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UNVEILING THE GENETIC WEALTH: CHARACTERIZATION OF WILD HAZELNUT (*Corylus avellana* L.) POPULATIONS IN DÜZCE PROVINCE FROM TÜRKIYE

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Abstract: This study was carried out in Yığılca, Gümüşova, Cumayeri and Akçakoca districts of Düzce province in 2023. In the study, pomological and morphological characteristics of 129 genotypes in natural hazelnut populations and orchards were determined. Genotypes were distributed in the altitude range of 25-760m, 90.5% were detected in orchards and 9.5% in areas such as roadsides, stream beds and mountain slopes. When the genotypes were grouped in terms of plant height, it was determined that 75.39% were taller than 4 m, 22.24% were between 3-4 m, 1.58% were between 2-3 m and 0.79% were between 1-2 m. In the examined genotypes, nut length was measured between 15.0-25.4 mm, nut width was measured between 14.5-28.1 mm, nut size was measured between 14.19-20.61 mm and nut shape index was measured between 0.75-1.84. Leaf length varied between 8.92-15.36 mm, leaf width between 6.85-12.89 mm, and petiole length varied between 0.5-2.68 mm. While 79.13% of the genotypes have a husk longer than the nut, 66.09% have a husk slit. The number of hazelnut husk, one of the basic elements of yield, was determined to be 3 and above in 50% of the genotypes. In the study, it was evaluated that the hazelnut genetic resources in Düzce have a wide variation and that it is important to protect and use them in breeding studies. It was emphasized that especially genotypes with a nut size of 20 mm and above, round-shaped and number of nuts in cluster is over four in new cultivar development.

Keywords: *Corylus avellana*, Biodiversity, Climate change, Wild hazelnut

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1. Introduction

The Corylus genus of the Betulaceae family is in the form of hazelnut bushes or trees, and is among the hard-shelled fruits with the highest economic value. Species in tree form are highly valued as timber. Molnar (2011) reported that there are 10 polymorphic species in the Corylus genus as a result of morphological and molecular studies. The most studied and best known of these species is *Corylus avellana* L. Hazelnut is an endemic plant in the northern hemisphere and is widespread in countries such as Türkiye, Italy, Spain and the USA (Özçağıran et al., 2014). Commercial production in Türkiye is largely concentrated in the Black Sea Region, and important cultivars such as 'Tombul' and 'Palaz' have been developed as a result of local selection (Balık and Arif, 2023). Türkiye has an important place in terms of plant biodiversity, being located at the intersection of the Mediterranean and Near East Gene Centers (Vavilov, 1994). Anatolia is the origin of hazelnuts (*C. avellana* L. and *C. colurna* L.), as well as many other fruit species (Molnar, 2011). Significant variations are observed among hazelnut cultivars in orchards and natural populations in the Black Sea Region (Balık et al., 2014). Some researchers note that in addition to the variation among Turkish hazelnut cultivars, there is also a rich variation within the cultivar. They even classify Turkish hazelnut cultivars as a collection of clones (İslam, 2008; Balık et al., 2018; Bostan and Karakaya 2024). In order to take advantage of this clonal variation in Türkiye, many clonal selection have been carried out in different cultivars and locations (Demir, 1997; İslam and Özgüven 2001; Turan, 2007; Çayan, 2019; Karakaya, 2021; Uzun, 2021; Bilgen, 2023). The main characteristics taken into consideration in hazelnut breeding are nut and yield characteristics, morphological and phenological characteristics, resistance, and rootstock (İslam, 2019).

Climate change has caused yield and quality problems in hazelnut production, as in other agricultural products, in recent years. Especially the risk of late spring frost, pollination and fertilization problems, and drought negatively affect yield (Beyhan and Odabaş, 1996; Ustaoğlu, 2009; Balık et al., 2021). Determination of genotypes tolerant to biotic and abiotic stresses is of great importance in hazelnut production. Population growth, urbanization and climate change threaten hazelnut genetic resources, making new cultivar development studies necessary (Erat and Balık, 2022). Türkiye, the world's number one hazelnut producer, has 70% of the world's hazelnut production area and 80% of its trade, but lags behind countries such as the USA and China in terms of yield. In Türkiye, hazelnut cultivation is carried out as licensed production in 16 provinces and 123 districts on an area of 760.000 hectares. While Ordu, Samsun and Giresun are at the top in terms of production area and quantity, the highest yield is in Sakarya. Düzce produces approximately 83 thousand tones of hazelnuts, accounting for 11% of the country's hazelnut production; most of the production takes place in the Akçakoca, Merkez and Yığılca districts (Ünver, 2024).

