties, such as size, mass, volume, porosity, and friction behavior, as well as mechanical properties, including firmness, fracture resistance, elasticity, and deformation, directly impact equipment design and processing efficiency (Hacıseferoğulları et al., 2007; Lang et al., 2022). Failing to consider these characteristics when designing systems may lead to increased product loss and reduced operational efficiency (Hacıseferoğulları et al., 2007). Similar engineering-oriented approaches have been successfully applied to medicinal and aromatic plants. In these cases, physical and mechanical parameters, such as projection area, detachment (picking) force, and friction-related properties, were used as key design inputs for threshing and separation machinery (Yilmaz and Gökduman, 2014).

Studies on the physico-mechanical properties of rosehip fruits are limited. Demir and Özcan (2001), measured the dimensions of the fruit, its thousand-seed weight, its bulk density, its porosity, its friction coefficient, and its shell-breaking resistance. They reported the shell strength values, as measured by the BMTI test, in terms of force (N). Other studies have emphasized that quality attributes such as flesh firmness, color changes dependent on ripening, fruit-to-seed ratio, and pulp composition vary significantly during stages of fruit development and maturity (Güneş et al., 2016; Medveckienė et al., 2023).

However, information on mechanical parameters that directly affect the harvesting, handling, and transportation processes, such as fruit-pedicel detachment force and puncture force, is still scarce. While Ionescu et al., (2025) evaluated the mechanical behavior of rosehip seeds and fruits, they also emphasized the necessity of further research on the postharvest mechanical properties of whole fruits.

Additionally, processing-related parameters, such as moisture content, fruit-to-seed ratio, flesh thickness, friction coefficient, and angle of repose, significantly impact the behavior of rosehip fruits during the drying, conveying, sorting, and extraction processes (Babalau-Fuss et al., 2020). Previous studies have reported that convective drying processes significantly alter the physical and textural properties of rosehip fruits, leading to changes in hardness, shrinkage, and overall structural behavior, which are critical for product quality and process design (Pashazadeh et al., 2021). Rosehip fruits are generally processed into various food products due to their short harvesting season, storage sensitivity, and slightly tart taste, highlighting the need for suitable technological designs to ensure product quality and efficient processing (Teodorescu et al., 2023). Large quantities of seeds are produced as by-products when rosehip fruits are processed into products such as marmalade, pulp, and juice, and the effective utilization of these seeds is important in terms of economic value and sustainability (Köksal and Tuğlu, 2025).

Although numerous chemical and pomological studies on rosehip fruits are available, comprehensive data integrating the physico-mechanical properties of naturally harvested rosehip fruits during the harvest period remains limited (Ionescu et al., 2025). Thus, this study aimed to determine the postharvest physico-mechanical properties of rosehips naturally grown in Isparta Province. These properties included fruit detachment force, puncture force, flesh thickness, color parameters, friction behavior, moisture content, fruit-to-seed ratio, and angle of repose. The findings of this study are expected to provide practical engineering data for the design of harvesting and postharvest handling systems for wild rosehip fruits.

## MATERIALS AND METHODS

### Plant Material

The rosehip (*Rosa canina* L.) fruit used in this study were harvested in October from natural populations in Isparta Province, Turkey (Figure 1). Previous studies have reported that rosehip fruits collected from natural habitats may exhibit wide variation in physical characteristics, such as size, shape, flesh thickness, and color, due to genetic and ecological factors (Yılmaz et al., 2016; Medveckienė et al., 2023). The harvested fruits were transported to the laboratory on the same day and were not pretreated prior to measurements.



**Figure 1.** Rosehip (*Rosa canina* L.) fruit collected from shrubs in natural populations in Isparta Province

The moisture content of the fruits and seeds was determined using the oven-drying method at 105 °C until a constant weight was reached, in accordance with the standard procedures applied to rosehip fruits and similar fruits. Demir and Özcan (2001), reported a similar drying approach for determining the initial moisture content of rosehip fruits. Moisture content was expressed on a wet basis (w.b.) and calculated using the following equation:

$$MC\ (\%) = (W1 - W2) / W1 \times 100 \quad (1)$$

where $W_1$ is the initial mass of the sample (g) and $W_2$ is the mass after oven drying (g).

