Turkish Journal of Agricultural and Natural Sciences
Special Issue: 1, 2014

TÜRK
TARIM ve DOĞA BİLİMLERİ
DERGİSİ

TURKISH
JOURNAL of AGRICULTURAL
and NATURAL SCIENCES

www.turkjans.com

Study on The Selection of Walnut (*Juglans Regia* L.) In Trabzon

Semanur KIRCA[a], Tarık Yarılgaç[a], Levent KIRCA[b], Tuba BAK[a]
[a] Ordu Üniversitesi, Ziraat Fakültesi, Bahçe Bitkileri Bölümü, Merkez, Ordu
[b]Pamukkale Üniversitesi, Tavas Meslek Yüksekokulu, Tıbbi ve Aromatik Bitkiler Programı, Tavas, Denizli
Correspondin author: Semanur.Reis@hotmail.com

Abstract

The present analysis is intended to shed light on the species with the supreme characteristics from walnut population grown from the seed in Trabzon between the years of 2008 and 2009. According to the selection criteria, over 500 trees have been scrutinized, and seventy three of these are worth having fruit samples. As a result of the research, 10 walnut genotypes have been selected. The fruit weights of the chosen genotypes are10.2-12.4 grams, and interior weights are 5.2-6.7 grams. The inside proportions are by % 44.5-63.0. The Shell thicknesses are 1.3-2.1 mm. Ashby %1.5-2.1, protein by %13.3-17.2, lipid by %52.2-68, palmitic acid by %4.9-6.4, stearic acid by %1.4-2.3, oleic acid by %18.5-27.0, linoleic acid by %51.7-63.0, linolenic acid by %10.8-16.1 have varied between these values. The eight of the chosen genotypes have protandrous flowering, one of them has protogenous flowering and one of them has homogamous flowering type.

Key Words: Walnut, selection, pomology.

Introduction

Turkey, the homeland of walnut, is one of those countries that have been growing walnut since very old times and have well-established fruit growing culture in the world. So far in the world, 21 walnut cultivars, belonging to Juglans type, have been known. Among these cultivars scattered over many parts of the world, the type involving commercially the most valuable and popular cultivars is *Juglansregia* L.. The walnuts grown in Anatolia are included in this type as well (Şen 1986; Özbek 1987). Our country is also among the native lands of walnut, as of plenty other fruit types (Akça, 2005; Şen, 2006). In our country, walnut cultivation has been done with seed since old times. Owing to its dichogamy feature, as a result of using allogamy and generative reproduction methods, walnut has formed a wide genetic variability, each different from one another and adapted to the local ecology. This genetic richness that our country has is of vital importance in terms of genetic improvement and establishes a significant ground for selection works (Ölmez, 1971; Şen, 1980; Akça, 1993; Özkan, 1993; Osmanoğlu, 1998; Yavic, 2000; Şahinbaş, 2001; Yilmaz, 2001; Taşkın, 2004; Muradoğlu, 2005). Since the very times fruit growing started, fruit improvement has also been carried out. For a very long time, as in other cultivars, in fruit growing as well, intended selections from wild forms have been conducted and these constituted the beginning of improvement (Özbek 1971). Whatever method is applied for the improvement of the plants, selection is always the last step. Because the aim in every improvement program is to obtain a line or clone embodying the required features. Just before trying to create a new genetic formation having the required features with the planned improvement works, it is necessary to check if such a plant is available or not (Şen 1986). Many researchers stated that primarily important criteria in fruit quality are such qualities as shelled fruit weights, kernel weight, kernel/weight nut ratios, shell thickness, color of shell and kernel, protein and oil ratios (Germain, 1997; Mitroviç et al., 1988; Akça, 2005; Yarılgaç, 1997; Muradoğlu, 2005). This study aims to determine the high quality genotypes grown naturally in Trabzon having a large amount of walnut population, to prevent them from disappearing and to detect their pomological qualities and chemical compounds.

Material and Method

This study was carried out in order to determine high quality walnuts and their

characteristics between the years 2008-2009 in Trabzon. Within the scope of the study, 10 districts of Trabzon (Merkez, Akçaabat, Çarşıbaşı, Vakfıkebir, Maçka, Yomra, Araklı, Arsin, Sürmene, Of) were included and their existing walnut capacity was tried to be found out. In the first year of the study 35 of the 73 types whose fruit quality features were determined were eliminated as a result of weighted averages; in the second year, fruit samples were taken again from the other remained 38 types in the second year and re-analyzed. After two years of analysis, the means of all values of inspected samples were calculated and as a result of the weighted averages, 10 genotypes were determined as promising. (Table 1.)