Genes possessed by genetic resources are valuable in the process of increasing yield in agriculture and developing cultivars that are resistant to diseases and pests and have high adaptability. Therefore, genetic resources offer significant advantages, especially against climate change. In order to benefit from the advantages of plant biodiversity against the negativities caused by climate change, strategies for the survey, collection, characterization and evaluation of genetic resources are needed. Genetic resources research in Anatolia, a place where three important gene centers intersect, has been carried out since the 1930s. Research on hazelnut genetic resources was initiated by the Hazelnut Research Institute in 1969. 460 genotypes are preserved in the field gene bank (Anonymous, 2024a). However, no studies on hazelnut genetic resources conducted in Düzce province, which is an important hazelnut production region, have been found in the literature. Biodiversity studies will not only protect valuable hazelnut genetic resources but will also enable the development of new cultivars through the use of genotypes with different characteristics in selection and hybridization.

The aim of this research was to determine and characterize wild hazelnut types found in natural populations and orchards in Yığılca, Gümüşova, Cumayeri and Akçakoca districts of Düzce province.

2. Materials and Methods

The material of the research consists of 129 hazelnut genotypes determined as a result of surveys conducted in the districts of Düzce province in 2023 (Figure 1). 33 of the genotypes were identified in Akçakoca, 35 in Cumayeri, 32 in Gümüşova and 29 in Yığılca district. Genotypes are distributed in the altitude range of 25-760m. 90.5% were detected in orchards and 9.5% in areas such as roadsides, stream beds and mountain slopes.

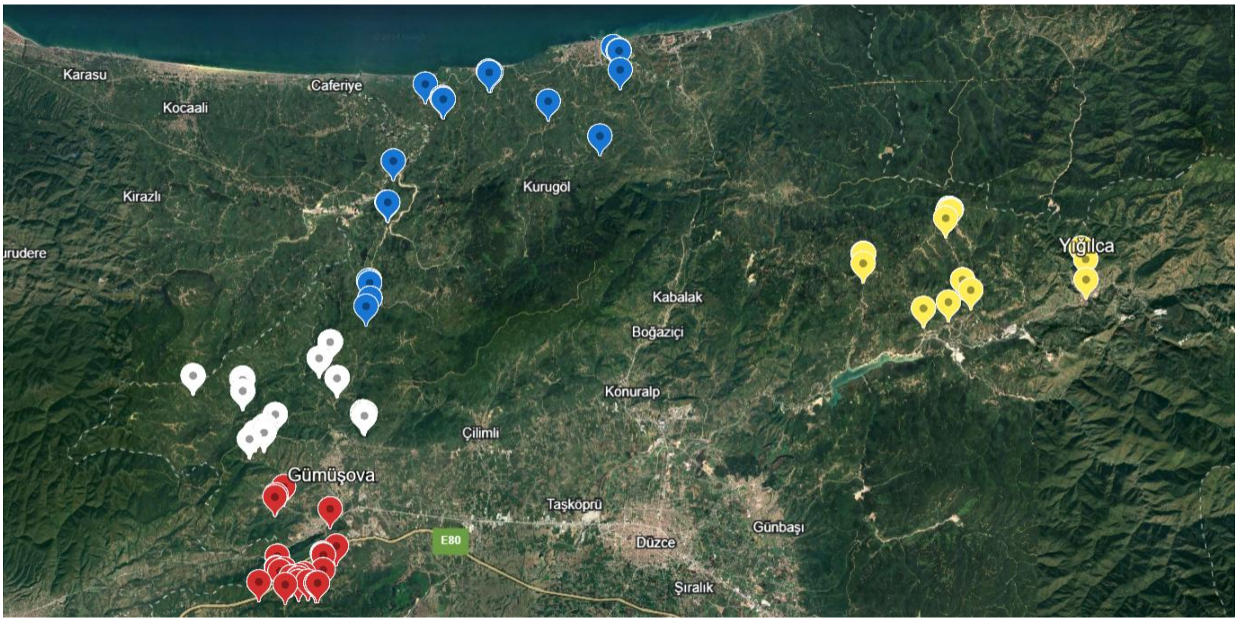

Figure 1. Locations of genotypes (blue: Akçakoca, white: Cumayeri, red: Gümüşova, yellow: Yığılca)

2.1. Surveys

Before the survey, contact was made with Düzce province Akçakoca, Cumayeri, Gümüşova and Yığılca Agriculture and Forestry District Directorates, Chambers of Agriculture, leading farmers and producers, and potential villages where wild hazelnut types could be found were determined and determinations were made by sampling method in areas with different altitudes, directions and locations. The location and altitude of the points where samples were taken were determined and recorded with the GPS location application. Tree, trunk, husk and nut photos were taken to be used in the identification of hazelnut types. Additionally, leaf, nut and shoot samples of the genotypes were taken and characterized (UPOV, 2025).