**Determination of Physical Properties**

Dimensional measurements (length, width and thickness) were taken on 50 randomly selected fruits using a digital calliper (Mitutoyo Absolute Digimatic 500-184-20 CD-15CPXR, Japan) with a resolution of 0.01 mm. The fruit weight (with and without the pedicel), total fruit mass and seed mass were determined using a precision electronic balance (RADWAG PS 600/C/2, Poland) with a readability of 0.001 g and a maximum capacity of 600 g. The fruit-to-seed ratio was then calculated. Each measurement was taken once per fruit and the results are presented as the mean ± standard deviation.

The projected area of rosehip fruits (mm²) was determined using an image analysis method. High-resolution digital images were captured under uniform illumination on a flat, non-reflective surface. A reference square with a known area of 1 cm² was placed within the imaging field for calibration purposes. The images were imported into ImageJ software (version 1.53, NIH, USA) and pixel-to-millimetre conversion was performed using the 'Set Scale' function, based on the known reference area. The images were then converted to binary format and the "Analyse Particles" function was used to calculate the projected surface area of individual fruits, ensuring objective and repeatable measurements (Figure 2).

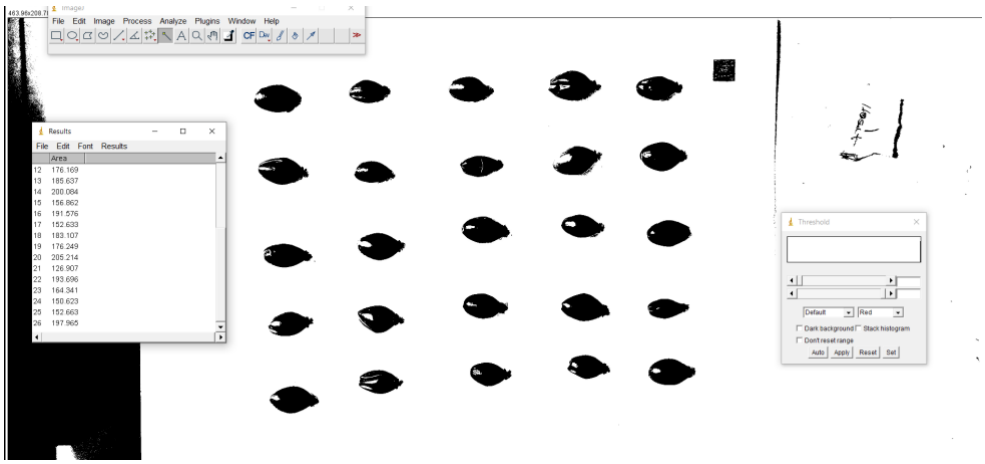


**Figure 2.** Binary image of rosehip fruits used to determine projected area in ImageJ.

The color of the fruit surface was measured using a Minolta CR-400 chromameter (Konica Minolta, Japan) based on the CIE L*a*b* color space system, as defined by the International Commission on Illumination (CIE). In this system, the L*

value indicates brightness (0 = black, 100 = white); the a* value represents the red-green axis (positive = red, negative = green); and the b* value represents the yellow-blue axis (positive = yellow, negative = blue) (Doymaz, 2015; Kuş et al., 2017).

**Friction Coefficient and Angle of Repose**

The static friction coefficient was determined using a screw-driven, manually adjustable tilt table equipped with an integrated analog angle indicator. The galvanized steel test surface was mounted on the adjustable frame. Individual fruits were placed on the surface with no external constraints. The inclination angle was gradually increased by rotating the screw mechanism until the onset of sliding motion occurred. The critical angle at the onset of motion was recorded directly from the analog scale. Each measurement was repeated three times for each fruit, and the average value was used in the calculations. The static friction coefficient ($\mu_s$) was calculated using the following equation:

$$\mu_s=\tan(\theta), \quad (2)$$

where θ represents the angle at which sliding is initiated (degrees).