Phenological observations related to the types inspected in the study were used and flowering dates, flowering types and flower attitudes on lateral side branches were determined. Nut analyses were conducted in 25-30 fruit each randomly chosen from 40-50 fruits incidentally taken from trees. Pomological features such as the shell color of the nuts, shell roughness, nut width (mm), nut height (mm), nut length (mm), shelled nut weight (g), kernel weights (g), kernel ratio (%), kernel color (DFA of California color scale), shell thickness (mm), kernel streak, full outbreak of the nut, nut shape and nut size were determined and subjected to weighted rating. As a result of the weighted averages, our types got points ranging between 26 and 107 (Table 1). After this point scoring and the evaluations, 10 types with 80 points and over were selected as promising.

Before the chemical analyses of walnuts were done, they were ground. The protein ratios of the walnuts were determined with Kjhedal method (Bayraklı, 1987), oil ratios with soxholet method, oil acid ratios with GC-2010 AF 230V model gas chromatography with GC-2010 SHIMADZU brand in percentages (Kacar and İnal, 2008; AOAC, 1990). As for the ash analysis, shelled walnuts were kept in stove at 105^{o}C for 24 hours, and to prevent overflowing they were kept waiting in a 200^{o}C drying-oven for 24 hours and then they were burned in 550^{o}C incinerator for 5.5 hours to get the ash ratios in percentages. All these calculations were made considering the dry matter.

Results

The weighted rating values of walnut genotypes *(Juglansregia* L.*)* grown in Trabzon and inspected for two years (2008-2009) were given in Table 1 and the physical and chemical properties of the fruit belonging to 10 genotypes determined as promising were presented by annual averages in Tables 2,3,4 and 5.

The shelled fruit weights of genotypes selected as promising in the study were on average 11.19, the lowest found to be 10.22 g (61AKÇ06) and the highest 12.40 g (61VKF09), their kernel weight was 5,81 on average, the lowest as 5.28 g (61ARK07), and the highest 6.73 g (61ARS03). The kernel/weight nut was 52.16% on average; the lowest %44.59 (61VKF09) and the highest 63.01 (61AKÇ06) (Table 2). The shell thickness of the genotypes included in the study was 1,67 mm on average, the lowest was found to be 1.06 mm (61ARS03) and the highest 2.12 mm (61AKÇ06) (Table 2). In addition, nut length was found to be between 31.75-40.92 mm, nut width 27.45-32.34 mm, and nut thickness was between 30.59-33.35 mm. Also it can be said that the selected types are included in "extra group" in terms of nut size.

The types subjected to selection were in good condition in terms of kernel color; 50% of the seleted types have light, 30% intermediate and 20% dark colors. When it comes to another essential criteria which is shell color, 40% of the types have dark, 60% light color; as for shell roughness, in 50% it is intermediate, in 30% smooth and only in 20% rough; and the shell adhesion is intermediate in 50% and low in 50% (Table 3).

From the chemical compounds of the selected genotypes in the study, the protein ratio is found to be between 13.37% (61 ARS 03) and 17.21% (61 ARK 04), and in 6 types it is over 15%; and the oil ratio is between 52.27% (61 MRK 03) and 67.97% (61 VKF 09) and in 6 types it is over 60%. Also, the ash ratios of these promising 10 selected types in the study were between 1.50-2.14% (Table 4).

"The palmitic acid ratio in the selected types was found to be between 4.99% (61 MRK 03) and 6.43% (61 VKF 09); stearic acid between 1.46% (61 VKF 01) and 2.37%; oleic acid between 18.50% (61 MRK 07) and 27.03% (61 SRM 03); linoleik acid ratio between 51.76% (61 AKÇ 06) and 63.00% (61 MRK 07) and linolenik acid ratio between 10.85% (61 MRK 07) and 16.10% (61 AKÇ 06) (Table 4). This means, the sum percentage of unsaturated fatty acids specifically oleic acid, linoleic acid and stearic acid is 92,29% on average. The data obtained through phenological observations within the scope of the study is presented in table 5. According to this, the eight of the chosen genotypes have protandrous flowering, one of them has protogenous flowering and one of them has homogamous flowering type. (Table 5). Flower ratios on lateral side branches, another criterion for productivity considered as an objective tool by

many researchers, is desired to be high. In the selected types of the present study, the fruit ratios on lateral branches was found to be between 30% and 60.