2.2. Nut characteristics

Nut sizes were determined on 30 randomly selected nuts using a digital caliper sensitive to 0.01 mm (Figure 2). Nut shape is classified from 1 to 6 (Figure 3). The number of nuts in cluster was calculated by counting the fruits in each of 10 randomly selected clusters and the average was taken. Curvature of basal scar is divided into 3 classes as concave, flat and convex according to the criteria specified (Figure 4). Shape of apex was according to the criteria specified, it is divided into 4 classes: narrow acute, broad acute, obtuse, truncate (Figure 5).

2.3. Morphological characters

Plant height is divided into four classes as 1-2m, 2-3m, 3-4m and longer than 4m, measured from the soil level to the tip of the top shoot. The suckers were counted and divided into four classes: 1-3, 3-5, 5-7 and more than 7. Leaf dimensions were measured as in Figure 6. Leaf color is divided into four classes yellow, light green, green and dark green. Leaf shape was divided into four classes (Figure 7).

The size of the involucre is divided into three classes: shorter, equal and longer (Figure 8). Density of hairs are divided into three classes: sparse, medium, dense. Additionally, depth of indentation and serration of indentation of the involucre were evaluated based on observation.

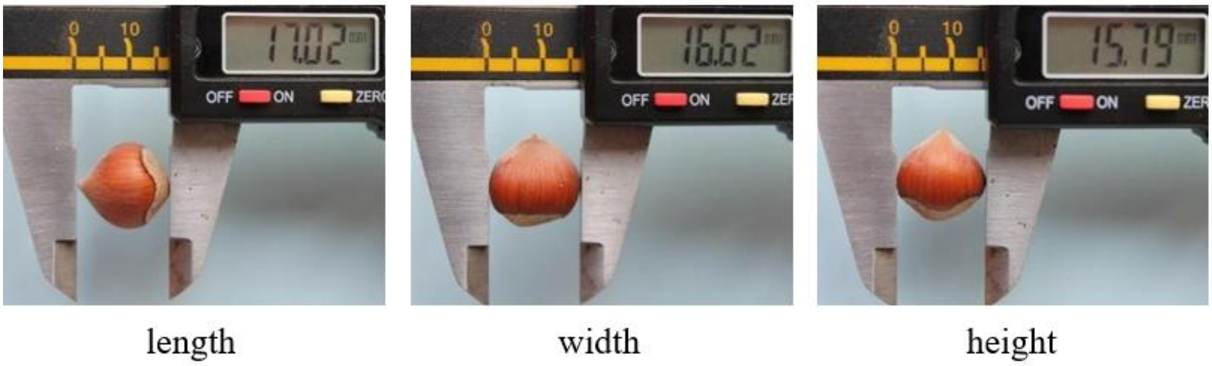

Figure 2. Measuring nut dimensions.

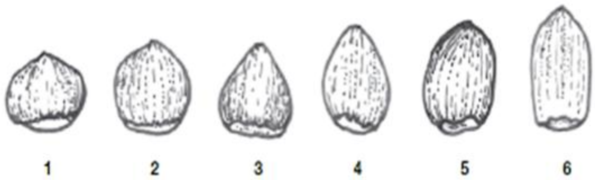

Figure 3. Classification of genotypes according to nut shape (1: globose 2: conical, 3: ovoid, 4: obloid, 5: Short-sub cylindrical, 6: Long-sub cylindrical) (UPOV, 2025).

Figure 4. Curvature of basal scar; concave (1), flat (2) and convex (3) (UPOV, 2025).

Figure 5. Classification of genotypes according to shape of apex, narrow acute (1), broad acute (2), obtuse (3), truncate (4) (UPOV, 2025).

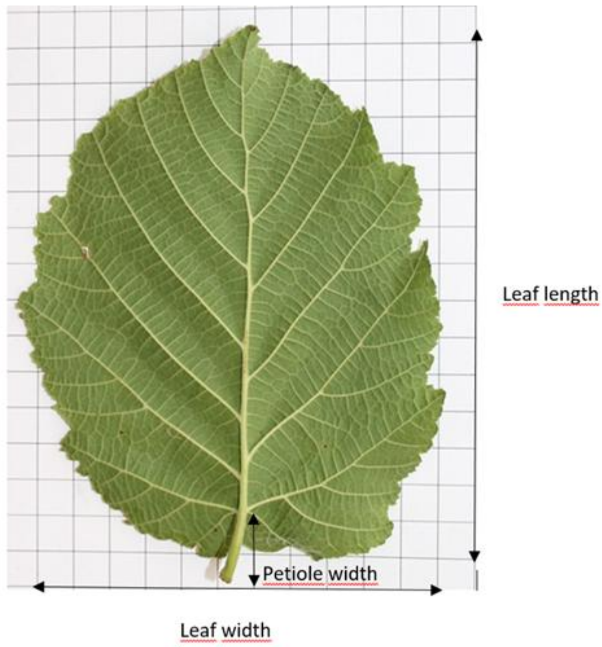

Figure 6. Leaf dimensions (leaf length, leaf width, petiole width).