The angle of repose was determined to evaluate the flow behavior of rosehip fruits. Approximately 1 kg of fruit was allowed to fall freely to form a conical pile, and the experiment was repeated three times. The height of the pile (h) was measured from the base plane to the apex using a digital caliper. To account for irregularities in the pile base, four base radii ($r_1$, $r_2$, $r_3$, and $r_4$) were measured at approximately equal angular intervals (Figure 3). The mean radius (r) was calculated as the arithmetic average of these four measured radii:

$$r = (r_1 + r_2 + r_3 + r_4) / 4, \quad (3)$$

The angle of repose was then calculated using the following equation:

$$\tan(\theta)=h/r, \quad (4)$$

where r represents the mean radius of the pile base and h represents the pile height. (cm). This approach has been widely used to characterize the flow behavior of agricultural products (Hacıseferoğulları et al., 2007).

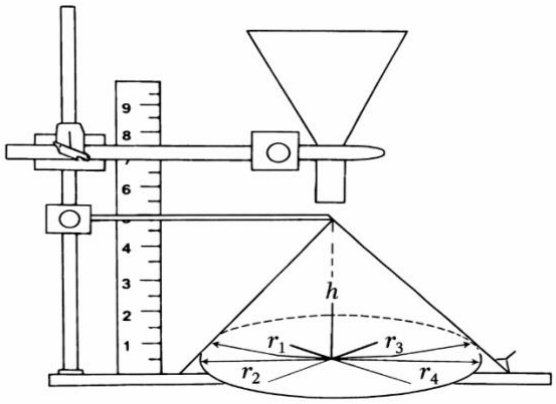
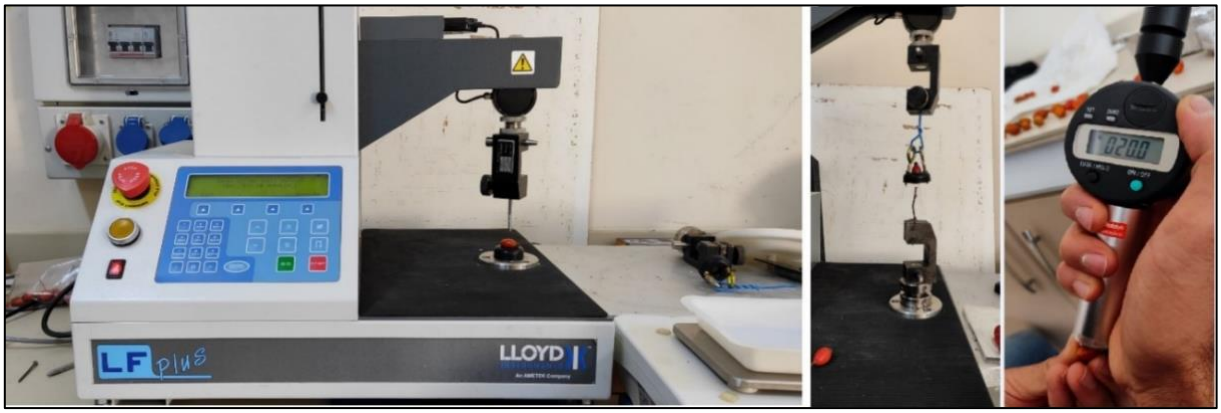



**Figure 3.** Schematic representation of the angle of repose experimental setup used for rosehip fruits

**Mechanical Properties**

To evaluate the mechanical resistance of rosehip fruits, we conducted fruit detachment, puncture, and firmness tests. For these tests, we used a universal testing machine an analog fruit penetrometer, and a digital Shore A durometer (Figure 4).




**(a)** **(b)** **(c)**

**Figure 4.** Experimental setups used for measuring fruit detachment (a), puncture (b), and firmness (c) of rosehip fruits.

For the detachment tests, a tensile load was applied to the fruit-pedicel junction until separation occurred, and the maximum force was recorded. Fruit detachment tests were performed on 50 fruits that were randomly selected from the sample population. Each fruit was tested once, and force-deformation data were continuously recorded during loading. These tests were performed using a Lloyd Instruments LF Plus universal testing machine (Lloyd Instruments Ltd., UK) equipped with a 500 N load cell. The machine was operated at a constant crosshead speed of 200 mm/min. Force-deformation curves were recorded, and the following parameters were calculated: detachment force, tensile stress, stiffness, deformation at break, and energy to break. Stiffness was determined by calculating the slope of the linear portion of the force-deformation curve. Energy to break was calculated by determining the area under the curve up to the failure point. Similar forcedeformation based mechanical evaluation procedures have been reported for small fruits and biological materials (Gökduman, 2025).