Table 1. Relative Weighted Scores in Fruit Traits of 39 Walnut Genotypies Selected from Trabzon.

Tree No	Fruit Weight (g)	FW Score	Kernel Weight (g)	KW Score	Kernel Ratio (%)	KR Score (%)	General Total
61 MRK 03	12.19	37	6.23	36	51.10	34	107
61 ARS 03	10.86	31	6.73	38	61.97	37	106
61 MRK 07	11.46	35	5.84	35	50.95	33	103
61 AKÇ 06	10.22	23	6.44	37	63.01	38	98
61 VKF 01	10.63	28	5.59	33	52.58	36	97
61 ÇRŞ 03	11.83	36	5.68	34	48.01	24	94
61 ARK 04	10.93	32	5.45	31	49.86	30	93
61 SRM 03	10.78	31	5.36	30	49.72	28	89
61 ARK 07	10.60	27	5.28	29	49.81	29	85
61 VKF 09	12.40	38	5.53	32	44.59	31	81
61 SRM 04	9.59	20	4.82	24	50.26	32	76
61 VKF 05	11.18	34	5.05	28	45.16	13	75
61 VKF 07	10.51	26	5.01	27	47.66	22	75
61 MÇK 06	10.71	29	5.00	26	46.68	19	74
61 ARK 05	9.95	19	4.82	24	48.44	25	68
61 OF 03	10.38	25	4.82	24	46.43	18	67
61 ARK 01	10.47	27	4.77	23	45.58	14	64
61 MÇK 10	10.05	22	4.71	22	46.86	20	64
61 YMR 15	8.73	9	4.50	19	51.54	35	63
61 MRK 05	9.16	15	4.51	20	49.23	26	61
61 ARK 03	9.11	14	4.51	20	49.50	27	61
61 AKÇ 03	9.98	21	4.85	25	45.59	14	60
61 ÇRŞ 05	10.63	28	4.71	22	44.30	10	60
61 VKF 02	10.45	26	4.52	21	43.25	8	55
61 AKÇ 08	11.03	33	4.44	18	40.25	2	53
61 SRM 02	9.43	17	4.36	16	46.27	17	50
61 YMR 14	8.25	7	4.12	12	49.93	31	50
61 MRK 01	10.29	24	4.43	17	43.05	7	48
61 YMR 12	8.80	10	4.21	13	47.84	23	46
61 MÇK 08	8.96	12	4.21	13	46.98	21	45
61 ARS 02	9.47	18	4.27	14	45.08	12	41
61 VKF 04	9.97	20	4.28	15	42.92	6	35
61 ÇRŞ 01	9.46	19	4.05	10	42.81	5	34
61 OF 04	8.81	11	4.01	9	45.51	14	34
61 OF 01	8.53	8	3.92	6	45.95	16	30
61 YMR 07	9.47	18	3.96	7	41.81	3	29
61 OF 07	9.35	16	3.98	8	42.56	4	28
61 ARS 01	8.99	13	3.92	6	43.60	9	28
61 ARK 02	8.25	6	3.77	5	45.69	15	26

Discussion

The shelled fruit weights of 10 types selected as promising in the study were between 10.22-12.40 g, their kernel weight between 5.28-6.73 g and the kernel/weight nut between 44.59-63.01%.About these parameters, in a selection study conducted in Gürün, in genotypes determined as promising. Akça (1993) found fruit weight to be between 10.36-19.61 g, kernel weight 5.77-9.41 g, kernel ratio 46.12-64.19%; Yarılgaç (1997) found fruit weight to be between11.2-16.8 g, kernel weight 5.8-7.5 g, and kernel ratio 41.1-53.1% in walnut genotypes of Gevaş region; Özkan ve Koyuncu (2005), in some walnut genotypes they inspected, found fruit weight to be between 8.43-11.09 g, kernel weight 4.35-6.2 g; also Oğuz and Aşkın, (2007), in a similar selection study in Ermenek region, selected 16 genotypes as promising. The fruit weight of the selected types were found to be between 10.45-15.88 g, kernel weight 5.26-6.93 g, kernel ratio 41.05-50.33%; Özcan (2009), in a study he conducted, found the