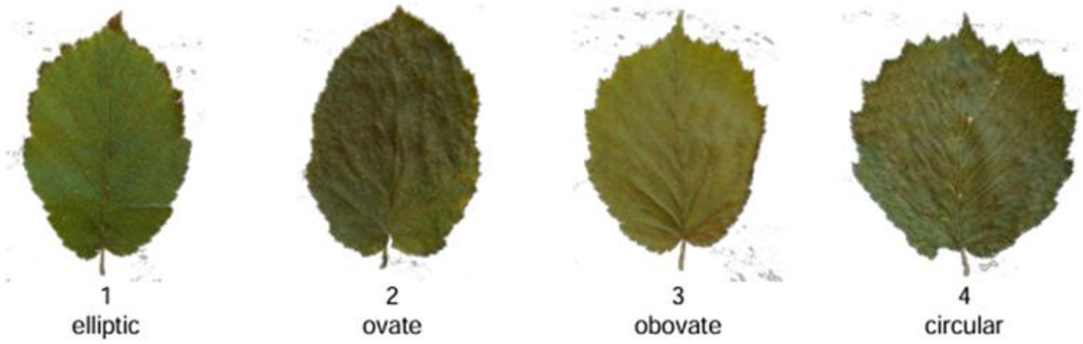

Figure 7. Leaf shape (elliptical, ovate/obovate and circular) (UPOV, 2025).

Figure 8. Involucre categories: shorter, equal and longer.

3. Results

In the research, nut length, nut width, nut height, nut size, nut shape index, nut oblateness index, nut shape, curvature of basal scar, shape of apex and number of nuts in cluster of the genotypes were determined (Table 1).

Table 1. Nut characteristics of genotypes

Characteristics	Max	Min	Average
Nut length (mm)	25.4	15	19.02
Nut width (mm)	28.1	14.5	18.07
Nut height (mm)	27.6	11.8	15.57
Nut size (mm)	20.61	14.19	17.44
Nut shape index	1.84	0.75	1.14
Nut oblateness index	1.39	1.04	1.17

Nut length of the genotypes was determined between 15.0-25.4 mm. While Köksal (2002) determined the nut length as 19.6 mm in Turkish hazelnut cultivars, Ünver (2024) determined the nut length as 13.5-15.94 mm in the 'Mincane' grown in the Akçakoca region. In the same region, nut length of 'Yomra' (Sny. Yomrali) was determined to be between 16-75-20.43 mm by Akça and Söylemezoğlu (2024). Nut width of the examined genotypes was determined between 14.5-28.1 mm. While Köksal (2002) determined the nut width as 17.6 mm in Turkish hazelnut cultivars, Ünver (2024) determined the nut width as 15.26-17.90 mm in the 'Mincane' grown in the Akçakoca region. Nut width in 'Yomra' (Sny. Yomrali) was determined to be between 16.89-20.61 mm by Akça and Söylemezoğlu (2024). The nut heigth of the genotypes was determined to be between 11.8-27.6 mm. While Köksal (2002) determined the nut heigth as 15.5 mm in Turkish hazelnut cultivars, Ünver (2024) determined the nut heigth as 16.34-18.67 mm in the 'Mincane' grown in the Akçakoca region.

Nut size is an important quality parameter in terms of marketability, and genetic and environmental factors play a role in the formation of nut size. Nut size was determined between 14.19-20.61 mm. Nut size was determined as 16.43-17.90 mm in 'Palaz' by Balık and Beyhan (2007); 15.38-18.91 mm in 'Tombul' and 'Palaz' by İşbakan and Bostan (2020); 16.54-21.81 mm in standard hazelnut cultivars by Balık et al. (2016); and 16.34-18.67 mm in 'Mincane' by Ünver (2024).

The nut shape index was determined between 0.75-1.84. While Köksal (2002) determined the nut shape index between 0.8-1.7 in Turkish hazelnut cultivars, Ünver (2024) determined the nut shape index between 0.97-1.16 in the 'Mincane' grown in the Akçakoca region. Nut shape index is especially important for export. It is an important factor affecting the marketing, processing, quality control and storage processes of hazelnuts. By choosing symmetrical and regular shaped hazelnuts, companies can improve product quality and thus achieve a higher market value. It is also extremely important in terms of addressing consumer preferences and ensuring product segmentation (Anonymous, 2024b).

Nut shape was classified according to UPOV; 73% were globose, 16% short-sub cylindrical, 7% long-sub cylindrical, 2% ovoid and 2% conical. Curvature of basal scare was evaluated under 3 classes and 53% was determined as concave, 33% as flat and 14% as convex.

