DETERMINATION OF SOME BOTANICAL, PHENOLOGICAL, PHYSICAL AND CHEMICAL CHARACTERISTICS OF WALNUT (*JUGLANS REGIA* L.) GENOTYPES GROWN IN TURKEY

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Abstract. Botanical, phenological, physical and chemical characteristics of promising walnut (*Juglans regia* L.) genotypes grown in the Beyazsu region (Mardin) of Turkey were studied during years 2012-2013. The physical properties of genotypes were attributed to the quality criteria of nuts. Fruit weight (Fw1), kernel weight (Kw), fruit length (Fl), fruit witdh (Fw2), fruit height (Fh), kerrnel ratio (Kr) and shell thickness (St) were determined as 9.67-15.68 g, 5.35-8.54 g, 5.35-8.54 g, 33.53-45.78 mm, 28.42-37.00 mm, 28.30-36.32 mm, 48.35-67.27 % and 0.66-1.40 mm, respectively. The kernel color (Kc) and fruit size (Fs2) were light yellow and ekstra of all the genotypes. The fruits were found to be rich in crude protein (Cp) and crude oil (Co). The total energy (Toe), moisture (Mo), total ash (Ta), crude oil (Co), crude protein (Cp) and total carbohydrate (Toc) contents were determined as 692.37-723.37 kcal., 3.11-3.98%, 1.30-2.09%, 62.25-68.91%, 14.92-18.27% and 10.21-16.15%, respectively. Fruitful laterals (Frl) ranged from 40 to 90% while harvest date (Hd) ranged from 10-15 September to 1-10 October. The flowering habits (Fh) observed as 6 protandrous, 6 protogynous and 2 homogamous of the promising genotypes. The results might contribute to breeding studies in order to identify better walnut genotypes, the commercial production for the farmers in the region, and healthy diets in future.
Keywords: *tree properties, fruit properties, physicochemical characteristics, SPSS, Mardin*

Introduction

The Persian walnut (*Juglans regia* L.) is one of the most horticulturally developed and widely cultivated walnut species (Akca et al., 2012). This plant is native to central Asia and grows as a wild or semi-cultivated tree in a wide area from southeastern Europe and the Caucasus to Turkey and Iran, through southern portions of the former Soviet Union into China and the eastern Himalayas (Ercisli et al., 2011).

Turkey ranks fourth in the world with a production of 212.140 tons (FAO, 2013), which is mostly from spontaneously growing trees, but the cultivation of new walnut cultivars from selective breeding programs will lead to commercially competitive walnut production (Koyuncu et al., 2004; Simsek et al., 2010). Therefore, in Turkey the

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researches on walnut genotypes and cultivars have been ongoing and their production is being encouraged to increase its world market share.

Turkish Standard Institute established physical chaacteristics of walnut as a quality criteria (TSE, 1990; TSE, 1991). The chemical compositions of walnut ranged from 13.60-18.10% crude protein (Cp), from 62.60 to 70.30% crude oil (Co) (Savage, 2001) and from 682 to 728 kcal energy (Yerlikaya et al., 2012). Moreover, Ozkan and Koyuncu (2005) reported the chemical compositions of 10 walnut genotypes as follows: crude protein (Cp); 15.17-19.24%, total ash (Ta); 1.26 to 2.06%, crude oil (Co); 61.97-70.92%, moisture (Mo); 3.25-3.91%, and total carbohydrate (Toc); 8.05-13.23%.

Many studies have been carried out especially dealing with the phenological, botanical, physical and chemical characteristics of walnuts types and cultivars grown in different areas of Turkey (Askin and Gun, 1995; Bakkalbasi et al., 2010; Kazankaya et al., 2008; Koyuncu et al., 2004; Muradoglu and Balta, 2010; Oguz and Askin, 2007; Unver and Celik, 2005; Polat et al., 2015; Simsek, 2010a). However, there is no any reported previous study conducted in this microclimate area, Beyazsu region. The present study was of significant importance in achieving high quality walnut production for a sustainable and competitive market share. Therefore, it was aimed to determine some phenological, botanical, physical and chemical properties, resistant to anthrachnosis *(Gnomonia leptostila),* bacterial blight *(Xanthomonas juglandis)* and codling moth *(Cydia pomonella)* of the walnut genotypes grown in this region.

