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Original scientific paper

PRELIMINARY RESULTS OF TURKISH HAZELNUT (*Corylus colurna* L.) POPULATIONS FOR TESTING THE NUT CHARACTERISTICS

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Ayan S., E. Ünalan, O. E. Sakıcı, E. N. Yer, F. Duccı, V. V. Isajev, H. B. Ozel (2018*): Preliminary results of Turkish hazelnut (Corylus colurna* L.*) populations for testing the nut characteristics.*- Genetika, Vol 50, No.2, 669-686.

This paper aims to identify the hazelnut characteristics of four different populations (Ağlı-Tunuslar, Ağlı-Müsellimler, Araç-Güzlük and Tosya-Küçüksekiler) in the North Western Black Sea Region of Turkey, one of the most important areas of economic interest for this species. There, the Turkish hazel (*Corylus colurna* L.) grows in its optimal conditions and reveals relatively high inter-population and intra-population variation in terms of nut characteristics. With the purpose of assessing variation, measurements were performed in four populations in Kastamonu district on 14 different nut characteristics (number of nuts per cluster, nut length (mm), nut width (mm), nut thickness (mm), shell thickness (mm), nut size (mm), nut shape, compression index, nut weight (g), kernel length (mm), kernel width (mm), kernel thickness (mm), kernel weight (g) and kernel ratio (%) of representative samples of the populations. Significant differences were found out among populations with regard to all of nut characteristics ($p<0.05$). The four populations have created two groups, population of Ağlı-Tunuslar and the others, according to cluster analysis. The closest populations have been Tosya-Küçüksekiler and Araç-Güzlük in terms of nut characteristics. According to the results

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obtained either on population basis or without population discrimination; significant correlations were determined between the majorities of the nut characters. The Araç-Güzlük population showed nuts the biggest among those examined and it is the population which took the highest values in terms of nut size traits while the Tosya-Küçüksekiler provenance showed the highest values with the average values of 5, 15.92 mm, 1.32 and 11.75 mm respectively for nuts per cluster, nut width, compression index and kernel width. The Ağlı-Tunuslar population showed the highest kernel ratio with 38.2%.

Key words: *Corylus colurna* L., Nut characteristics, Population diversity, Turkey Turkish hazel

INTRODUCTION

The Turkish hazelnut (*Corylus colurna* L.) a member of the Europe-Siberia flora region (MOLNAR, 2011) and a Turkey gene-originated species is a taxon ranked as "Low Risk" category according to IUCN Red List (SHAW *et al.*, 2014). It is called as "tree hazelnut", "rock hazelnut", "Balkan hazelnut", "bear hazelnut", "filbert" and "Turkish hazelnut" in literature (YALTIRIK, 1993). Turkish hazelnut grows as scattered, in small stands, in groups or isolated clusters and sometimes by discrete individual trees, in Turkey. Nonsuckering ability of filbert can be transferred by hybridization to other hazelnut trees (ERDOGAN and MEHLENBACHER, 2000). The main core of *C. colurna* range is located on the Caucasus Mountains (SMEKALOVA and USHAKOVA, 2009). Anyway, the Turkish populations even if relatively marginal from the geographic point of view, find optimal ecological conditions also in the Northern Anatolian forests (AYAN *et al.*, 2016) and the local range is relatively extended.

Turkish hazelnut is considered to be appropriate to plant in agricultural lands which are stable to drought (ARSLAN, 2005; TOSUN, 2012), abstemious according to ground claim (YILMAZ, 1998; POLAT, 2014; PALASHEV and NIKOLOV, 1979) and especially to rehabilitate drought lands. It is tolerant to air pollution and can be planted to protect and stabilize soils. It is proved that Turkish hazelnut can resist low temperatures such as -20 ºC as well as high temperatures and drought and also harmful gas emission (ARSLAN, 2005). PALASHEV and NIKOLOV (1979) state that Turkish hazelnut range is between 100 and 1400 m altitude and needs minimum 500 mm annual precipitations and annual average temperatures ranging between 5 and 13 ºC.

ARSLAN (2005, in GHIMESSY, 1980) states that Turkish hazelnut is a valuable reserve tree species in Hungary and is accepted as a fast growing type. For the above reasons it is also selected as a valuable rootstock source (NINIC-TODOROVIC *et al.*, 2012).

Nuts of this species which is as a favorite landscape element in parks and gardens are also evaluated as a precious medical herbal product (AKHTAR *et al.*, 2010). Because the fruit forms an ingredient of various phenolic compound (RIETHMULLER, 2016), its valuable timber, fruits and its being a decoration plant filbert is considered a valuable tree; besides, it is emphasized that 10 ton hazelnuts can be produced per year from 250 mature trees. It is determined that 1200 kg/ha nut are produced annually from plantations with plus trees (BOBRIKOV, 1979).

Several nuts exist together in Turkish hazelnut infructescence. Sides of pericarp are torn spasmodically and its cusps are rolled back; there is sticky hair on it; the nut is 15-20 x 10-18 mm, and mightily flattened above, in a large egg shape; pericarp is very thick. Shell compared to other hazelnut fruits, "Dull part" at the bottom side where fruit holds the cover reaches to about hazelnut's semi-size and it is characteristic for Turkish hazelnut (YALTIRIK, 1993; ISLAM *et al.*, 2004; AYDINOĞLU, 2010).

Turkish hazelnut differentiates from *C. avellana* clearly as its habitus is vertical and it forms high trees in height. Hard and thick shells are another characteristic of this species. From the genetic point of view the structure of the species has not been widely investigated. Anyway, indirectly a behavior of filbert similar to other hazelnuts can be inferred. The post glacial recolonization of Europe by hazelnut was probably issued also from contacts among several species including filbert (PALMÉ and VENDRAMIN, 2002). ZONG *et al.* (2015) showed for *C. mandshurica* that the within population diversity (87.85%) was significantly higher than that between populations (12.15%) as in several broadleaved scattered species. MOHAMMADZEDEHA *et al.* (2014) showed long genetic distances between varieties of *C. avellana* showing the importance of individual variability. SRIVASTAVA *et al.* (2010) found a similar structure and divergence using phenotypic traits in *C. colurna*.

Nut characteristics of Turkish hazelnut that is beginning to gain commercial value start to be an extra value. This is the reason why, in this research, pomological characteristics of Turkish hazelnut are focused. The aim of this research is to identify the nut characteristics of four main different populations in the Northwestern Black Sea Region in Turkey. There the Turkish hazel shows its natural spreading in the most intense way and reveals the inter-population and intra-population variation in terms of nut characteristics.

MATERIALS AND METHODS

Material

Four different populations were sampled among the most economically important ones in areas defined by climatic indexes [Erinç aridity index (EAI) and Thornthwaite's Climate Classification (TCC) in Table 1] as humid - semi-humid: Ağlı-Tunuslar (TUN), Ağlı-Müsellimler (MUS), Araç-Güzlük (ARA) and as nearly semi-arid: Tosya-Küçüksekiler (TOS) (Figure 1). These populations are located in Kastamonu province in the Northwestern Black Sea Region, Turkey, and the variation of nut characters in these populations constitutes the object of this research.