Puncture tests were conducted on the fruit using the same testing machine to evaluate its resistance to localized mechanical damage. Puncture tests were conducted on 50 fruits using a cylindrical probe with a diameter of 1.20 mm. To avoid structural bias, each fruit was punctured once at the equator. A cylindrical probe with a diameter of 1.20 mm was inserted into the surface of the fruit at a constant speed of 200 mm/min. The maximum puncture force, deformation, tensile stress, stiffness, and energy to puncture were obtained from the force-deformation data. Different fruits were used for detachment and puncture tests to prevent mechanical pre-damage. The tensile and puncture testing procedures and the force-deformation analysis approach adopted in this study are consistent with the methodologies commonly used to mechanically characterize agricultural materials with universal testing machines (Mohsenin, 1986; Duran, 2025).

Fruit firmness was evaluated using an analog fruit penetrometer (FT 011, capacity 5 kg, resolution 50 g), suitable for soft fruits. Penetration force values were recorded in kgf and converted to newtons (1 kgf = 9.81 N) for statistical analysis. In addition, fruit surface hardness was measured using a digital Shore A durometer (Mitutoyo Hardmatic HH-300 Series 811, Japan) with a measurement range of 10-90 HA. Two consecutive Shore A measurements (Shore A1 and Shore A2) were taken at adjacent positions on the fruit surface, and the corresponding values were recorded. Güneş et al. (2016) reported on similar penetration-based firmness measurement principles for rosehip fruits.

### Statistical Analysis

Descriptive statistical analyses were performed, and the results are presented as the mean ± standard deviation. No comparative statistical tests were applied as the study primarily aimed to provide baseline engineering data for design-oriented applications.

## RESULTS

### Physical Properties of Rosehip Fruits

The average fruit length and width were 20.19 ± 1.50 mm and 12.13 ± 1.14 mm, respectively. The mean pedicel diameter was 1.23 ± 0.17 mm. The average fruit mass and the average fruit mass with the pedicel were measured as 1.56 ± 0.39 g and 1.79 ± 0.46 g, respectively. The mean projected area of rosehip fruits was determined to be 174.86 ± 30.52 mm². Table 1 presents the dimensional and mass-related properties of rosehip fruits.

The flesh thickness of 50 fruits was measured using a digital calliper, revealing an average value of 1.34 ± 0.31 millimetres. This indicates moderate variability among the samples. These results describe the fundamental dimensional and mass characteristics of rosehip fruits collected from natural populations (Table 1). Previous studies have reported similar ranges of dimensional variability for rosehip fruits grown under natural conditions, reflecting the influence of genetic and environmental factors (Yılmaz et al., 2016; Medveckienė et al., 2023).

**Table 1.** Physical properties of rosehip (*Rosa canina* L.) fruits (mean ± standard deviation).

| Parameter | Mean ± Standard Deviation |
|---|---|
| Fruit width (mm) | 12.13 ± 1.14 |
| Pedicel diameter (mm) | 1.23 ± 0.17 |
| Fruit length (height) (mm) | 20.19 ± 1.50 |
| Fruit weight (g) | 1.56 ± 0.39 |
| Fruit weight with pedicel (g) | 1.79 ± 0.46 |
| Flesh thickness (mm) | 1.34 ±0.31 |
| Projected area ($mm^2$) | 174.86 ± 30.52 |

**Moisture Content and Fruit-Seed Ratio**

The average moisture content of rosehip fruits collected from Isparta Province was 32.46%, while the moisture content of the seeds was 18.90%. These values fall within the range reported for rosehip fruits harvested at similar stages of maturity (Demir and Özcan, 2001).