Materials and Methods

Materials

This study was carried out in Beyazsu region (Mardin) of Turkey between the years 2012-2013. It has been estimated that the research region has around 1000 walnut genotypes propagated naturally by seed. Study area is situated between $37^0 16' 3.23''$ N-$41^0 18' 4.60''$ E coordinates in the North and $37^0 5' 52.84''$ N–$14^0 42' 5''$ E coordinates in the South, at altitude ranging from 350 to 1000 meters asl (Anonymous, 2016). The walnut trees were at various ages, but not younger than 20 years old. In the research area, average annual temperature and precipitation are 16.6°C, and 648 mm, respectively (Anonymous, 2015). In the present study, 14 promising genotypes were purposively selected among the walnut trees and used as plant material in 2 consecutive years.

Botanical and phenological characteristics

Botanical and phenological characteristics of 14 promising walnut genotypes were observed and/or measured according to the method reported by Akca and Ozongun (2004), Bakkalbasi et al. (2010) and Simsek (2010a). Botanical characteristics such as tree habit, density of branch, vigour, age (estimated year), trunk circumference and brancing height were determined. The fruitful laterals (Frl), the tolerance to diseases and pests of all the genotypes were investigated. Phenological characteristics such as date of the first foliation (Dff), Flower habits (Fh), blooming date of male flowers (Bdmf), blooming date of female flowers (Bdff), date of the first budding (Dfb), date of full flowering (Dff) and Harvest date (Hd) observed. Walnut samples were collected from the selected 14 trees according to completely randomized experimental design with 3 replications and 30 fruits per tree for each year. The walnut trees received no cultural practices such as fertilization, irrigation, plant protection, etc.

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Physical characteristics

Physical measurements of fruits were carried out after drying in the shade. Features such as fruit weight (Fw1), kernel weight (Kw), kernel ratio (Kr), shell thickness (St), Fruit length (Fl), fruit width (Fw2), fruit height (Fh) and other characteristics were determined according to the UPOV standards (Anonymous, 1994). While weighing was performed with sensitive precision scales, measuring was made with 0.01 mm precision digital caliper.

Chemical characteristics

Walnut kernels of the genotypes were grinded and Mo was determined before chemical analysis. Samples were dried in shadow for one week prior to determination of the Mo content, which was calculated by subtracting the dry weight from fresh weight (TSE, 1991). Crude protein (Cp) content (N×6.25) was determined by using kjeldahl method (Jung et al., 2003). Prior to total ash (Ta) calculation samples were kept at 105°C for 24 h in an oven and then exposed to a muffle furnace (AOAC, 1990). The temperature was gradually raised to 600°C and the samples were ashed for 10-12 h to a white colour. Crede oil (Co) content was determined by extracting 8 g dried, grounded kernels per replicate with petroleum ether using a soxhlet apparatus at 45-50°C for 8-9 h. The Crude oil (Co) content was detected as the difference in weight of dried kernel sample before and after the extraction according to AOAC (1995). Total carbohydrate (Toc) was calculated by subtracting other nutrient contents from total weight. Total energy (Toe) values were calculated by multiplying the amounts of Crude protein (Cp) in and total carbohydrate (Toc) by the factor of 4 kcal/g and Crude oil (Co) by the factor of 9 kcal/g.

Statistical analysis

Analyses of physical and chemical characteristics were performed in triplicate on walnut genotypes for subsequent two years. All data were subjected to analysis of variance with the aid of SPSS (ver. 18).

Results

The fruitful laterals (Frl) ranged from 40 for MBSU121 and MBSU143 to 90% for MBSU83, the promising genotypes (*Table 1*). The tree habit (Th) of walnut genotypes were determined as erect, semi-erect, semi-spreading and spreading; density of branch (Db) was determined as very sparse, sparse, dense and medium; vigour (V) was determined as strong, medium and weak. In addition, trunk circumference (Tc) ranged from 85 to 160 cm. Moreover, the altitude (A), brancing height (Bh) and age (estimated year) (Aey) of the promising genotypes ranged from 475 to 625 meters, from 700 to 1300 cm and from 30 to 80 years, respectively (*Table 1*). In addition, The promosing walnut genotypes were resistant to anthrachnosis *(Gnomonia leptostila),* bacterial blight *(Xanthomonas juglandis)* and codling moth *(Cydia pomonella).*

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Table 1. *Some botanical characteristics, fruitful laterals and altitudes of the promosing walnut genotypes (average 2012-2013)*