Table 1. Introductory information on the populations used in the research

No	Population name and short name	Management Unit	Climate type as to EAI	Climate type as to TCC	Latitude N	Longitude E	Altitude range (m)	Aspect
1	Ağlı-Müselimler/MUS	Kastamonu-Daday	52.76	3.32	41°38' 05.93”	33°30' 4681"	1151-1326	S
2	Ağlı-Tunuslar/TUN	Kastamonu-Daday	52.76	3.32	41°37' 46.08"	33°31' 10.65"	1290-1340	S - N
3	Tosya-Küçüksekiler/TOS	Kastamonu-Tosya	33.48	-20.82	40°54' 33.33"	34°02' 54.69"	940-980	N-NW
4	Araç-Güzlük/ARA	Kastamonu-Araç	37.65	14.02	41°03' 08.22"	33°21' 10.78"	980-1140	N

The information was taken by TEMEL *et. al.* (2017) except ARA population.

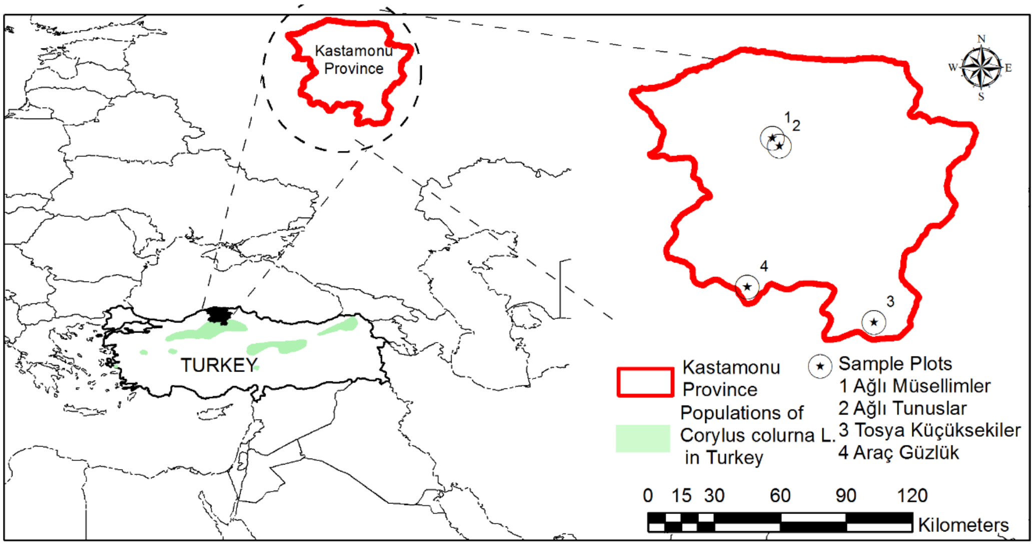

Figure 1.The working area

Method

Measurements of the four populations and 14 different nut characteristics (nut counts per cluster, nut length (mm), nut width (mm), nut thickness (mm), shell thickness (mm), nut size (mm), nut shape, compression index, nut weight (g), kernel length (mm), kernel width (mm), kernel thickness (mm), kernel weight (g) and kernel ratio (%)) in individuals representing the populations were carried out in 2014 and 2015.

Nut clusters were collected from 57 trees sampled out from the selected populations (11 trees from ARA population, 20 from MUS population, 19 from TOS population, 7 from TUN population). Concerning measurements of nut size and weights, one nut per cluster was chosen randomly. Measurements were carried out using digital caliper with a sensitivity of 0.01 mm, and measurements of the weights were made using an electronic scale with a sensitivity of 0.01 g. The nut characteristics measured in the study and the methods of measurement and calculation related to these characteristics are explained below (ISLAM, 2000):

- Nuts per cluster: determined by the count of nuts found in cluster.
- Nut Length (mm): the distance between the nut receptacle and the end point.
- Nut Width (mm): the widest distance between the two cotyledon junction lines (suture) of the nut.
- Nut Thickness (mm): the widest distance between the two pericarp cheeks.
- Nut Size (mm) = (Fruit length + Fruit width) / 2
- Nut Shape = Nut length / Nut width
- Nut Weight (g): determined by weighing the nut on the sensitive scale.

- Shell Thickness (mm): measured from the center of the nut pericarp upwards or from the widest point nearest the nut receptacle.
- Compression index = Fruit width / Fruit depth
- Kernel Length (mm): measured between the receptacle and end point of the kernel.
- Kernel Width (mm): by measuring the widest part of the side junctions of internal sutures.
- Kernel Thickness (mm): measured by the widest part of the distance between the two cheeks.
- Kernel Weight (g): determined by weighing kernel on the sensitive scale.
- Kernel Ratio (%) = (Kernel weight / Nut weight) x 100

Statistical analysis and evaluation methods

The Kolmogorov-Smirnov Test was used to check the suitability of the normal distribution of the data obtained from the nut characteristics. The Correlation Analysis was performed to determine statistical relations between nut characteristics and Pearson Correlation Coefficient for normal distribution characteristics and Spearman Correlation Coefficient for non-normal distribution characteristics were taken into consideration. As it is aimed to reveal both intra- and inter-population variations within the scope of the study, Kolmogorov-Smirnov Tests and Correlation Analyses for nut characteristics were carried out separately for each population as well as for the whole population.

The characteristics showing normal distribution were analyzed with Variance Analysis (ANOVA) and those not showing normal distribution were analyzed with Kruskal Wallis Test while determining the inter-population variations. In case of a significant difference in nut characteristics among populations, the Duncan's Test (for characteristics with normal distribution) and the Mann Whitney U Test (for characteristics with non-normal distribution) for the formation of homogeneous groups. In addition, the Hierarchical Cluster Analysis was applied to group populations according to nut characteristics. Variance analysis (ANOVA) was used for characteristics showing normal distribution and Kruskal Wallis test was used for those not showing normal distribution while determining the variations in populations. Statistical analyses were performed with the IBM SPSS Statistics 23 package.

RESULTS AND DISCUSSION

Table 2 shows the descriptive statistics of 14 different nut characteristics of randomly selected cluster and nut samples from four different populations of Turkish hazelnut pomological features. The nut per cluster are between 1 and 10, the kernel ratio is between 18.1 and 57.9% and the nut weight is between 0.61 and 2.61 g. ERDOĞAN and AYGÜN (2005) investigated the nut characteristics and fatty acids composition of *C. colurna* and found that shell thickness was between 0.67 and 3.69 mm, nut weight varied between 1.33 and 2.91 g and the kernel ratio between 25-36%. MITROVIC *et. al.* (2001) conducted a study on Turkish hazelnuts in Serbia and measured nut weight was between 1.20 and 2.59 g, kernel weight was between 0.38 and 0.74 g, kernel ratio was between 29 and 40.1% and shell thickness was between 1.0 and 1.3 mm. SRIVASTAVA *et al.* (2010) found the following values for *C. colurna*: nut count 2.83-3.53, nut weight 1.29-1.75 g, kernel weight 0.47-0.53 g, kernel ratio 28-41%, nut length 16.28-18.13 mm, nut width 16.36-17.88 mm, nut thickness 11.67-12.54 mm. In addition MILETIC *et al.* (2005) found following average values of *C. colurna*: nut coarseness; 16.3x14.0x11.0 mm, kernel coarseness 13.9x9.7x6.5 mm, nut weight 1.00-1.75 g, kernel weight 0.3-0.65 g.