fruit weight as 10.5 g, kernel weight 5.09g and kernel ratio 48.45% in walnut genotype; Muradoğlu ve Balta (2010), reported the fruit weight as 9.91-15.22 g, kernel weight 5.00-6.24 g, kernel ratio 40.9-52.3% in walnuts in Ahlat region; Celik et al. (2010) found the fruit weight of 9 genotypes selected in a study they carried out in Tavas as 7.30-12.72 g, kernel weight as 3.44-6.30 g and kernel ratio as 42.22-56.60%; and Karadeniz (2011), in the study he conducted in Ordu and its surroundings, reported the fruit weights of the selected genotypes as 9.20-15.60 g, kernel weight 5.86-8.60, kernel ratio %44.02-66.74. While the fruit weight and kernel weight in some of our selection types are in parallel with the findings in the literature, in some others, the obtained values are found to be lower comparatively. This is most probably because of the ecological differences in the regions where studies were carried out and also due to the genetic qualities of the grown types. However, when compared with the literature findings in terms of kernel ratio, it can be said that our selected types can compete with all of the types.

Table 2. Nut Traits of Selected Walnut Types from Trabzon District.

Tree No	Fruit Weight (g)	Kernel Weight (g)	Kernel Ratio (%)	Nut Length (mm)	Nut Width (mm)	Nut Height (mm)	Shell Thickness (mm)
61 ÇRŞ 03	11.83	5.68	48.01	36.33	31.15	33.35	1.50
61 MRK 07	11.46	5.84	50.95	32.89	29.50	33.24	1.35
61 MRK 03	12.19	6.23	51.10	34.28	29.15	32.60	1.85
61 VKF 01	10.63	5.59	52.58	40.92	31.71	32.81	1.92
61 VKF 09	12.40	5.53	44.59	33.65	32.34	32.89	1.87
61 ARK 04	10.93	5.45	49.86	38.79	31.60	32.11	1.74
61 ARK 07	10.60	5.28	49.81	35.67	30.98	30.91	1.46
61 AKÇ 06	10.22	6.44	63.01	37.89	30.36	32.25	2.12
61 ARS 03	10.86	6.73	61.97	40.78	29.54	31.16	1.06
61 SRM 03	10.78	5.36	49.72	31.75	27.45	30.59	1.84

Table 3. Nut Traits of Selected Walnut Types from Trabzon District.

Tree No	Kernel Color	Shell Color	Shell Roughness	Kernel Fullness	Fruit Shape	Kernel Streak
61 ÇRŞ 03	Light	Dark	Intermediate	Good	Round	H.S
61 MRK 07	Dark	Dark	Smooth	Good	Round	H.S
61 MRK 03	Yellow	Light	Rough	Good	Round	S.S
61 VKF 01	Light	Light	Intermediate	Good	Oval	S.S
61 VKF 09	Light	Light	Smooth	Good	Round	S
61 ARK 04	Light	Light	Smooth	Average	Round	S.S
61 ARK 07	Yellow	Dark	Intermediate	Average	Round	S
61 AKÇ 06	Yellow	Light	Intermediate	Good	Round	S
61 ARS 03	Dark	Dark	Intermediate	Good	Oval	H.S
61 SRM 03	Light	Light	Intermediate	Average	Oval	S

H.S: Highly Streaked, **S.S:** Slightly Streaked, **S:** Streaked

Table 4. Total Protein, Fat, Ash And Fatty Acid Contents of Selected Walnut Types from Trabzon.

Tree No	Protein Ratio (%)	Oil Ratio (%)	Ashes Ratio (%)	Oleic Asid (%)	Linoleic Asid (%)	Linolenic Asid (%)	Palmitic Asid (%)	Stearic Asid (%)
61 ÇRŞ 03	15.54	63.51	1.82	23.98	55.92	12.16	5.28	2.37
61 MRK 07	15.75	55.97	2.07	18.50	63.00	10.85	5.53	1.87
61 MRK 03	15.34	52.27	2.14	24.70	56.22	11.97	4.99	1.85
61 VKF 01	16.65	65.12	1.81	22.40	53.94	15.77	6.18	1.46
61 VKF 09	14.68	67.97	1.73	20.74	54.84	15.31	6.43	2.36
61 ARK 04	13.37	62.74	2.12	21.74	55.02	15.61	5.47	1.86
61 ARK 07	14.44	61.10	1.86	22.08	56.75	16.01	5.63	1.97
61 AKÇ 06	15.12	60.27	1.79	24.30	51.76	16.10	5.69	1.88
61 ARS 03	17.21	58.89	2.01	23.09	59.76	13.98	5.77	2.11
61 SRM 03	14.90	56.85	1.50	27.03	52.21	13.40	5.21	1.86