Genotype	Th	Db	V	A (ey)	Tc (cm)	Fl(%)	Bh(cm)	A(m)
MBSU14	Ss	Sp	St	50	160	50	1200	475
MBSU37	S	M	M	45	100	70	850	548
MBSU44	Se	D	W	50	120	70	850	604
MBSU53	E	M	St	35	95	60	850	556
MBSU79	S	Sp	St	40	95	50	950	493
MBSU83	E	M	M	65	115	90	1000	565
MBSU95	S	D	W	50	85	80	800	534
MBSU100	Ss	M	M	80	135	70	1300	530
MBSU113	O	Sp	St	40	145	60	850	612
MBSU121	Se	Sp	St	40	100	40	800	598
MBSU128	S	D	W	20	90	70	700	625
MBSU130	S	D	W	50	130	60	1100	596
MBSU134	Se	Sp	St	35	125	50	1100	480
MBSU143	E	Vs	St	25	95	40	950	540

S: Spreading, Ss: Semi-spreading, Se: Semi-erect, E: Erect, O: Open, Sp: Sparse, Vs: Very sparse, M: Medium, D: Dense, St: Strong, W: Weak, Th: Tree habit, Db: Density of branch, V: Vigour, A (ey): Age (estimated year), Tc: Trunk circumference, Frl: Fruitful laterals, Bh: Brancing height, A: Altitude

The date of the first foliation (Dff), blooming date of male flowers (Bdmf), blooming date of female flowers (Bdff), date of the first budding (Dfb), date of full flowering (Dff) and Harvest date (Hd) of the genotypes ranged from 20 March to 2 April, from 30 March to 10 April, from 30 March to 15 April, from 26 March to 13 April, from 3 April to 20 April and from 10 September to 10 October, respectively (*Table 2*). In addition, it was determined that the Flower habits (Fh) observed as 6 protandrous, 6 protogynous and 2 homogamous of the promising genotypes. In this study, the genotypes with early foliation were eliminated (*Table 2*).

Table 2. *Some phenological characteristics of promosing walnut genotypes*

Genotype	Dff	Fh	Bdmf	Bdff	Dfb	Dff	Hd
MBSU14	20-21M	PD	30M	6A	4-5 A	12-13A	10-5S
MBSU37	21-22M	PG	1A	30M	26-7M	4-5A	15-0S
MBSU44	23-24M	PD	30M	8A	4-5A	13-14A	25-0S
MBSU53	29-30M	PG	9A	6A	3-4A	14-15A	1-10O
MBSU79	29-30M	PD	7A	15A	10-11A	17-18A	25-0S
MBSU83	22-23M	PG	1A	30M	27-8M	3-4A	10-5S
MBSU95	29-30M	PG	8A	5A	2-3A	13-14A	1-10O
MBSU100	30-31M	HO	10A	10A	9-11A	19-20A	15-0S

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MBSU113	25-26M	PG	4A	1A	5-6A	10-11A	15-0S
MBSU121	23-24M	PD	3 M	8A	4-5A	11-12A	1015S
MBSU128	24-25M	PD	31M	8A	4-5A	14-15A	25-0S
MBSU130	1-2A	HO	12A	12A	11-13A	21-22A	1-10O
MBSU134	25-26M	PG	6A	3A	1-2A	9-10A	15-0S
MBSU143	21-22M	PD	30M	8A	4-5A	11-12A	10-5S

M: March, A: April, PD: Protandrous, PG: Protogynous, HO: Homogamous, S: September, O: October, Dff: Date of the first foliation, Fh: Flower habits, Bdmf: blooming date of male flowers, Bdff: blooming date of female flowers, Dfb: Date of the first budding, Dff: Date of full flowering, Hd: Harvest date