The values obtained by this study are similar to the literature findings and the values of some regions are superior in terms of the nut counts per cluster and the kernel ratio of the plants. The basic statistics of nut characters for the populations are given in Table 3 for the original data used to perform the analyses.

Table 2. Basic statistics of nut characteristics in the study

Nut Characteristics	N	Mean	Std. Dev.	Minimum	Maximum
Nut counts per cluster (number)	570	4.2	1.6	1	10
Nut Length (mm)	570	15.45	1.15	11.04	18.83
Nut Width (mm)	570	15.53	1.55	10.32	19.61
Nut Thickness (mm)	570	12.04	1.30	7.67	16.92
Nut Size (mm)	570	15.49	1.10	10.74	18.53
Nut Shape	570	1.00	0.11	0.71	1.49
Nut Weight (g)	570	1.48	0.33	0.61	2.61
Shell Thickness (mm)	570	2.28	0.68	0.92	11.88
Compression Index	570	1.30	0.10	0.86	1.73
Kernel Length (mm)	570	12.46	0.94	9.16	15.45
Kernel Width (mm)	570	11.37	1.05	8.05	16.64
Kernel Thickness (mm)	570	7.56	0.78	4.52	10.09
Kernel Weight (g)	570	0.50	0.09	0.25	0.83
Kernel Ratio (%)	570	34.8	6.1	18.1	57.9

Table 3. Basic statistics of nut characteristics in terms of population

	Population	N	Mean	Standard deviation	Minimum	Maximum	Coefficient of variation (%)
Nuts per cluster (number)	Araç-Güzlük ARA	110	3.9	1.3	1	8	34.4
	Ağlı-Müsellimler MUS	200	3.9	1.3	1	7	34.5
	Tosya-Küçüksekiler TOS	190	5.0	1.8	1	10	37.1
	Ağlı-Tunuslar TUN	70	3.9	1.7	1	9	42.1
Nut length (mm)	Araç-Güzlük ARA	110	15.92	1.23	13.34	18.83	7.7
	Ağlı-Müsellimler MUS	200	15.16	1.09	11.31	17.81	7.2
	Tosya-Küçüksekiler TOS	190	15.59	0.93	11.07	18.06	5.9
	Ağlı-Tunuslar TUN	70	15.15	1.41	11.04	17.36	9.3
Nut width (mm)	Araç-Güzlük ARA	110	15.85	1.29	12.77	19.61	8.2
	Ağlı-Müsellimler MUS	200	15.27	1.35	10.96	18.76	8.8
	Tosya-Küçüksekiler TOS	190	15.92	1.45	12.81	19.33	9.1
	Ağlı-Tunuslar TUN	70	14.72	2.16	10.32	19.12	14.7
Nut thickness (mm)	Araç-Güzlük ARA	110	12.84	1.21	11.01	16.92	9.4
	Ağlı-Müsellimler MUS	200	11.82	1.14	8.35	14.77	9.6
	Tosya-Küçüksekiler TOS	190	12.07	1.19	8.29	14.98	9.8
	Ağlı-Tunuslar TUN	70	11.32	1.54	7.67	15.44	13.6

Nut size (mm)	Araç-Güzlük ARA	110	15.88	1.07	14.09	18.53	6.7
	Ağlı-Müsellimler MUS	200	15.22	0.94	12.27	17.89	6.2
	Tosya-Küçüksekiler TOS	190	15.76	0.91	12.76	17.79	5.8
	Ağlı-Tunuslar TUN	70	14.94	1.56	10.74	18.11	10.5
Nut shape	Araç-Güzlük ARA	110	1.01	0.09	0.84	1.24	8.6
	Ağlı-Müsellimler MUS	200	1.00	0.11	0.71	1.41	10.7
	Tosya-Küçüksekiler TOS	190	0.99	0.10	0.72	1.26	10.1
	Ağlı-Tunuslar TUN	70	1.04	0.14	0.71	1.49	13.2
Nut weight (g)	Araç-Güzlük ARA	110	1.67	0.34	1.12	2.61	20.4
	Ağlı-Müsellimler MUS	200	1.40	0.28	0.71	2.24	20.0
	Tosya-Küçüksekiler TOS	190	1.55	0.31	0.87	2.31	19.8
	Ağlı-Tunuslar TUN	70	1.25	0.32	0.61	1.97	26.0
Shell thickness (mm)	Araç-Güzlük ARA	110	2.34	0.54	1.33	4.72	23.3
	Ağlı-Müsellimler MUS	200	2.34	0.90	0.95	4.61	38.2
	Tosya-Küçüksekiler TOS	190	2.34	0.50	1.17	4.39	21.3
	Ağlı-Tunuslar TUN	70	1.89	0.41	0.92	2.79	21.6
Compression index	Araç-Güzlük ARA	110	1.24	0.10	0.86	1.58	8.4
	Ağlı-Müsellimler MUS	200	1.30	0.10	0.94	1.63	7.8
	Tosya-Küçüksekiler TOS	190	1.32	0.10	1.09	1.73	7.6
	Ağlı-Tunuslar TUN	70	1.30	0.09	1.08	1.50	7.2
Kernel length (mm)	Araç-Güzlük ARA	110	12.87	0.99	10.81	15.33	7.7
	Ağlı-Müsellimler MUS	200	12.21	0.95	9.16	15.45	7.8
	Tosya-Küçüksekiler TOS	190	12.51	0.84	9.24	14.62	6.8
	Ağlı-Tunuslar TUN	70	12.39	0.88	10.05	14.87	7.1
Kernel width (mm)	Araç-Güzlük ARA	110	11.30	0.92	8.96	14.06	8.2
	Ağlı-Müsellimler MUS	200	11.25	0.91	9.33	16.64	8.1
	Tosya-Küçüksekiler TOS	190	11.75	1.05	9.13	14.54	8.9
	Ağlı-Tunuslar TUN	70	10.76	1.21	8.05	13.45	11.2
Kernel thickness (mm)	Araç-Güzlük ARA	110	7.89	0.71	5.66	9.75	9.1
	Ağlı-Müselimler MUS	200	7.47	0.66	5.57	9.20	8.8
	Tosya-Küçüksekiler TOS	190	7.60	0.85	5.73	10.09	11.2
	Ağlı-Tunuslar TUN	70	7.22	0.80	4.52	8.83	11.1
Kernel weight (g)	Araç-Güzlük ARA	110	0.55	0.09	0.37	0.83	16.6
	Ağlı-Müsellimler MUS	200	0.49	0.07	0.25	0.69	15.1
	Tosya-Küçüksekiler TOS	190	0.51	0.10	0.31	0.78	18.7
	Ağlı-Tunuslar TUN	70	0.46	0.09	0.31	0.68	18.8
Kernel ratio (%)	Araç-Güzlük ARA	110	33.9	7.2	18.8	57.9	21.3
	Ağlı-Müsellimler MUS	200	35.4	5.9	18.1	50.6	16.5
	Tosya-Küçüksekiler TOS	190	33.4	4.7	21.0	46.2	14.2
	Ağlı-Tunuslar TUN	70	38.2	6.8	23.6	55.7	17.9

It is clear that there are differences and similarities between populations in terms of some nut characteristics. Similarly, it is clear that among the populations some of the nut characteristics have high variations while some have lower. For example, in terms of the nuts per cluster TOS, in terms of kernel ratio TUN are different and superior. According to the coefficient of variation of the characters, the nut counts per cluster have more variation than the other characters, followed by nut shape, shell thickness, nut weight, kernel weight and kernel ratio. The variation in nut sizes is the lowest.