In walnut selection studies, shell thickness is one of the crucial selection criteria effecting the fruit quality and easiness in cracking. In studies conducted about this criterion, shell thickness was founded to be between 0.9-2.0 mm by Gumanyuk and Komaniche (1985); 0.59-1.45 mm by Akça (1993); 0.69-1.75mm by Oğuz et al. (2003), 1.43-2.30 mm by Yarılgaç et al. (2005); 1.23-1.80 mm by Oğuz ve Aşkın (2007); 1.27-1.90 mm by Şimşek and Osmanoğlu (2010); 1.26-2.06 mm by Çelik et. al. (2010), 1.23-2.06 mm by Karadeniz (2011). Shell thickness values determined in our study showed similarities with other studies conducted on this topic.

Serr (1962) finds it enough if the light colored kernel ratio is at least 50% in new types. Likewise, as a result of the studies conducted in Gürün by Akça (1993); in Tokat by Özkan (1993) and in Gevaş by Yarılgaç, the light colored kernel ratio was found to be over 70-80%. In his study, Beyhan (1993) found the shell color of the walnuts as 80.85% dark, 17.70% light, 1.61% intermediate, but Gün (1998) gathered better results and found the shell color of the types as 83.33% light, 13.89% dark and 2.78% intermediate. In the light of these studies, it is detected that the selected types in the study are good in terms of kernel and shell colors and 50% of the selected types have light kernel color while 60% have light shell color.

Table 5. Some Phenological Charectristics of Selected Walnut Types from Trabzon District.

Tip No	MFD	FFD	FT	HH	FRLB(%)
61 ÇRŞ 03	23-26 Apr.	26-29 Apr.	PR	17-21 Sep.	50
61 MRK 07	25-28 Apr.	29 Apr.-1 May	PR	11-15 Sep.	50
61 MRK 03	20-23 Apr.	25-28 Apr.	PR	11-15 Sep.	40
61 VKF 01	30 Apr.-2 May	4-7 May	PR	17-21 Sep.	60
61 VKF 09	25-28 Apr.	28-30 Apr.	PR	17-21 Sep.	40
61 ARK 04	1-3 May	3-6 May	PR	20-25 Sep.	30
61 ARK 07	29 Apr.-2 May	2-7 May	PR	21-26 Sep.	50
61 AKÇ 06	2-5 M	1-5 May	H	16-20 Sep.	40
61 ARS 03	23-26 Apr.	27-30 Apr.	PR	4-8 Oct.	50
61 SRM 03	27-30 Apr.	25-28 Apr.	PG	4-8 Oct.	30

MFD: Male Flowering Date, **FFD:** Female Flowering Date, **FT:** Flowering Type, **HH:** History of Harvest, **FRLB:** Fruit Ratios on Lateral Side Branches, **M:** May, **N:** April, **PG:** Protogeny, **PR:** Protandry, **H:** Homogamy, **Sep:** September, **Oct:** October

It is a desired situation for the consumers that shell roughness in our types are mainly intermediate and the adhesion in shell is intermediate and low, and it is a sign that they will constitute no problem during the shelled selling of the types. At the same time, in terms of the positive effect in their commercial values it is extremely important that the kernel fills the shell fully in walnuts (Şen, 1986). Regarding that kernels are good in 7 selected types and in 3 types moderately stuffed, it is better understood that our selection types are in good condition in terms of kernel fullness. In addition, the fact that the kernel rottenness and shrinkage ratio in our types are 0% makes our walnuts commercially more valuable.