The lowest and the highest Fruit weight (Fw1) in the promising genotypes were determined as 9.67 g (MBSU128) and 15.68g (MBSU14), respectively (*Table 3*). The lowest Kernel weight (Kw) was 5.35 g (MBSU130) while the highest Kernel weight (Kw) was 8.54g (MBSU14). Moreover, the lowest and the highest Kernel ratio (Kr) were found as 48.35% (MBSU95) and 67.27% (MBSU128), respectively (*Table 3*). In this study, the thin Shell thickness (St) was 0.66 mm (MBSU128) whereas the Shell thickess (St) was 1.40 mm (MBSU83) (*Table 3*). This study revealed that the widest fruits (37.00 mm) were obtained from the MBSU143 genotype, while the narrowest fruits (28.42 mm) were obtained from MBSU134 genotype (*Table 3*). Fruit height (Fh) changed between 28.30 mm (MBSU134) and 36.32 mm (MBSU14) (*Table 3*). Fruit length (Fl) was found to be from 33.53 mm (MBSU130) to 45.78 mm (MBSU14) (*Table 3*). In addition, fruit shape (Fs1) was determined as oval and spherical; Shell thickess (St) was determined as very thin, thin and medium; Fruit size (Fs2) was determined as extra; shell roughness (Sr1)was determined as weak, smooth and medium; shell adhesion (Sa) was determined as weak and strong; shell removal (Sr2) was determined as easy and medium; wholeness ratio of kernel (Wrk) ranged from 80 to 100%; peel color (Pc) was determined as light brown and dark; Kernel color (Kc) was determined as light yellow for all the genotypes (*Table 3*).

Table 3. *Some physical characteristics of the promising walnut genotypes (average 2012-2013)*

Genotype	Fw1 (g)	Kw (g)	Kr (%)	Fl (mm)	Fw2 mm)	Fh (mm)	St (mm)
MBSU14	15.68±1.15	8.54±0.69	54.48±2.10	45.78±2.26	36.41±2.55	36.32±1.72	1.39±0.02
MBSU37	13.79±0.77	7.35±0.32	53.32±0.96	39.00±1.49	34.97±1.84	35.95±1.21	1.18±0.09
MBSU44	13.00±0.58	6.87±0.31	52.84±0.70	40.68±2.33	34.14±2.00	34.76±1.67	1.27±0.04
MBSU53	12.19±0.84	6.40±0.42	52.57±1.36	37.38 2.38	34.75±2.04	34.83±2.01	1.36±0.09
MBSU79	11.86±0.78	6.54±0.32	55.17±0.95	36.89±1.99	33.64±1.56	33.67±2.10	1.31±0.06
MBSU83	10.95±0.66	5.55±0.36	50.66±0.29	38.87±1.63	32.84±1.80	35.29±1.95	1.40±0.06
MBSU95	12.49±1.30	6.01±0.45	48.35±2.23	42.83±2.75	34.25±1.69	33.92±1.99	1.22±0.04
MBSU100	12.72±0.57	7.04±0.28	55.46±4.06	38.77±1.99	34.66±2.07	34.02±2.00	1.00±0.01
MBSU113	11.17±0.77	6.47±0.40	56.87±3.32	39.22±2.40	30.73±1.95	31.85±2.23	1.02±0.06
MBSU121	11.88±1.02	6.45±0.49	54.64±0.96	36.41±2.19	33.88±1.51	32.80±1.08	1.06±0.05
MBSU128	9.67±0.98	6.35±0.52	67.27±1.61	35.13±1.72	31.56±2.13	32.38±2.13	0.66±0.04
MBSU130	11.07±1.17	5.35±0.44	48.45±1.20	33.53±1.70	31.53±1.50	31.23±1.56	1.12±0.04

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MBSU134	9.98±1.24	5.46±0.58	54.81±0.95	42.56±2.13	28.42±2.21	28.30±1.84	1.06±0.06
MBSU143	11.60±0.79	6.73±0.54	57.98±1.63	34.03±2.51	37.00±1.20	33.70±2.03	1.25±0.03
Mean	12.00	6.51	54.49	38.65	33.48	33.50	1.16
Min.	9.0	5.00	45.88	31.90	27.00	27.00	.63
Max.	16.8	9.33	68.94	48.24	39.32	38.01	1.46
S.D.	1.69*	0.89*	4.78*	3.83*	2.75*	2.56*	0.20*

*statistically significant at 0.05. Fw1. Fruit weight, Kw: Kernel weight, Kr: Kernel ratio, Fl: Fruit length, Fw2: Fruit width, Fh: Fruit height, St: Shell thickness