Shape of apex was evaluated under 4 classes and 47% was determined as narrow acute, 34% as broad acute, 14% as obtuse and 5% as truncate. When genotypes were grouped according to the number of nuts in cluster, genotypes with one nut in the cluster were determined as 13%, genotypes with two nuts as 17%, genotypes with three nuts as 42%, genotypes with four nuts as 17%, and genotypes with more than four nuts as 11% (Figure 9).

Çalışkan (1992) determined the number of nuts in cluster of genotypes preserved in the Hazelnut Research Institute field gene bank between 1.42-6.40. While Beyhan and Demir (1998) determined the number of nuts in cluster in the 'Palaz' to be between 1.82-2.15, İslam and Özgüven (2001) determined it to be between 3.25-4.67. Although a higher number of nuts in cluster generally means higher yield, this is an indication of a balance between yield and quality. Balık (2018) noted that the number of nuts in cluster may change due to the effect of pollen, and if there are too many, the shape of the nut may deteriorate. Bak et al. (2024) reported that nut weight and nut length decreased when the number of nuts in cluster was more than four in 'Foşa'.

When the genotypes were grouped in terms of plant height, it was determined that 75.39% were taller than 4m, 22.24% were between 3-4m, 1.58% were 2-3m and 0.79% were between 1-2m (Figure 10). Çalışkan (1992) grouped 676 genotypes preserved in the field gene bank of the Hazelnut Research Institute into 8 classes ranging from very short (< 150cm) to very tall (601cm <) and 4 of the genotypes were categorized as very short (< 150cm), 108 as very short-short (151-250cm), 202 as short (251-300cm), 234 as short-medium (301-350cm), 57 as medium-long (401-450cm), 26 as long (451-500cm), 28 as long-very tall (501-600cm) and 17 as very tall (601cm <). In the same study, the habitus of the genotypes was also evaluated and 60.5% were classified as spreading, 28.7% as semi-erect, 10.5% as upright, 0.24% as drooping and 0.12% as very upright. In recent years, the development of cultivars suitable for mechanization has become more important in developing cultivars with strong growth and upright growing habitus (Anonymous, 2024a).

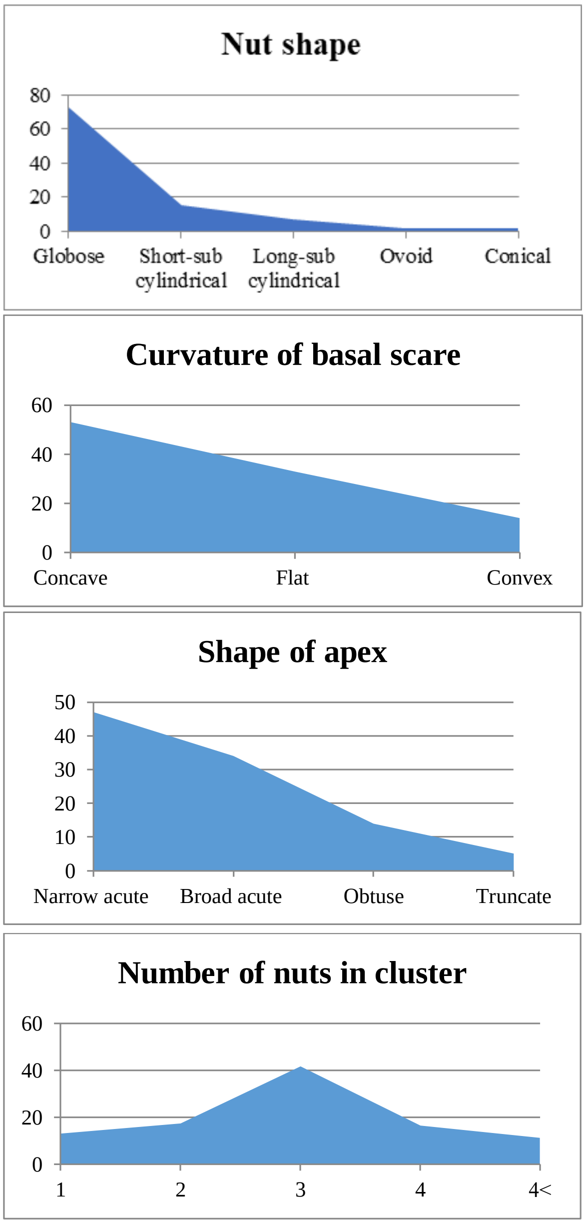

Figure 9. Classification of genotypes according to nut characteristics (%).