Pandele (1968) asserts that protein ratio should be at least 16% and oil ratio 65%. Generally, in the studies, in new types and standard walnut cultivars, protein ratios are minimum 10% and maximum 26%, while oil ratios range between 50% and 80.4% in the literature of national and international research (Pandele, 1968; Nedev, 1975; Kawecki, 1977; Şen, 1980; Çelebioğlu, 1985; Bugaric et al., 1986; Mitrovic et al., 1988; Strila et al., 1988; Pieklo and Czynczyk; 1990; Akça, Beyhan, 1993). In their selection studies, Ölez (1971); Özkan (1993); Koyuncu and Aşkın (1971); Yarılgaç (1997); Gün (1998); Oğuz and Aşkın (2007); Çelik et al. (2010) found the oil ratios to be between 58.34-72-54%, 58.04-73.65%, 66.30-76.94%, 56.29-69.40%, 54.09-68.77%, 54.07-67.63%, 62.02-71.56% respectively and the protein ratios to be between 16.08-25.27%, 14.70-22.80%, 15.95-20.92%, 12.50-23.80%, 17.00-29.95%, 12.11-20.75%, 11.31-17.69% respectively in promising types. As can be understood from all these comparisons, the protein and oil ratios of our selected types are found to be generally similar to that of the mentioned types and cultivars. On the other hand, Lotti et al. (1980) found 7.41-8.55% palmitic, 2.13-2.48% stearic, 11.96-12.90% oleic, 61.70-62.14% linoleic and 14-16% linoleic acid in walnut oil, while Koyuncu and Aşkın (1995) determined it as 7.22% palmitic, 1.07% stearic, 28.51% oleic, 52.46% linoleic and 10.54% linolenic acid in walnut oil; and Ünver and Çelik (2005), in the types they studies, reported it as 41.13-61.15% linoleic acid, 22.39-49.12% oleic acid, 6.01-10.21%

palmitic acid and 2.17-4.99% stearic acid. As can be seen, oil acids composition in the studied types show similarities with the other studies on this topic.

Ash analysis in the endocarps of the selected types is a sign showing the amount of mineral matter in endocarp. As a result of the analysis within this framework, ash ratios in 10 types selected as promising range between 1.50-2.14% on average. In the studies that are in parallel with ours, ash ratios are averagely found to be 2.42%, 1.77% and 1.86% by Beyhan (1993); Akça (1993); Koyuncu and Aşkın (1995) respectively.

As is known, walnut has a monoic flower structure. That is, stamens and pistils are present in different flowers but in the same tree. That is why, it creates two different flower type as male and female. The fact that these flower types blossom at different times creates a tendency for dichogamy. Many researchers state that dichogamy is common in walnuts (Ölez, 1971; Şen, 1983c; Akça, Özkan, Beyhan1993; Aşkın and Gün, 1995; Yarılgaç, 1997; Gün, 1998). As in these studies, in our study as well, dichogamy feature was observed in the selected types. According to this, the eight of the chosen genotypes have protandrous flowering, one of them has protogenous flowering and one of them has homogamous flowering type.

Flower ratios on lateral side branches, determined as another criteria for productivity, considered as an objective tool by many researchers, is desired to be high. In the present study, Flower ratios on lateral side branches of the selected types are found to be between 30 -60%. As a result of a similar study carried out in Ermenek, the Flower ratios on lateral side branches ranged between 10-85% in the genotypes considered as promising. Among the genotypes, 7 genotypes were determined as over 60% (Oğuz and Aşkın, 2007). In a study conducted in Yalvaç, Flowering attitudes on lateral side branches were reported as between 10-80%, Female Flowering on lateral side branches was averagely found to be 28% (Yıldırım et al., 2005). In 20 genotypes considered as promising in the study on the breeding of walnuts in Şemdinli and Yüksekova regions, flowering ratios on lateral side branches ranged between 20-60% (Taşkın, 2004). The findings in the literature and phenological observations of the types obtained in our study are in parallel with each other.

Conclusion

In conclusion, when inspected all together in terms of their fruit properties and also regarding these characteristics when compared with the significant fruit characteristics of the types obtained after several studies both in our country and in the world, it is seen that the selected types as a result of this study conducted for two years in Trabzon have great values considering lots of features. This can become more of an issue for our country since it demonstrates the rich genetic source of walnut it has. Before these gene resources are cleared off, breeding studies in walnut should be given importance and our genetic existence, acquired through centuries, should be preserved. The present study will lead up to further detailed studies to be conducted in the region and enlighten the studies on the preservation, reproducing and standardization of genotypes.

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