Table 3. *(Continued)*

Genotype	St	Sr	Fs1	Fs2	Pc	Kc	Sa	Sr	Wrk (%)
MBSU14	M	S	O	E	L	Ly	W	E	90 - 100
MBSU37	T	S	Sp	E	D	Ly	W	E	90 - 100
MBSU44	M	S	Sp	E	L	Ly	W	M	80 -90
MBSU53	M	M	Sp	E	L	Ly	St	E	80 -90
MBSU79	M	S	Sp	E	D	Ly	St	E	90 - 100
MBSU83	M	M	Sp	E	L	Ly		M	80-90
MBSU95	M	S	O	E	L	Ly	St	E	90 - 100
MBSU100	T	M	Sp	E	B	Ly	W	E	80 -90
MBSU113	T	S	O	E	D	Ly	W	E	80 -90
MBSU121	T	S	Sp	E	L	Ly	St	M	90 - 100
MBSU128	Vt	M	S	E	L	Ly	W	E	80 -90
MBSU130	T	S	Sp	E	D	Ly	W	E	80 -90
MBSU134	T	S	O	E	L	Ly	St	M	80 -90
MBSU143	M	S	Sp	E	B	Ly	W	E	90 - 100

M: Medium, T: Thin, Vt: Very thin, S: Smooth, O:Oval, Sp: Spherical, E: Extra, L:Light, B: Brown, D: Dark, Ly: Light yellow, W: Weak, St: Strong, E: Easy, St: Shell thickness, Sr1. Shell roughness, Fs1: Fruit shape, Fs2: Fruit size, Pc: Peel color, Kc. Kernel color, Sa: Shell adhesion, Sr2: Shell removal, Wrk: Wholeness ratio of kernel

The Crude oil (Co), crude protein (Cp), total carbohydrate (Toc), total ash (Ta) and moisture (Mo) percentages of 14 promising walnut genotypes ranged from 62.25 (MBSU130) to 68.91% (MBSU44), from 14.92 (MBSU37) to 18.27% (MBSU83), from 10.21 (MBSU44) to 16.15% (MBSU130), 1.30 (MBSU130) to 2.09% (MBSU14) and from 3.11 (MBSU128) to 3.98%(MBSU95), respectively (*Table 4*).

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Table 4. *Some chemical chaacteristics of the promising walnut genotypes (average 2012-2013)*

Genotype	Mo (%)	Ta (%)	Co (%)	Cp (%)	Toc (%)
MBSU14	3.26±0.33	2.09±0.23	63.91±1.14	15.39±0.57	15.37±1.80
MBSU37	3.601±0.42	1.86±0.18	67.00±0.01	14.92±1.80	12.63±2.04
MBSU44	3.45±0.06	1.84±0.05	68.91±0.21	15.60±0.25	10.21±0.57
MBSU53	3.63±0.16	1.86±0.19	65.42±0.71	17.89±0.57	11.21±0.21
MBSU79	3.41±0.13	1.76±0.23	66.99±.41	15.71±0.98	12.14±0.35
MBSU83	3.84±0.11	1.81±0.07	62.99±0.54	18.27±0.92	13.10±0.42
MBSU95	3.98±0.02	1.83±0.07	65.03±0.14	16.88±1.20	12.29±1.29
MBSU100	3.32±0.08	1.89±0.06	66.31±0.84	16.40±0.85	12.09±1.67
MBSU113	3.14±0.18	1.76±0.24	65.01±0.16	15.14±1.22	14.96±1.48
MBSU121	3.33±0.06	1.77±0.11	65.91±0.28	15.97±0.25	13.03±0.35
MBSU128	3.11±0.06	1.36±0.36	65.55±0.57	16.48±0.20	13.51±0.47
MBSU130	3.49±0.18	1.30±0.37	62.25±1.14	16.83±2.41	16.15±1.46
MBSU134	3.91±0.08	1.55±0.05	65.27±0.99	14.98±0.88	14.30±0.03
MBSU143	3.38±0.39	1.51±0.27	64.44±0.59	14.95±0.12	15.73±0.83
Mean	3.49	1.73	65.35	16.10	13.33
Minimum	3.01	1.03	61.44	13.65	9.81
Maximum	3.99	2.25	69.05	18.92	17.18
S.D.	0.31*	0.26*	1.76*	1.31*	1.91*

*statistically significant at 0.05. Mo: Moisture, Ta: Total ash, Co: Crude oil, Cp: Crude protein, Toc: Total carbohydrate

The Total energy (Toe**)** values of the promising walnut genotypes ranged from 692.09 (MBSU130) to 723.37 kcal (MBSU44) (*Figure 1*).