The Kolmogorov-Smirnov Test results showed no significant differences for nuts per cluster, nut weight, shell thickness and kernel ratio (*$p<0.05$*) while other characteristics showed normal distribution (*$p>0.05$*). In analysis of intra-population variation according to the results of Kolmogorov-Smirnov test for the fitness of the normal distribution of the measured values of the nut characters separately for each population, nut per cluster and nut weight for the ARA population, nut per cluster and shell thickness for the MUS and TOS populations did not show normal distribution (*$p<0.05$*) while all other traits showed normal distribution (*$p<0.05$*).

Table 4 shows the results after the Correlation Analysis for all the measurements was integrated by population in order to determine relationships between the nut characteristics.

According to the results no discrimination among populations was recorded. Significant correlations were observed between the majorities of the characteristics. Nut counts had non-significant correlations with nut length, compression index and kernel length (*$p>0.05$*) while positive correlation with nut shape and negative correlation with the other nut characteristics (*$p<0.05$*) were found. Nut length had significant correlation with all characters except nut count and kernel ratio (*$p<0.05$*). Nut width and nut size were negatively correlated with nut counts, nut shape and kernel ratio, and showed positive correlation with the other characters (*$p<0.05$*). Nut thickness showed negative correlation with nut counts, nut shape, compression index and kernel ratio and positive correlation with the other characteristics (*$p<0.05$*). Nut shape had positive correlations with nut counts, nut length, kernel length and kernel ratio and negative correlation with the others (*$p<0.05$*).

Fruit weight had no correlation with compression index (*$p>0.05$*) and had negatively significant correlation with nut counts, nut shape and kernel ratio and positively significant correlation with the others (*$p<0.05$*). Shell thickness were not correlated with compression index and kernel length (*$p>0.05$*) and correlated negatively with nut counts, nut shape and kernel ratio and positively with the other characteristics (*$p<0.05$*). Compression index did not correlate with nut count, nut weight, shell thickness and kernel length (*$p>0.05$*) and correlated with nut thickness, nut shape and kernel ratio negatively while with the others positively (*$p<0.05$*). Kernel length did not correlate with the nut counts, shell thickness and compression index (*$p>0.05$*) and showed positive correlations with all other characteristics (*$p<0.05$*). Kernel width showed negative correlation with nut counts and nut shape and positive with other characters except with kernel (*$p<0.05$*). Kernel thickness had negative correlation with nut counts, nut shape and compression index, and positive correlation with other characters except kernel ratio (*$p<0.05$*). Kernel weight had negative correlation with nut counts and nut shape and positive with the other characteristics (*$p<0.05$*). Kernel ratio did not correlate with nut length, kernel width and kernel thickness (*$p>0.05$*), positively correlated with nut counts, nut shape, compression index, kernel length and kernel weight and negatively correlated with other characteristics (*$p<0.05$*). Analyses carried out independently in populations show that the resulting correlations are largely similar to the results of integrated analysis.

Table 4. Correlation analysis results of nut characteristics

	Nut counts	Nut length	Nut width	Nut thickness	Nut size	Nut shape	Nut weight	Shell thickness	Compression Index	Kernel length	Kernel width	Kernel Thickness	Kernel Weight
All data (n=570)													
Nut length	0.049												
Nut width	-0.289**	0.329**											
Nut thickness	-0.282**	0.235**	0.701**										
Nut size	-0.181**	0.750**	0.871**	0.613**									
Nut shape	0.317**	0.385**	-0.736**	-0.510**	-0.315**								
Nut weight	-0.259**	0.400**	0.814**	0.821**	0.784**	-0.491**							
Shell thickness	-0.158**	0.103*	0.518**	0.526**	0.409**	-0.415**	0.581**						
Compression index	0.011	0.084*	0.296**	-0.466**	0.251**	-0.236**	-0.072	-0.045					
Kernel length	0.049	0.653**	0.178**	0.097*	0.464**	0.282**	0.279**	-0.045	0.080				
Kernel width	-0.187**	0.228**	0.669**	0.426**	0.586**	-0.479**	0.547**	0.204**	0.253**	0.212**			
Kernel thickness	-0.186**	0.104*	0.482**	0.506**	0.392**	-0.385**	0.459**	0.142**	-0.106*	0.084*	0.474**		
Kernel weight	-0.251**	0.457**	0.612**	0.486**	0.686**	-0.284**	0.628**	0.115**	0.111**	0.505**	0.689**	0.670**	
Kernel ratio	0.113**	-0.077	-0.445**	-0.548**	-0.352**	0.389**	-0.608**	-0.641**	0.170**	0.171**	-0.073	0.000	0.169**
Araç-Güzlük ARA Pop. *(n=110)*													
Nut length	-0.105												
Nut width	-0.103	0.439**											
Nut thickness	-0.204*	0.132	0.524**										
Nut size	-0.137	0.840**	0.857**	0.393**									
Nut shape	0.010	0.500**	-0.555**	-0.376**	-0.048								
Nut weight	-0.173	0.533**	0.728**	0.743**	0.732**	-0.219*							
Shell thickness	0.017	0.291**	0.458**	0.369**	0.444**	-0.178	0.581**						
Compression index	0.176	0.256**	0.394**	-0.568**	0.385**	-0.150	-0.066	0.029					
Kernel length	-0.029	0.792**	0.242*	-0.027	0.601**	0.491**	0.327**	0.123	0.242*				
Kernel width	-0.253**	0.249**	0.599**	0.297**	0.505**	-0.335**	0.348**	-0.025	0.255**	0.223*			
Kernel thickness	-0.212*	0.023	0.173	0.067	0.118	-0.140	-0.015	-0.450**	0.082	0.057	0.439**		
Kernel weight	-0.333**	0.462**	0.453**	0.166	0.539**	-0.004	0.237*	-0.208*	0.231*	0.505**	0.775**	0.663**	
Kernel ratio	-0.118	-0.106	-0.340**	-0.510**	-0.267**	0.227*	-0.649**	-0.663**	0.229*	0.166	0.246**	0.480**	0.486**