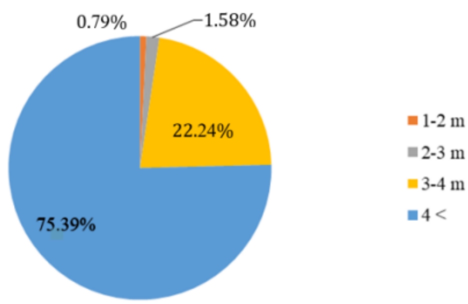

Figure 10. Classification of genotypes according to plant height (%).

Leaf length, leaf width, petiole length and leaf color of the genotypes were determined (Table 2). Leaf length varied between 8.92-15.36 cm. Çalışkan (1995) determined the leaf size (width+length/2) in Turkish hazelnut cultivars as between 7.9-11.8cm. Balık and Beyhan (2007) determined the leaf length in the 'Palaz' as 10.23-13.21mm. Bostan and Karakaya (2024) determined the leaf length as 11.6cm in the hazelnut types they examined in Gürgentepe district of Ordu province. Leaf width of the genotypes was determined between 6.85-12.89cm. Balık and Beyhan (2007) found the leaf width to be between 9.09-12.19 cm in 'Palaz', while Bostan and Karakaya (2024) found the leaf width to be 9.9 cm on average in the hazelnut types they examined in the Gürgentepe district of Ordu province. The leaf petiole length of the genotypes was determined between 0.5-2.68 cm. Balık and Beyhan (2007) determined the leaf petiole length in 'Palaz' to be between 1.18-2.72 cm.

Table 2. Leaf characteristics of genotypes

Characteristics	Max	Min	Average
Leaf length (cm)	15.36	8.92	11.09
Leaf width (cm)	12.89	6.85	8.86
Petiole length (cm)	2.68	0.5	1.37

In the study, the leaf shape of the genotypes was evaluated under 3 classes according to UPOV and it was determined that 59% of them had ovate/obovate, 25% elliptical and 16% circular leaf shape. It was determined that 54% of the genotypes had dark green, 37% green and 9% light green leaf color. Yellow leaf color was not recorded (Figure 11).

The size of the involucre is divided into three classes: shorter, equal and longer. It was found that 79% of the time it was longer than the nut, 18% of the time it was equal to the nut and 3% of the time it was shorter. In Turkish hazelnut cultivars, the involucre is longer and tightly wraps the nut. This feature of the cultivars makes mechanical harvesting difficult. Therefore, there is a need to develop new cultivars suitable for mechanical harvesting, which are separated from the involucre spontaneously when ripe and where the husk is shorter than the nut and wraps loosely (Anonymous, 2018) (Figure 12). Balık and Beyhan (2019) stated that involucre characteristics may differ depending on the pollinators.

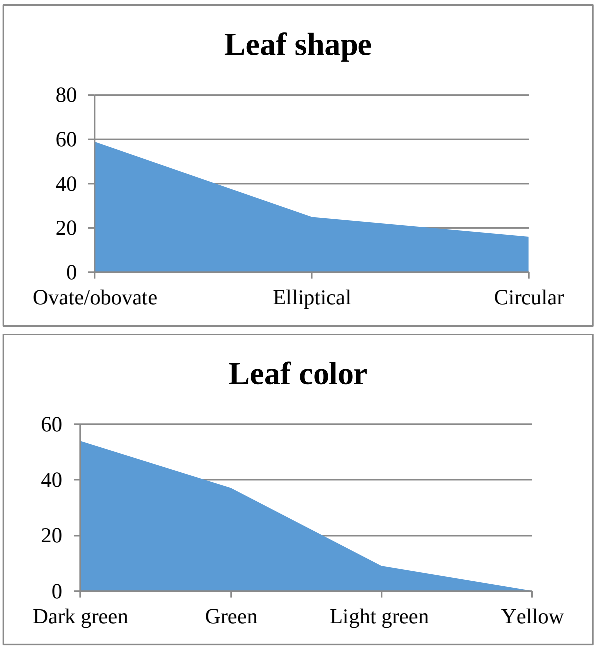

Figure 11. Classification of genotypes according to leaf characteristics (%).

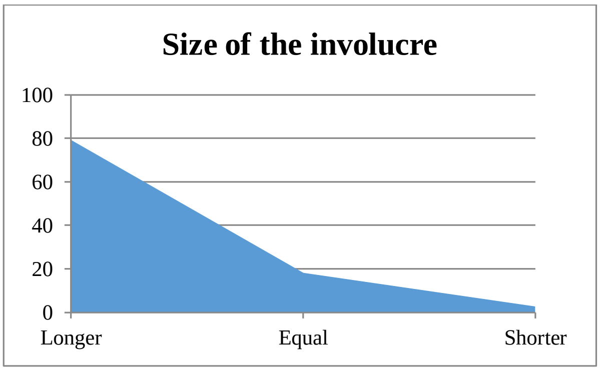

Figure 12. Classification of genotypes according to involucre characteristics (%).