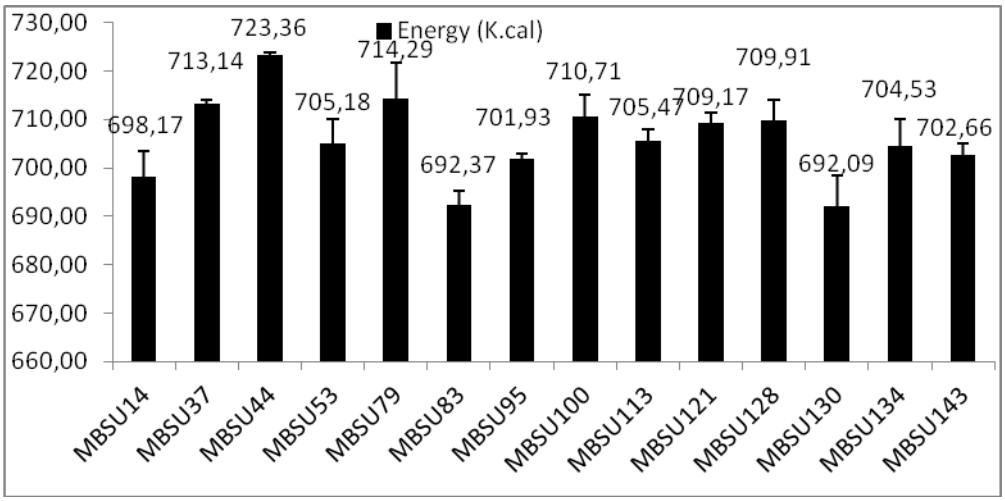

Figure 1. *Total energy (Toe) values of the promising walnut genotypes average (2012-2013)*

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Discussion

Some botanical characteristics, fruitful laterals and altitudes of the promosing walnut genotypes

The fruitful laterals (Frl), date of the first foliation (Dff), blooming date of male flowers (Bdmf), blooming date of female flowers (Bdff), date of the first budding (Dfb), date of full flowering (Dff), Hd and altitude (A) of the promising walnut genotypes (*Table 1*). The fruitful laterals (Frl) are the significant factor that determines the potential yield in walnut species. The fruit yield in the lateral shoots were also associated with precocity (Germain, 1999). The percentage of the fruitful laterals (Frl) of Turkish walnut genotypes and cultivars is very low than Californian and French walnut cultivars. The average of percentage of the fruitful laterals (Frl) in Turkish walnut cultivars, Yalova 1', 'Yalova 3', 'Şebin', 'Bilecik', 'Kaman 1', 'Şen 1' 'and 'Bursa 95' were determined to be between 20 and 40% (Akca, 2012). Akca and Ozongun (2004) observed as from 10 to 70% for the fruitful laterals (Frl) of the promising walnut genotypes in Ermenek district of Karaman province. Simsek (2010a) was determined that the fruitful laterals (Frl) changed from 75 and 90% of the selected types. Study results according to fruitless laterals (Frl) were partly different from those of the researchers. The fruitful laterals (Frl) of walnut genotypes and cultivars can change according to the genetic characteristics and the ecological conditions. In addition, Akca et al. (2015) observed that the superior walnut genotypes were found to be resistant to anthrachnosis, bacterial blight and codling moth in Kemah district in Eastern Anatolia of Turkey. The results obtained in this study are in agreement with Akca et al. (2015). Akca and Sen (2001) determined that average age (Aey) of the promising walnut genotypes changed from 35 to 40 years. Simsek et al. (2010) determined that the branching height (Bh), trunk circumferences (Tc) and age (Aey) of the promising walnut types of the promising genotypes from Diyarbakir and Mardin central districts were changed from 200 to 450 cm, from 55 to 380 cm and from 10 to 80 years, respectively. In the same survey, it was observed that the tree habits (Th) of the genotypes were determined to be erect for 3 genotypes, semi-erect for 3 genotypes, weeping for 3 genotypes, spreading for 2 genotypes and open for 1 genotype. Many studies have been carried out dealing with the botanical characteristics of walnut genotypes and cultivars in different region of Turkey (Akca and Ozongun, 2004; Akca et al., 2015; Sen, 1986; Simsek, 2010a, 2010b; Simsek and Osmanoglu, 2010; Simsek et al., 2010). The results of botanical characteristics and Fl of walnut genotypes are in agreement with most studies in the literatures.