Ağlı-Müsellimler MUS Pop. (n=200)														
Nut length	-0.025													
Nut width	-0.419**	0.190**												
Nut thickness	-0.320**	0.070	0.660**											
Nut size	-0.309**	0.713**	0.824**	0.512**										
Nut shape	0.366**	0.504**	-0.746**	-0.518**	-0.243**									
Nut weight	-0.336**	0.324**	0.791**	0.788**	0.752**	-0.460**								
Shell thickness	-0.187**	0.107	0.520**	0.578**	0.410**	-0.385**	0.602**							
Compression index	-0.047	0.123	0.315**	-0.500**	0.296**	-0.210**	-0.080	-0.128						
Kernel length	-0.120	0.623**	0.136	-0.016	0.457**	0.294**	0.222**	-0.088	0.164*					
Kernel width	-0.347**	0.140*	0.518**	0.371**	0.451**	-0.357**	0.508**	0.165*	0.123	0.132				
Kernel thickness	-0.100	0.068	0.306**	0.352**	0.258**	-0.222**	0.352**	0.147*	-0.112	0.020	0.320**			
Kernel weight	-0.368**	0.437**	0.581**	0.397**	0.667**	-0.210**	0.617**	0.112	0.155*	0.501**	0.592**	0.489**		
Kernel ratio	0.155*	-0.024	-0.482**	-0.636**	-0.359**	0.400**	-0.698**	-0.650**	0.231**	0.180*	-0.126	-0.014	0.108	
Tosya-Küçüksekiler TOS Pop.(n=190)														
Nut length	0.213**													
Nut width	-0.338**	0.133												
Nut thickness	-0.297**	0.087	0.699**											
Nut size	-0.186*	0.615**	0.863**	0.600**										
Nut shape	0.405**	0.469**	-0.807**	-0.566**	-0.403**									
Nut weight	-0.386**	0.220**	0.855**	0.842**	0.793**	-0.622**								
Shell thickness	-0.311**	-0.091	0.423**	0.516**	0.290**	-0.451**	0.498**							
Compression Index	-0.035	0.033	0.273**	-0.492**	0.234**	-0.227**	-0.098	-0.164*						
Kernel length	0.291**	0.720**	-0.006	-0.056	0.362**	0.424**	0.073	-0.183*	0.058					
Kernel width	-0.226**	0.287**	0.780**	0.482**	0.766**	-0.517**	0.698**	0.226**	0.292**	0.209**				
Kernel thickness	-0.234**	0.081	0.697**	0.723**	0.595**	-0.555**	0.707**	0.192**	-0.130	-0.018	0.577**			
Kernel weight	-0.171*	0.368**	0.731**	0.568**	0.769**	-0.425**	0.733**	0.114	0.107	0.387**	0.779**	0.780**		
Kernel ratio	0.280**	0.186*	-0.244**	-0.449**	-0.099	0.330**	-0.441**	-0.559**	0.298**	0.418**	0.059	0.013	0.272**	
Ağlı-Tunuslar TUN Pop. (n=70)														
Nut length	-0.178													
Nut width	-0.655**	0.518**												
Nut thickness	-0.641**	0.498**	0.881**											

Nut size	*-0.538***	0.807**	0.923**	0.832**									
Nut shape	*0.645***	0.151	-0.758**	-0.619**	-0.456**								
Nut weight	*-0.620***	0.426**	0.915**	0.855**	0.823**	-0.726**							
Shell thickness	*-0.453***	0.262*	0.527**	0.414**	0.482**	-0.432**	0.571**						
Compression index	*-0.200*	0.123	0.401**	-0.077	0.332**	-0.406**	0.265*	0.317**					
Kernel length	*-0.169*	0.288*	0.347**	0.377**	0.369**	-0.143	0.379**	0.172	-0.007				
Kernel width	*-0.442***	0.157	0.675**	0.560**	0.537**	-0.649**	0.686**	0.416**	0.356**	0.413**			
Kernel thickness	*-0.338***	-0.014	0.491**	0.527**	0.332**	-0.571**	0.620**	0.428**	-0.011	0.198	0.537**		
Kernel weight	*-0.436***	0.402**	0.756**	0.722**	0.703**	-0.552**	0.790**	0.347**	0.191	0.595**	0.793**	0.561**	
Kernel ratio	*0.515***	-0.213	-0.607**	-0.545**	-0.515**	0.557**	-0.704**	-0.513**	-0.228	0.043	-0.204	-0.363**	-0.147

Normally written values are Pearson's and italic values are Spearman's correlation coefficients. ** $P<0.01$; * $P<0.05$

According to the results no discrimination among populations was recorded. Significant correlations were observed between the majorities of the characteristics. Nut counts had non-significant correlations with nut length, compression index and kernel length ($p>0.05$) while positive correlation with nut shape and negative correlation with the other nut characteristics ($p<0.05$) were found. Nut length had significant correlation with all characters except nut count and kernel ratio ($p<0.05$). Nut width and nut size were negatively correlated with nut counts, nut shape and kernel ratio, and showed positive correlation with the other characters ($p<0.05$). Nut thickness showed negative correlation with nut counts, nut shape, compression index and kernel ratio and positive correlation with the other characteristics ($p<0.05$). Nut shape had positive correlations with nut counts, nut length, kernel length and kernel ratio and negative correlation with the others ($p<0.05$). Fruit weight had no correlation with compression index ($p>0.05$) and had negatively significant correlation with nut counts, nut shape and kernel ratio and positively significant correlation with the others ($p<0.05$). Shell thickness were not correlated with compression index and kernel length ($p>0.05$) and correlated negatively with nut counts, nut shape and kernel ratio and positively with the other characteristics ($p<0.05$). Compression index did not correlate with nut count, nut weight, shell thickness and kernel length ($p>0.05$) and correlated with nut thickness, nut shape and kernel ratio negatively while with the others positively ($p<0.05$). Kernel length did not correlate with the nut counts, shell thickness and compression index ($p>0.05$) and showed positive correlations with all other characteristics ($p<0.05$). Kernel width showed negative correlation with nut counts and nut shape and positive with other characters except with kernel ($p<0.05$). Kernel thickness had negative correlation with nut counts, nut shape and compression index, and positive correlation with other characters except kernel ratio ($p<0.05$). Kernel weight had negative correlation with nut counts and nut shape and positive with the other characteristics ($p<0.05$). Kernel ratio did not correlate with nut length, kernel width and kernel thickness ($p>0.05$), positively correlated with nut counts, nut shape, compression index, kernel length and kernel weight and negatively correlated with other characteristics ($p<0.05$). Analyses carried out independently in populations show that the resulting correlations are largely similar to the results of integrated analysis.

According to ANOVA results for nut characteristics with normal distribution, significant differences were found among the populations in terms of all characteristics ($p < 0.05$). Results for differentiating groups are given in Table 5.