Based on separate measurements of the fruit and seed masses, the average total fruit mass was found to be 1.53 g, with an average flesh mass of 0.88 g. Thus, the fruit-to-seed ratio was calculated to be 58.75% fruit and 41.25% seed. This ratio falls within the range reported for rosehip fruits in previous studies, which documented pulp-to-seed ratios between 0.70 and 1.35 (Ionescu et al., 2025). The relatively high proportion of seed mass indicates that the seed fraction constitutes a substantial part of the total fruit mass and should be considered in processing and separation applications.

**Friction Coefficient and Angle of Repose**

The static friction coefficient of rosehip fruits depended on the orientation of contact. The average sliding angle measured in the transverse direction was 5.30°, corresponding to a static friction coefficient of 0.093. In contrast, the average sliding angle in the longitudinal direction was 15.90°, resulting in a higher friction coefficient of 0.285. These results suggest that resistance to sliding is significantly impacted by the orientation of the fruit relative to the contact surface.

The angle of repose, which characterizes the flow behavior of particulate agricultural materials, was calculated as 12.3°. During measurements, the average values of the semi-axes defining the elliptical base of the pile (a, a′, b, b′) were 24.31, 24.51, 24.65, and 23.49 cm, respectively, while the mean pile height was 5.27 cm. The relatively low angle of repose suggests favorable flow characteristics of rosehip fruits, which may facilitate handling and conveying operations in appropriately designed systems.

**Fruit Detachment and Puncture Properties**

Mechanical properties associated with the fruit-pedicel connection were evaluated using tensile tests. The mean detachment force was 8.19 ± 4.12 N. Tensile stress at break was calculated as 6.82 ± 2.82 N/mm², while the stiffness value representing system rigidity was 2.80 ± 1.85 N/mm. The average deformation at break was 7.14 ± 2.33 mm, and the load at break was 4.85 ± 4.74 N. The energy required for fruit detachment was determined as 0.023 ± 0.010 J (Table 2).

**Table 2.** Mechanical parameters obtained from detachment and puncture tests of rosehip fruits.

| | Maximum Force (N) | Load at Break (N) | Tensile Stress($N/mm^2$) | Deformation (mm) | Stiffness (N/mm) | Energy to Break (J) |
|---|---|---|---|---|---|---|
| Detachment Parameters | 8.19 ± 4.12 | 4.85 ± 4.74 | 6.82 ± 2.82 | 7.14 ± 2.33 | 2.80 ± 1.85 | 0.023 ± 0.010 |
| Puncture Parameters | 2.84 ± 0.77 | 2.14 ± 0.63 | 3.62 ± 0.98 | 9.03 ± 1.85 | 1.28 ± 0.49 | 0.626 ± 0.253 |

Puncture tests revealed an average puncture force of 2.84 ± 0.77 N for rosehip fruits. The corresponding tensile stress, stiffness, and deformation values were 3.62 ± 0.98 N/mm², 1.28 ± 0.49 N/mm, and 9.03 ± 1.85 mm, respectively. The energy required for puncturing the fruit was notably higher (0.626 ± 0.253 J) than the energy required for detaching the fruit, indicating that localized tissue penetration involves greater energy absorption than pedicel separation.

**Firmness and Color Properties**

Fruit firmness measurements taken with a 1 mm penetrometer probe yielded an average value of 3.34 ± 0.98 N. Shore hardness measurements performed according to the Shore A scale resulted in mean values of 12.86 ± 3.55 (Shore A1) and 12.27 ± 5.09 (Shore A2) (Table 3). These results demonstrate that fruit firmness values vary depending on the measurement technique and probe characteristics.

**Table 3.** The hardness measurement results in rosehip fruit.

| Parameter | Mean ± Standard Deviation |
|---|---|
| Penetrometer (N, 1 mm probe) | 3.34 ± 0.98 |
| Shore hardness (A 1) | 12.86 ± 3.55 |
| Shore hardness (A 2) | 12.27 ± 5.09 |

Color measurements conducted using the CIE L*, a*, b* color space indicated an average L* value of 40.04 ± 4.49, an a* value of 33.72 ± 5.70, and a b* value of 25.56 ± 6.23. Calculated chroma (C*) and hue angle (h°) values were 42.32 ± 4.06 and 37.20° ± 3.75, respectively. These findings suggest that rosehip fruits exhibited moderate brightness with pronounced red and yellow color components, which are characteristic of mature fruits.