Some phenological characteristics of promosing walnut genotypes

Some phenological characteristics of the promosing walnut genotypes were presented in *Table 2*. Akca and Ozongun (2004) observed as from 15 April to 10 May for the bloom period (Bp) of the promising walnut genotypes in Ermenek district of Karaman province. Simsek (2010a) was determined that the date first foliation (Dff), blooming date of male (Bdmf) and female flowers (Bdff), date of first bud breaking (Dfb), date of full flowering (Dff) and Harvest date (Hd) of the selected types in Sanliurfa population changed from 21 March to 28 March, from 30 March to 6 April, from 29 March to 7 April, from 26 March to 6 April, from 3 April to 12 April and from 5 September to 20 September, respectively. Oguz and Askin (2007) studied on first leafing time, the lower habits, blooming date of the male (Bdmf) and the female flowers

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(Bdff), date of the first bud breaking (Dfb) and the date of full flowering (Dff) and Harvest date (Hd) of the walnut types in Ermenek and finally they (Oguz and Askin, 2007) observed the similar results like Simsek (2010a). In addition, He (2010a) determined that the protandrous and the protogynous of these types in Sanliurfa province observed as 63.63% and 33.37%, respectively. Simsek (2010b) determined that the protandrous, protogynous and homogynous of 17 promising walnut genotypes in Cermik and Cungus populations in Southeast Anatolia observed as 6, 4 and 2, respectively. Beyhan and Ozatar (2007) observed that the flowering habit (Fh) of the selected types determined as 58.59% protandrous, 28.30% protogynous and 13.20% homogomous in Kahramanmaraş province. Gulsoy et al. (2016) observed that the protandrous, protogynous and homogynous of 21 promising walnut genotypes in Iğdır central district and its villages observed as 11, 9 and 1, respectively. The botanical chaacteristics of walnut genotypes and cultivars can vary with the year of harvest, environmental conditions, horticultural practices and genetic characteristics.

Some physical characteristics of the promising walnut genotypes

Some physical chaacteristics of the promising genotypes were presented in *Table 3*. Polat et al. (2015) carried out as 10.42-14.25 g fruit weight (Fw1), 4.52-7.44 g kernl weight (Kw), 42.38-54.07% kernel ratio (Kr) and 1.20-1.80 mm shell thickness (St) for 17 promising genotypes in Bitlis province. Gulsoy et al (2015) determined that the fruit weight (Fw1), kernl weight (Kw), kernel ratio (Kr), fruit width (Fw2), fruit height (Fh), fruit length (Fl) and shell thickness (St) of walnut genotypes in the villages located in the Tuzluca district of the Igdir province changed from 10.12-13.22 g, 5.00-6.07 g, 40.01-52.63%, 30.67-34.75 mm, 29.75-35.52 mm, 31.78-44.38 mm and 1.46-2.46 mm, respectively. Gulsoy et al. (2016a) determined that fruit weight (Fw1), kernl weight (Kw), kernel ratio (Kr) and shell thickness (St) of the superior walnut genotypes from Iğdır central district and its villages were changed from 10.04-15.77g, 5.57-7.46 g, 42.87-59.62% and 1.25-3.10 mm, respectively. Simsek and Osmanoglu (2010) determined that superior walnut genotypes in Mazidagi district had fruit length (Fl) 35.64-42.02 mm, fruit width (Fw2) 29.78-34.46 mm, fruit hight (Fh) 29.69-35.56 mm, extra fruit size (Fs2) for all the genotypes studied according to Turkish standards. Akca and Sen (2001) determined that the fruit weight (Fw1), the kernel weight (Kw), the shell thickness (St), the fruit width (Fw2) and the fruit length (Fl) changed from 13.93 to 7.49 g, from 5.73 to 2.61 g, from 2.45 to 1.32 mm, from 32.26 to 22.30 mm and from 49.25 to 32.90 mm, respectively. Kuden et al. (1995) determined the kernel ratio (Kr) changed from 41.44 to 56.25%. Beyhan and Ozatar (2007) determined to be fair or smoorh of shell roughness (Sr1), dark or light of peel color (Pc), light yellow, yellow, yellow brown and brown of Kernel color (Kc) of the selected types in Kahramanmaras province. The values obtained on physical characteristics in this study were in agreement with the values found in similar studies conducted in Turkey (Beyhan and Ozatar, 2007; Kuden et al., 1995; Oguz and Askin, 2007; Polat et al., 2015; Simsek and Osmanolu, 2010; Gulsoy et al., 2015; Gulsoy et al., 2016a).