Table 5. Inter-population ANOVA and Duncan's test results

Population name and Short name	n	Nut Length (mm)			Nut Width (mm)			Nut Thickness (mm)		
		Mean	*p*	Group	Mean	*p*	Group	Mean	*p*	Group
Araç-Güzlük/ARA	110	15.92	0.000	c	15.85	0.000	c	12.84	0.000	c
Ağlı-Müsellimler/MUS	200	15.16		a	15.27		b	11.82		b
Tosya-Küçüksekiler/TOS	190	15.59		b	15.92		c	12.07		b
Ağlı-Tunuslar/TUN	70	15.15		a	15.92		a	11.32		a
Population	**n**	**Nut Size (mm)**			**Nut Shape**			**Compression Index**		
		Mean	*p*	Group	Mean	*p*	Group	Mean	*p*	Group
Araç-Güzlük/ARA	110	15.88	0.000	c	1.01	0.001	a	1.24	0.000	a
Ağlı-Müsellimler/MUS	200	15.22		b	1.00		a	1.30		b
Tosya-Küçüksekiler/TOS	190	15.76		c	0.99		a	1.32		c
Ağlı-Tunuslar/TUN	70	14.94		a	1.04		b	1.30		bc
Population	**n**	**Kernel Length (mm)**			**Kernel Width (mm)**			**Kernel Thickness (mm)**		
		Mean	*p*	Group	Average	*p*	Group	Mean	*p*	Group
Araç-Güzlük/ARA	110	12.87	0.000	c	11.30	0.000	b	7.89	0.000	c
Ağlı-Müsellimler/MUS	200	12.21		a	11.25		b	7.47		b
Tosya-Küçüksekiler/TOS	190	12.51		b	11.75		c	7.60		b
Ağlı-Tunuslar/TUN	70	12.39		ab	10.76		a	7.22		a
Population	**n**	**Kernel Ratio (%)**								
		Mean	*p*	Group						
Araç-Güzlük/ARA	110	33.9	0.000	ab						
Ağlı-Müsellimler/MUS	200	35.4		b						
Tosya-Küçüksekiler/TOS	190	33.4		a						
Ağlı-Tunuslar/TUN	70	38.2		c						

According to the Duncan's multiple mean test TUN population showed low values for nut length, nut width, nut thickness, nut size, kernel width and kernel thickness characteristics. According to the results of Kruskal Wallis test carried out for nut characteristics that do not show normal distribution, significant differences between populations for all variables were found ($p<0.05$). Results after the Mann Whitney Test carried out to reveal differences between groups are given in table 6. TOS population displays high values and TUN population displays low values in terms of four characteristics.

Table 6. Inter-population Kruskall Wallis and Mann Whitney U test results.

Population name and Short name	n	Nut Counts			Nut Weight (g)			Shell Thickness (mm)		
		Median	*p*	Group	Median	*p*	Group	Median	*p*	Group
Araç-Güzlük/ARA	110	4	0.000	a	1.55	0.000	d	2.24	0.000	b
Ağlı-Müsellimler/MUS	200	4		a	1.40		b	2.31		b
Tosya-Küçüksekiler/TOS	190	5		b	1.51		c	2.33		b
Ağlı-Tunuslar/TUN	70	4		a	1.27		a	1.94		a

Population name and short name	n	Kernel Weight (g)		
		Median	*p*	Group
Araç-Güzlük/ARA	110	0.56	0.000	d
Ağlı-Müsellimler/MUS	200	0.48		b
Tosya-Küçüksekiler/TOS	190	0.50		c
Ağlı-Tunuslar/TUN	70	0.46		a

According to the Hierarchical Multivariate Cluster Analysis carried out on the measured nut characteristics, the dendrogram showed differences between populations (Figure 2).

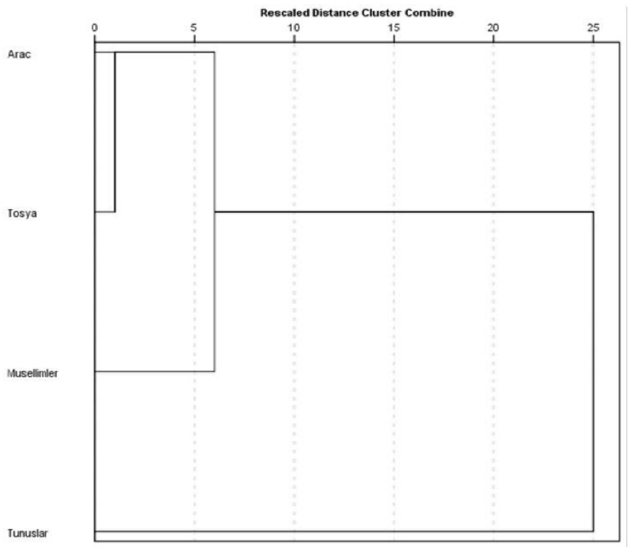

Figure 2. Grouping dendrogram that shows inter-population difference

The results that were obtained with this analysis support the results of Variance Analysis and Kruskal Wallis Test that are explained above. As it is understood from the obtained grouping dendrogram that when all nut characteristics are evaluated together, ARA and TOS populations resemble each other considerably and MUS Population displays similarities to these two populations. TUN population, on the other hand, differs from the other three populations significantly.

It is striking that the two populations from Ağlı province do not resemble each other and, in contrast, MUS population resembles ARA and TOS populations.

After the Kruscal Wallis Test t and a Chi square test (Table 7) carried out to reveal the inter-population differences, significant differences were found out between the trees throughout the population ($p<0.05$).

When the results that were acquired in the scope of the study were compared with the results that were acquired about the nut characteristics studied by SRIVASTAYA *et al.* (2010) concerning *C. colurna* in the region of Indian Kashmir, it is understood that the Turkish population nuts, compared to the Kashmir ones, have higher values in terms of nut counts, shell thickness and kernel ratio characteristics and have lower values in terms of nut length and nut width characteristics, and they display similarities in terms of nut thickness, nut size, nut weight, kernel length, kernel thickness and kernel weight. It could be said that TOS population and the population in the region of Kashmir have similarities while the other three Turkish populations have higher values.

Table 7. Inter-population nut characteristics variations

Nut Characteristics	Populations							
	Araç-Güzlük ARA		Ağlı - Müsellimler MUS		Tosya – Küçüksekiler TOS		Ağlı – Tunuslar TUN	
	F (or X^2)	*p*	F (or X^2)	*p*	F (or X^2)	*p*	F (or X^2)	*p*
Nut counts	40.301[a]	0.000	78.530[a]	0.000	95.737[a]	0.000	36.486[a]	0.000
Nut length (mm)	10.143	0.000	9.552	0.000	8.411	0.000	3.432	0.005
Nut width (mm)	14.072	0.000	8.855	0.000	18.249	0.000	32.962	0.000
Nut thickness (mm)	4.977	0.000	10.546	0.000	11.121	0.000	16.663	0.000
Nut size (mm)	18.690	0.000	10.777	0.000	19.169	0.000	17.156	0.000
Nut shape	3.892	0.000	7.294	0.000	8.938	0.000	13.828	0.000
Nut weight (g)	68.227[a]	0.000	14.826	0.000	18.930	0.000	26.993	0.000
Shell thickness (mm)	10.995	0.000	109.874[a]	0.000	7.051	0.000	11.278	0.000
Compression index	2.469	0.011	3.824	0.000	4.669	0.000	3.732	0.003
Kernel length (mm)	6.755	0.000	10.498	0.000	14.383	0.000	3.336	0.006
Kernel width (mm)	8.827	0.000	3.852	0.000	22.467	0.000	18.284	0.000
Kernel thickness (mm)	16.505	0.000	4.135	0.000	24.450	0.000	6.679	0.000
Kernel weight (g)	23.445	0.000	6.785	0.000	42.883	0.000	11.231	0.000
Kernel ratio (%)	16.468	0.000	13.471	0.000	15.214	0.000	11.829	0.000