## DISCUSSION

This study quantitatively evaluated the physico-mechanical properties of rosehip fruits (*Rosa canina* L.) relevant to harvesting, handling, and processing operations. These results provide a baseline of engineering data for designing postharvest systems. The dimensions, mass, and projected area of the fruits were determined to provide a structural basis for interpreting mechanical response and bulk flow behavior. Projected area is a geometric parameter closely related to surface contact, frictional interaction, and flow characteristics. Image analysis-based approaches are widely used to objectively determine projected area in agricultural materials (Hacıseferoğulları et al., 2007; Lang et al., 2022; Dokumacı, 2025).

The measured moisture content of the fruit (32.46%) and seeds (18.90%) is an important reference point when evaluating mechanical behavior because moisture levels strongly influence deformation and fracture resistance in biological materials. Previous studies have shown that increasing moisture content generally increases deformability while decreasing mechanical strength (Dokumacı, 2025). Rosehip fruits have a mass ratio of approximately 59% fruit and 41% seed. This significant seed content must be carefully considered when designing separation, milling, and processing systems (Ionescu et al., 2025).

With an average flesh thickness of 1.34 mm, the tissue layer surrounding the seed mass is relatively thin. Together with penetrometer and Shore hardness measurements, these results suggest that rosehip fruit tissue exhibits moderate resistance to penetration and surface indentation. Using a combination of penetrometer force and Shore A hardness measurements, we evaluated the localized penetration resistance and surface indentation behavior of rosehip fruits. Previous studies have reported that penetration-based firmness measurements are suitable for characterizing the resistance of skin and tissue in rosehip fruits (Demir and Özcan, 2001). These results support the methodological approach adopted in this study.

Tilt tests conducted on a galvanized steel surface revealed that the frictional behavior of rosehip fruits depends on their orientation. The static friction coefficients obtained using the tilt method are essential input parameters for designing conveying and storage systems and are widely applied to agricultural materials (Boyar et al., 2023). Additionally, the calculated angle of repose (approximately 12°) suggests favorable flow characteristics and indicates that rosehip fruits can exhibit stable bulk flow in appropriately designed hoppers and bins. These findings are consistent with those reported for similar agricultural products (Hacıseferoğulları et al., 2007).

The mechanical properties of the fruit-pedicel connection are essential for assessing harvestability and the likelihood of mechanical damage. Similar mechanical evaluations focusing on detachment and separation have also been reported for medicinal and aromatic plants. In these evaluations, picking force was identified as a critical design parameter for mechanized threshing systems (Yilmaz and Gökduman, 2014). Measured detachment force, tensile stress, deformation, and energy to break quantitatively describe the mechanical behavior of the fruit-stem junction. In contrast, puncture tests characterize the fruit skin's and flesh's resistance to localized loading conditions. Penetration-based mechanical tests are widely recognized as effective tools for evaluating skin strength and susceptibility to damage in fruits (Demir and Özcan, 2001; Hacıseferoğulları et al., 2007). The limited number of studies addressing both detachment and puncture properties in rosehip fruits underscores the novelty and significance of the present study (Ionescu et al., 2025).

Color measurements performed in the CIE L*a*b* color space enabled objective evaluation of visual quality attributes. This system is widely used to quantify color intensity and hue changes in fruits and seeds (Stryjecka et al., 2024; Boyar et al., 2023). Variations in the L*, a*, and b* parameters have also been associated with ripening and quality assessment in rosehip fruits (Medveckienė et al., 2023). Thus, the color data obtained in this study provide supplementary information for classification and quality evaluation.

Although direct numerical comparisons with previous studies are limited due to differences in testing methods, loading conditions, and biological materials, the results presented here provide a comprehensive, integrated dataset on the physico-mechanical properties of rosehip fruits. These findings provide valuable baseline information that can inform the design and optimization of harvesting, handling, and processing systems for rosehip fruits.