Some chemical characteristics of the promising walnut genotypes

Some chemical characteristics of the promising walnut genotypes were presented in *Table 4*. Ozkan and Koyuncu (2005) reported that 10 walnut genotypes from Turkey contained 1.26–2.06 total ash (Ta), 61.97–70.92% crude oil (Co), 15.17–19.24% crude

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protein (Cp) and 3.25-3.91% moisture (Mo). Pereira et al. (2008) showed that six walnut cultivars from Portugal contained 3.31-4.26% total ash (Ta), 68.83-72.14% crude oil (Co), 14.38-18.03% crude protein (Cp) and 3.85-4.50% moisture (Mo). Oguz and Askin (2007) determined that crude protein (Cp), crude oil (Co), moisture (Mo) and total ash (Ta) content of the walnut genotypes changed from 12.11 to 20.75%, from 54.07 to 67.63 %, from 2.70 to 3.79% and from 1.00 to 2.22%, respectively. Ali et al. (2010) determined that promising walnut cultivars from Pakistan ranged from 63.54 to 69.25% crude oil (Co), from 15.96 to 19.15% crude protein (Cp), from 8.04 to 1.14% total carbohydrate (Toc), from 1.27 to 1.95% total ash (Ta) and from 2.76 to 4.20% moisture (Mo). Simsek (2010a) reported that total ash (Ta), crude oil (Co), crude protein (Cp) and moisture (Mo) contents of the selected walnut genotypes in Turkey ranged from 1.88 to 2.89%, 58.88 to 65.64%, 13.70 to 20.18% and 1.63 to 4.73%, respectively. Yerlikaya et al. (2012) also found that total ash (Ta), crude oil (Co), crude protein (Cp) and moisture (Mo) contents of walnut genotypes in Western Anatolia ranged from 1.53 to 1.99%, from 61.32 to 69.35%, from 10.58 to 18.19% and from 1.91 to 4.48%, respectively. Akca et al. (2015) reported that total ash (Ta), crude oil (Co) and crude protein (Cp) contents of 9 promising walnut selections in Kemah district of Turkey ranged from 1.50 to 2.27%, 55.18 to 65.70% and 14.70 to 20.10%, respectively. Gulsoy et al. (2016b) determined that the crude oil (Co), crude protein (Cp), total ash (Ta) and moisture (Mo) ratios of walnut genotypes of Tuzluca (Igdir) district varied in a range of 50.52-66.68%, 6.59-26.57%, 0.98-4.00% and 2.55-6.98%, respectively. Gulsoy et al. (2016c) determined that the crude oil (Co), crude protein (Cp), total ash (Ta) and moisture (Mo) content of selected walnut genotypes from Iğdır province varied from 50.03 to 64.98%, 10.23 to 22.14%, 0.97 to 3.96% and 3.05 to 4.48%, respectively. The results of the crude oil (Co), crude protein (Cp), total ash (Ta) and moisture (Mo) content of our selected walnut genotypes are mostly in agreement with previous studies. The walnut genotypes and cultivars had as high crude protein (Cp) levels as some legumes such as peas, chickpeas and lentils. The total carbohydrate (Toc) values of walnut genotypes and cultivars in previous studies were found in the range of 7.04 – 23.80% (Simsek et al., 2010), 8.05-13.23% (Ozkan and Koyuncu), 3.75–7.16% (Pereira et al., *2008)* and 8.04–12.41% (Ali et al., 2010).

Toe values of the promising walnut genotypes were presented in *Figure 1*. The total energy (Toe) values of walnut genotypes and cultivars are quite high. Total energy (Toe) values of walnut genotypes and cultivars in previous studies were found in the range of 682.0–728.0 kcal (Yerlikaya et al., 2012), 698.10-732.44 kcal (Ali et al., 2010) and 686.2 to 710 kcal (Simsek, 2016). The energy levels of the walnut genotypes are in agreement with other studies. The energy levels are attributable to differences in the chemical compositions of various walnut types and cultivars and may vary with the year of harvest, environmental conditions, horticultural practices, and genetics.

Conclusion

In this study, some botanical, phenological, physical and chemical characteristics of the promising walnut genotypes grown from seed in Beyazsu region of Mardin province of Turkey were investigated. The results obtained in this study were consistent with the values reported by other researchers. Kernels of MBSU83 genotype were determined to contain high crude protein (Cp) content (>18%) while all the genotypes contain high carbohydrate (Toc) content (>10%). The data reported in this study confirm that walnuts

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are a rich source of a number of significant nutrients. The results of the present study are expected to contribute to breeding studies and may help improve economically sustainable walnut production for the farmers of Southeastern Turkey in future.

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