4. Conclusion

In this study conducted to determine the hazelnut diversity in Düzce province, it was determined that the hazelnut genotypes in Akçakoca, Cumayeri, Gümüşova and Yığılca districts have a wide diversity in terms of the examined traits. Considerable variations were detected among genotypes in terms of nut size, nut shape, leaf characteristics and involucre structure. It has been determined that genotypes with globose nut shape and high number of nuts in cluster can be evaluated commercially. Research on the protection of hazelnut diversity in the region should be expanded, genotypes should be preserved in gene banks, characterised and evaluated in breeding programmes.

Author Contributions

The percentages of the authors' contributions are presented below. All author reviewed and approved the final version of the manuscript.

	E.D	H.İ.B
C		100
D		100
S		100
DCP	100	
DAI	40	60
L	80	20
W	20	80
CR		100
SR		100
PM		100
FA	60	40

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Since no studies involving humans or animals were conducted, ethical committee approval was not required for this study.

Acknowledgments

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References

Akça Y, Sönmezoğlu Y. 2024. Evaluation of Yomra hazelnut (Corylus avellana L.) clones. J Agric Fac Gaziosmanpasa Univ, 41(2):40–48. https://doi.org/10.55507/gopzfd.1462231

Anonymous. 2018. Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Agricultural Research. https://arastirma.tarimorman.gov.tr/findik/Menu/46/Sonuclanan-Projeler (accessed date: March 7, 2025).

Anonymous. 2024a. Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Agricultural Research. https://arastirma.tarimorman.gov.tr/findik/Menu/45/Devam-Eden-Projeler (accessed date: March 7, 2025).

Anonymous. 2024b. Republic of Türkiye Ministry of Agriculture and Forestry, General Directorate of Agricultural Research. https://arastirma.tarimorman.gov.tr/findik/Sayfalar/Detay.aspx?SayfaId=27 (accessed date: March 7, 2025).

Bak T, Güler E, Karadeniz T. 2024. Relationships between the number of nuts per cluster and fruit characteristics in the Foşa hazelnut cultivar. Mustafa Kemal Univ J Agric Sci, 29(3):622–628. https://doi.org/10.37908/mkutbd.1482947

Balık Hİ, Balık SK, Köse ÇB, Duyar Ö, Sıray E, Sezer A, Turan A, Beyhan N, Erdoğan V, İslam A, Kurt H, Ak K, Kalkışım Ö. 2014. Development of the new cultivars of hazelnut by selection from Tombul hazelnut populations in Giresun and Trabzon provinces. 22-25 September Int Mesopotamia Agric Congr, Diyarbakır, Türkiye, pp: 172-179.

Balık Hİ, Balık SK, Erdogan V, Kafkas S, Beyhan N, Duyar Ö, Köse Ç. 2018. Clonal selection in 'Tombul' hazelnut: preliminary results. Acta Hortic. 1226, 53-58 https://doi.org/10.17660/ActaHortic.2018.1226.7

Balık Hİ, Beyhan N. 2019. Xenia and metaxenia in hazelnuts: Effects on nut set and nut characteristics. Akad Ziraat Derg, 8(Special Issue):9-18. https://doi.org/10.29278/azd.562429

Balık Hİ, Beyhan N. 2007. Ordu'nun Ünye ilçesinde Palaz fındık klon seleksiyonu ilk sonuçları. 4-7 September Türkiye V. Ulusal Bahçe Bitkileri Kongresi, , Erzurum, Türkiye, pp: 343-346.

Balık Hİ, Kayalak Balık S, Beyhan N, Erdoğan V. 2016. Fındık Çeşitleri (Hazelnut Cultivars). Klasmat Matbaacılık, Ankara, Türkiye, pp: 96.

Balık Hİ, Kayalak Balık S, Duyar Ö. 2021. Fındıkta bitki besin elementleri ile verim ve meyve özellikleri arasındaki ilişki. Int J Agric Wildlife Sci, 7(2):189–199. https://doi.org/10.24180/ijaws.890329

Balık Hİ, Murat Arif T. 2023. Fındıkta tozlanma ve döllenme konusunda son gelişmeler. J Agric Biotechnol, 4(2):84-98. https://doi.org/10.58728/joinabt.1360882

Balık Hİ. 2018. Fındıkta Kseni ve Metakseni Üzerine Araştırmalar. PhD thesis, Ondokuz Mayıs Univ, Inst Sci, Samsun, Türkiye, pp: 258.

Beyhan N, Demir T, Sürücü A. 1998. Farklı azot dozlarının Palaz fındık çeşidinde verim meyve kalitesi ve beslenme üzerine etkisi. OMU J Agric Fac, 13:1-13.