From an engineering standpoint, the detachment and puncture force values obtained in this study can be used directly in the design of mechanical harvesting and damage-sensitive postharvest equipment

## CONCLUSION

This study evaluated the physico-mechanical properties of rosehip fruits (*Rosa canina* L.) collected from natural populations in Isparta Province. The results showed that rosehip fruits have unique physical, mechanical, and flow-related properties relevant to harvesting, handling, and processing. The determined moisture content and fruit-to-seed ratio revealed the fruit's structural composition, indicating a significant seed mass proportion that must be considered in processing and separation applications. Measurements of flesh thickness and firmness revealed that the fruit tissue has a relatively thin flesh layer with moderate resistance to penetration, which may increase susceptibility to mechanical damage during postharvest handling. Friction coefficient and angle of repose values indicated favorable flow behavior on galvanized steel surfaces, suggesting that flow-related problems may be limited in appropriately designed storage and conveying systems. Furthermore, quantified detachment and puncture parameters provided insight into the mechanical resistance of the fruit-pedicel connection and fruit tissue. These parameters are critical for assessing harvestability and the risk of mechanical damage. While direct numerical comparisons with previous studies were limited due to differences in testing methods and biological materials, this study's results fill an important gap in the literature by providing comprehensive physico-mechanical data on rosehip fruits. This information could support the design and optimization of efficient harvesting, handling, and processing equipment.

**Conflict of Interest**

The author declares that there is no conflict of interest.

**Author Contribution**

The author solely conceived, designed, and conducted the study, analyzed the data, and wrote the manuscript.

## REFERENCES


Alhassan, I., Gashua, A. G., Dogo, S., & Sani, M. (2018). Physical properties and organic matter content of the soils of Bade in Yobe State, Nigeria. International Journal of Agriculture, Environment and Food Sciences, 2, 160-163.

Babalau-Fuss, V., Becze, A., Roman, M., Moldovan, A., Cadar, O., & Tofana, M. (2020). Chemical and technological properties of blackthorn (Prunus spinosa) and rose hip (*Rosa canina*) fruits grown wild in Cluj-Napoca area. Agricultura, 113-114, 110-114.

Boyar, İ., Ozsan, T., Ertekin, C., & Onus, A. N. (2023). Some physical properties of bitter gourd (Momordica charantia L.) seeds and kernels. International Journal of Agriculture, Environment and Food Sciences, 7, 244-252.

Demir, F., & Özcan, M. (2001). Chemical and technological properties of rose (*Rosa canina* L.) fruits grown wild in Turkey. Journal of Food Engineering, 47, 333-336. https://doi.org/10.1016/S0260-8774(00)00129-1

Dokumacı, K. Y. (2025). Investigating the intrinsic physical and technological properties of naturally grown Christ's thorn (Paliurus spina-christi Mill.) in Türkiye: A comprehensive analysis. International Journal of Agriculture, Environment and Food Sciences, 9, 930-938.

Doymaz, İ. (2015). Infrared drying kinetics and quality characteristics of carrot slices. Journal of Food Processing and Preservation, 39(6), 2738-2745.

Duran, H. (2025). Physico-Mechanical Properties of Male and Female Hemp Plants. *Agriculture*, *15*(7), 776.

Ertaş, T. B. (2023). Odun dışı orman ürünü: Kuşburnu (*Rosa canina* L.). Theoretical and Applied Forestry, 3, 9-13.

Gökduman, M. E. (2025). Physicomechanical Characterization and Quality Assessment of Prunus Spinosa L. Fruits at Various Maturity Stages for Postharvest Optimization. *Applied Fruit Science*, *67*(4), 188.

Güneş, M., Dölek, Ü., & Elmastaş, M. (2016). Pomological changes in some rosehip species during ripening. Journal of Agricultural Faculty of Gaziosmanpaşa University, 33, 214-222.

Hacıseferoğulları, H., Gezer, I., Özcan, M. M., & Murat Asma, B. (2007). Post-harvest chemical and physical-mechanical properties of some apricot varieties cultivated in Turkey. Journal of Food Engineering, 79, 364-373. https://doi.org/10.1016/j.jfoodeng.2006.02.004

Ionescu, A. D., Voicu, G., Stefan, E. M., Constantin, G. A., Tudor, P., & Militaru, G. (2025). Physico-chemical and resistance characteristics of rosehip seeds. Agriculture, 15, 1539. https://doi.org/10.3390/agriculture15141539

Köksal, F., & Tuğlu, A. M. (2025). Atık kuşburnu çekirdeğinin kullanımı, ekonomik değeri ve insan sağlığı üzerine bir araştırma. Multidisipliner Yaklaşımlarla Coğrafya Dergisi, 3(2), 95-112.