[a]*Chi-square statistic (X^2)*

Genetic information based on neutral markers on this side of the range of Turkish hazelnut is very limited and difficult is obtaining information about the genetic structure of the species especially about the estimation of variance components. PALMÉ and VENDRAMIN (2002) using microsatellites, detected that post glacial recolonisation of Europe by hazelnut derived from areas other than Italian or Balkan refugia and contacts were shown among several species including filbert. In general *Corylus* species are characterized by low differentiation and higher genetic diversity within populations, ZONG *et al.* (2015) showed for *C. mandshurica* that within population diversity (87.85%) was significantly higher than that between populations (12.15%).

SRIVASTAVA *et. al.* (2010) reported that in the case of *C. colurna*, genotypes originating from the same locality were grouped in separate clusters, which indicates a wide diversity among genotypes originating from the same place. MURTY and ARUNANCHALAM (1966) stated that the genetic diversity among genotypes could be due to various factors such as genetic structure of the populations, developmental traits and heterogeneity.

CONCLUSION

In this study, because of the non-normal distribution of several traits found performing a complete multivariate analysis, but it was needed to perform non parametric or parametric analyses according to the trait. However, the results showed significant differences between the populations in terms of all studied characteristics.

While the four populations basically form two distinct groups as TUN and the other populations, ARA and TOS populations are the most similar ones in terms of nut characteristics.

Significant correlations were detected between the majorities of nut characteristics. ARA population showed to be the population with the highest values in terms of nut size characteristics (nut length, nut thickness, nut weight, nut size, kernel length, kernel thickness and kernel weight). On the other side, the TOS population showed highest values for nut quality (counts, nut width, compression index and kernel width). The separate population TUN population showed to be discriminated mostly for the highest values for nut shape and kernel ratio.

The regular and straight stem forms do this tree interesting from the technological point of view. Anyway, the detected variation in terms of nut quality could be an added value for the species, its use in plantations and for the agroforestry system. No large information is available on *C. colurna* and the present paper has to be considered as a first step to widening the knowledge on the genetic and cultural potential of the species as a multiservice supplier. In view of that the set of data produced gives a lot of useful information possibly useful to start genetic improvement programmes aimed to extend the planted productive area and cultivation systems. The extension of the potential area where *C. colurna* can be planted should be preliminary detected thanks to the delimitation of the ecological niche where the species can find suitable conditions.

Due to the relatively narrow genetic distances among populations and their scattered distribution, conservation programmes should integrate improvement, on one side to preserve *in situ* natural populations and on the other side selected materials can be preserved *ex situ* as progeny or clonal archives and seed orchards.

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REFERENCES

AKHTAR, P., M., ALI, M.P., SHARMA, M.D., WARIS, H., HASAN, B., ALI, N., CHAUDHARY, M., KHAN, A., ALI, S., NAJIB, H., FAROOQI, H.N., KHAN (2010): Development of quality standards of *Corylus colurna* (Linn.) fruit. J. Ecobiotech., *2* (9): 14-20.

ARSLAN, M. (2005): Batı Karadeniz Bölgesindeki Türk fındığı (*Corylus colurna* L.) populasyonlarının ekolojik ve silvikültürel yönden incelenmesi. [Ecological and silvicultural investigations of Turkish hazelnut (*Corylus colurna* L.) populations in the Western Black Sea Region]. University of Abant İzzet Baysal, The Institute of Applied Science, M. Sc. Thesis, Düzce, Turkey, pp. 88.

AYAN, S., D., AYDINÖZÜ, E.N., YER, E., ÜNALAN (2016): Türk fındığı (*Corylus colurna* L.)'nın Kuzeybatı Anadolu ormanlarındaki yeni bir yayılış alanı: (Kastamonu-Ağlı Müsellimler, Tunuslar Mevkii). [Turkish Filbert (*Corylus colurna* L.) a new distribution area in Northwestern Anatolia Forests: (Provinces of Müsellimler, Tunuslar in Ağlı, Kastamonu/Turkey)]. Biol. Diver. Conserv., *9* (1): 128-135.

AYDINOĞLU, A.C. (2010): Examining environmental condition on the growth areas of Turkish hazelnut (*Corylus colurna* L.). African Journal of Biotechnology, Academic Journals, Lagos, Nigeria, *9* (39): 6492-6502.

BOBRIKOV, B.P. (1979): *Corylus colurna* in the upper reaches of the River Fars. Lesnoe-Khozyaistvo, MK, Russia, *3*: 39-40.

ERDOĞAN, V. and A., AYGÜN (2005): Fatty acid composition and physical properties of Turkish tree hazelnuts. Chemistry of Natural Compounds, Springer, New York, USA, *41*(4): 378-381.

ERDOGAN, V. and S.A., MEHLENBACHER (2000): Interspecific hybridization in hazelnut (*Corylus*). J. Amer. Soc. Hort. Sci., *125* (4): 489–497.

ISLAM, A. (2000): Ordu ilinde yetişen fındık çeşitlerinde klon seleksiyonu. [Clone selection in hazelnut varieties grown in Ordu province]. Unpublished Ph.D. Thesis. University of Cukurova, The Institute of Applied Science, Adana, Turkey, pp. 192.

ISLAM, A., A.I., ÖZGÜVEN, S., ETI (2004): Fındığın döllenme biyolojisi ve meyve özellikleri. [Hazelnut's fertilization biology and fruit characteristics]. 3rd National Hazelnut Assembly, 10-14 October 2004, Mega Publication, İstanbul, Turkey: 495-498.

MOHAMMADZEDEHA, M., R., FATTAHI, Z., ZAMANI, A., KHADIVI-KHUBB (2014): Genetic identity and relationships of hazelnut (*Corylus avellana* L.) landraces as revealed by morphological characteristics and molecular markers, Sci. Hortic., *167*: 17–26.

MOLNAR, T.J. (2011): Chapter 2, *Corylus*. In: C. Kole (ed.), Wild Crop Relatives: Genomic and Breeding Resources, Forest Trees. Springer-Verlag Berlin Heidelberg: 15 – 48.

MILETIĆ, R., M., ŽIKIĆ, N., MITIĆ, R., NIKOLIĆ (2005): Pomological characteristics of superior selections of European filbert (*C. avellana* L.) and Turkish hazel (*C. colurna* L.), Genetika, *37* (3): 103-111.

MITROVIC, M., M., STANISAVLJEVIC, D., OGASANOVIC (2001): Turkish tree hazel biotypes in Serbia. Acta Hort., *556*:191-195.

MURTY, B.R. and V., ARUNACHALAM (1966): The nature of divergence in relation to breeding system in crop plants. Indian J. Gen. Plant Breed., *26*: 188-198.