Beyhan N, Odabaş F. 1996. Fındıkta çiçek ve meyve dökümlerinin incelenmesi üzerine bir araştırma. 10-11 January Tarımsal Öğretimin 150. Yıldönümü Fındık ve Diğer Sert Kabuklu Meyveler Sempozyumu, Samsun, Türkiye, pp: 110-118.

Bilgen Y. 2023. Clonal selection and determination of genetic diversity in Trabzon province fosa hazelnut population (Corylus avellana L.). PhD thesis, Tokat Gaziosmanpaşa Univ, Inst Sci, Tokat, Türkiye, pp: 229.

Bostan SZ, Karakaya O. 2024. Morphological, chemical, and molecular characterization of a new late-leafing and high fruit quality hazelnut (Corylus avellana L.) genotype. Genet Resour Crop Evol, 71:5113–5126. https://doi.org/10.1007/s10722-024-01968-7

Çalışkan T. 1992. Bazı fındık çeşit ve tiplerinde karakterizasyon çalışmaları: Sonuç raporu (Proje grup kodu: 3-478-1-280). Fındık Araştırma Enstitüsü, Tarım ve Orman Bakanlığı, Türkiye.

Çalışkan T. 1995. Fındık çeşit kataloğu. Tarım ve Köyişleri Bakanlığı, Tarımsal Üretim ve Geliştirme Genel Md., Mesleki Yayınlar, Ankara, Türkiye, pp:72.

Çayan M. 2019. Clonal selection of Çakıldak hazelnut cultivar in Gurgentepe (Ordu) district. MSc thesis, Ordu Univ, Inst Sci, Ordu, Türkiye, pp: 99.

Demir T. 1997. A pre-research on the selection of hazelnut grown in Samsun. MSc thesis, Ondokuz Mayıs Univ, Inst Sci, Samsun, Türkiye, pp: 69.

Erat K, Balık Hİ. 2022. Bitkisel biyoçeşitlilik ve genetik kaynaklar. J Agric Biotechnol, 3(2):117–125.

İsbakan H, Bostan SZ. 2020. Fındıkta bitki morfolojik özellikleri ile verim ve meyve kalite özellikleri arasındaki ilişkiler. Ordu Univ J Sci Technol, 10(1):32–45. https://doi.org/10.1234/orunivjst.2020.0101

İslam A, Özgüven AI. 2001. Clonal selection in the Turkish hazelnut cultivars grown in Ordu Province. Acta Hortic,

556:203–208.
İslam A. 2008. Clonal selection in 'Uzunmusa' hazelnut. Plant breeding, 122(4):368 – 371, https://doi.org/10.1046/j.1439-0523.2003.00853.x
İslam A. 2019. Fındık ıslahında gelişmeler. Akad Ziraat Derg, 8 (Special Issue): 167-174. https://doi.org/10.29278/azd.667662
Karakaya O. 2021. Clonal selection in Palaz and Çakıldak hazelnut cultivars grown in Fatsa. PhD thesis, Ordu Univ, Inst Sci, Ordu, Türkiye, pp: 334.
Köksal Aİ. 2002. Türk fındık çeşitleri. Fındık Tanıtım Grubu Yayınları, Ankara, Türkiye, pp: 136.
Molnar TJ. 2011. Corylus. In: Wild Crop Relatives: Genomic and Breeding Resources. Springer, Berlin, Heidelberg, Germany, pp: 15-48.
Özçağıran R, Ünal A, Özeker E, İsfendiyaroğlu M. 2014. Ilıman iklim meyve türleri: Yumuşak çekirdekli meyveler (Cilt III). Ege Univ Agric Fac Publ, İzmir, Türkiye, pp: 262.
Turan A. 2007. Tombul hazelnut clonal selection in Bulancak of Giresun. MSc thesis, Ondokuz Mayıs Univ, Inst Sci, Samsun, Türkiye, pp: 109.
UPOV. 2025. International Union for the Protection of New Varieties of Plants Official web site. URL: https://www.upov.int/meetings/en/doc_details.jsp?meeting_id=60592&doc_id=541353 (accessed date: March 7, 2025)
Ustaoğlu B. 2009. Türkiye'de iklim değişikliğinin fındık tarımına olası etkileri. PhD thesis, İstanbul Tech Univ, Inst Sci, İstanbul, Türkiye, pp: 205.
Uzun S. 2021. Clonal selection of Tombul and Karafindik hazelnut cultivars grown in Fatsa. PhD thesis, Ordu Univ, Inst Sci, Ordu, Türkiye, pp: 255.
Ünver H. 2024. Düzce ili fındık yetiştiriciliği. MAS J Appl Sci, 9(1):28–34. https://doi.org/10.5281/zenodo.10613104
Vavilov N. 1994. Origin and geography of cultivated crops. Cambridge Univ Press, UK, pp: 145.