Kuş, Z. A., Demir, B., Eski, I., Gürbüz, F., & Ercişli, S. (2017). Estimation of the colour properties of apple varieties using neural networks. Erwerbs-Obstbau, 59(4), 291-299.

Lang, Y., Xie, Z., & Chen, L. (2022). Finite element simulation of mechanical properties of Rosa roxburghii under compression loading. Journal of Food Process Engineering, 45, e13939. https://doi.org/10.1111/jfpe.13939

Macit, M. (2018). *Rosa canina* L. ve Rosa pimpinellifolia L. köklerindeki fenolik bileşiklerin miktarı ve biyoyararlılığının tespiti (Yüksek lisans tezi). İstanbul Üniversitesi, Fen Bilimleri Enstitüsü, İstanbul, Türkiye.

Medveckienė, B., Levickienė, D., Vaitkevičienė, N., Vaštakaitė-Kairienė, V., & Kulaitienė, J. (2023). Changes in pomological and physical parameters in rosehips during ripening. Plants, 12, 1314. https://doi.org/10.3390/plants12061314

Ministry of Agriculture and Forestry (2020). *Rosehip (Rosa canina L.) Feasibility Report and Investment Guide*. General Directorate of Crop Production (BÜGEM), Ankara, Türkiye.

Mohsenin, N. N. (1986) Physical properties of plant and animal materials. Gordon and Breach

Negrean, O. R., Farcas, A. C., Nemes, S. A., Cic, D. E., & Socaci, S. A. (2024). Recent advances and insights into the bioactive properties and applications of *Rosa canina* L. and its by-products. *Heliyon*, *10*(9).

Ochoa, M. R., Kesseler, A. G., Pirone, B. N., Márquez, C. A., & De Michelis, A. (2002). Shrinkage during convective drying of whole rose hip (*Rosa rubiginosa* L.) fruits. LWT - Food Science and Technology, 35, 400-406.

Pashazadeh, H., Zannou, O., Galanakis, C. M., Aldawoud, T. M., Ibrahim, S. A., & Koca, I. (2021). Optimization of drying process for *Rosa pimpinellifolia* L. fruit based on bioactive compounds and modeling of drying process. International Journal of Food Properties, 24, 1367-1386.

Sagbaş, H. I. (2023). Investigation of fruit quality and biochemical traits of rosehip (*Rosa canina*) ecotypes in the Aegean Region of Türkiye. Horticulturae, 9, 1292. https://doi.org/10.3390/horticulturae9121292

Stryjecka, M., Kiełtyka-Dadasiewicz, A., & Michalak, M. (2024). Physico-chemical characteristics of *Rosa canina* L. seeds and determining their potential use. Applied Sciences, 15, 168. https://doi.org/10.3390/app15010168

Teodorescu, A. A., Milea, Ș. A., Păcularu-Burada, B., Nistor, O. V., Andronoiu, D. G., Râpeanu, G., & Stănciuc, N. (2023). Customized technological designs to improve the traditional use of *Rosa canina* fruits in foods and ingredients. Plants, 12, 754. https://doi.org/10.3390/plants12040754

Yılmaz, K. U., Uzun, A., & Yaman, M. (2016). Orta Anadolu'da (Kayseri) yüksek rakımdan toplanan kuşburnu (*Rosa canina* L.) genotiplerinin meyve karakteristiklerinin belirlenmesi. In VII. Ulusal Bahçe Bitkileri Kongresi Bildirileri (Cilt I: Meyvecilik, ss. 396-400). 25-29 Mayıs 2016, Çanakkale, Türkiye.

Yılmaz, D., & Gökduman, M. E. (2014). Physical-mechanical properties of Origanum onites at different moisture contents. Journal of Essential Oil-Bearing Plants, 17(5), 1023-1033. https://doi.org/10.1080/0972060X.2014.890082