NINIC-TODOROVIC, J., V., OGNJANOV, Z., KESEROVIC, S., CEROVIC, S., BIJELIC, J., CUKANOVIC, A., KURJAKOV, R., CABILOVSKI (2012): Turkish hazel (*Corylus colurna* L.) offspring variability as a foundation for grafting rootstock productıon. Bulgarian J. Agric. Sci. Agric. Academy, *18* (6): 883-888.

PALASHEV, I. and V., NIKOLOV (1979): The distribution, ecology and biological features of *Corylus colurna* in Bulgaria. Forest Research Institute (BAS), Gorskostopanska-Nauka [Forest Science]. Sofia, Bulgaria, *16* (5): 26-42.

PALMÉ, A. and G.G., VENDRAMIN (2002): Chloroplast DNA variation, postglacial recolonization and hybridization in hazel, *Corylus avellana*. Mol. Eco., *11*: 1769-1779.

POLAT, S. (2014): Türk fındığı (*Corylus colurna* L.)'nın Türkiye'deki yeni bir yayılış alanı. [A new distribution area of Turkish filbert (*Corylus colurna* L.) in Turkey]. Marmara Üniversitesi, Atatürk Eğitim Fakültesi [Marmara University, Atatürk Education Faculty] Marmara Coğrafya Dergisi, [Marmara Geographical Review] Istanbul, Turkey, *29*: 136-149.

RIETHMULLER, E. (2016): Recovery of new diarylheptanoid sources in Betulaceae "Characterisation of the phenolic profile of *Corylus* species by HPLC-ESI-MS methods". Semmelweis University, Doctoral School of Pharmaceutical Sciences, Ph.D. Dissertation. Budhapest, Hungary, pp. 147.

SHAW, K., S., ROY, B., WILSON (2014): *Corylus colurna.* The IUCN Red list of threatened species.e.T194668A2356927.

SMEKALOVA, T.N. and R.S., USHAKOVA (2006): Range of distribution of *Corylus colurna* L. - Arboreous hazel, Turkish hazel. URL: http://www.agroatlas.ru/en/content/related/Corylus_colurna/map/.

SRIVASTAVA, K., ZARGAR, K., S. SINGH (2010): Genetic divergence among *Corylus colurna* genotypes based on morphological characters of Hazelnut. Biodiversity Research and Conservation, Committee of Botany of the Polish Academy of Science, Poznan, Poland, *17*:13-17.
URL:https://www.degruyter.com/downloadpdf/j/biorc.2010.17.issue--1/v10119-010-0003-5/v10119-010-0003-5.pdf .

TEMEL, F., ARSLAN, M., D. ÇAKAR (2017): Status of natural Turkish hazel (*Corylus colurna* L.) populations in Turkey. Artvin Çoruh University, Forestry Faculty Journal, Artvin, Turkey, *18* (1): 1-9.
URL: http://ofd.artvin.edu.tr/issue/25618/270346.

TOSUN, S. (2012): Cadde (Yol) ağacı olarak Amerika'da ve Avrupa'da popülerleşen Türk fındığı (*Corylus colurna* L.). [Turkish hazelnut (*Corylus colurna* L.), which is popular in America and Europe as a street (road) tree]. The Forester's Association of Turkey, Orman ve Av Dergisi, [Forest and Hunting Magazine], Ankara, Turkey, *3*:22-25.

YALTIRIK, F. (1993): Dendroloji Ders Kitabı II. [Dendrology Course Book II.] *Angiospermae*, Publication no of Istanbul University:3767, Publication No of Faculty of Forestry:420, İstanbul, Turkey, pp. 240.

YILMAZ, A. (1998): Türkiye'de fındık ziraatinin plansız gelişimi ve sonuçları [Unplanned development and results of hazelnut agriculture in Turkey]. Ondokuz Mayıs University, Journal of Education Faculty, Samsun, Turkey, *11*:101-114. URL: http://dergipark.ulakbim.gov.tr/omuefd/article/view/5000118035/5000109519

YOO, K.O. and J. WEN (2008): *Corylus colurna* voucher CS96134 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene, complete sequence; and internal transcribed spacer 2, partial sequence. (11-AUG-2008) Division of Life Sciences, Kangwon National University, Hyo-Ja 2 dong, 192-1, Chuncheon 200-701, Korea. NCBI Gene Bank. URL: https://www.ncbi.nlm.nih.gov/nuccore/FJ011739.1 .

ZONG, J.W., ZHAO, T.T., MA, Q.H., LIANG, L.S., G.X. WANG (2015): Assessment of Genetic Diversity and Population Genetic Structure of Corylus mandshurica in China Using SSR Markers. PLoS ONE, 10(9): e0137528.
URL: https://doi.org/10.1371/journal.pone.0137528.

PRELIMINARNI REZULTATI ISPITIVANJA KARAKTERISTIKA PLODA KOD POPULACIJE TURSKOG LEŠNIKA (*Corylus colurna* L.)

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Izvod

Ovaj rad ima za cilj da identifikuje karakteristike lešnika četiri različite populacije (Aglı-Tunuslar, Aglı-Musellimler, Arac-Guzluk i Tosia-Kucuksekiler) u severozapadnom regionu crnomorske regije Turske, jednoj od najvažnijih oblasti od ekonomskog interesa za ovu vrstu. Tamo, Turski lešnik (*Corylus colurna* L.) raste u optimalnim uslovima i otkriva relativno visoku među-populacionu i intra-populacionu varijaciju u pogledu karakteristika ploda. U cilju procene varijacije, izvršene su merenja u četiri populacije u okrugu Kastamonu za 14 različitih karakteristika ploda (broj matica po klasteru, dužina lešnika (mm), širina lešnika (mm), debljina lešnika (mm), debljina školjke (mm), veličina lešnika (mm), oblik lešnika, indeks kompresije, težina matice (g), dužina jezgra (mm), širina jezgra (mm), debljina jezgra (mm), težina jezgra (g) i odnos jezgra (%) na reprezentativnim uzorcima populacije. Značajne razlike su utvrđene među populacijama u odnosu na sve karakteristike lešnika (p <0,05). Prema klaster analizi četiri populacije su stvorile dve grupe, populaciju Aglı-Tunuslar i ostale. Najbliže populacije bile su Tosia-Kucuksekiler i Arac-Guzluk u pogledu karakteristika lešnika. Prema rezultatima dobijenim bilo na osnovu populacije ili bez diskriminacijepopulacije, utvrđene su značajne korelacije između većine osobina lešnika. Populacija Arac-Guzluk je imala najveće lešnike među onima koji su ispitivani i to je populacija koja je imala najviše vrednosti u pogledu karakteristika veličine oraha dok je provincija Tosia-Kucuksekiler pokazala najviše vrednosti, sa prosečnim vrijednostima od 5, 15,92 mm, 1,32 i 11,75 mm respektivno za lešnike po klasteru, širinu lešnika, indeks kompresije i širinu jezgra. Populacija Aglı-Tunuslar je pokazala najviši odnos jezgra sa 38,2%.

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