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Evaluation of some newly introduced pomegranate (*Punica granatum*) genotypes under mid-hills conditions of Himachal Pradesh

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ABSTRACT

Twenty pomegranate (*Punica granatum* L.) genotypes namely Parfyanets, Saharnyi, Loulou, Nusai, Cloud, Green Globe, Podarok, Crab, Al-sirin-nar, Purple Heart, Kaim-anar, 20090265, Gulyalek, Haku-botan, Alk Pust Ghermez Saveh, Eve, Dewey, Ovadan, Sogdiana and Orange were evaluated under mid hills conditions of Himachal Pradesh. Largest and heaviest fruits were observed in Green Globe (296.3 g), whereas lightest fruits were in 20090265 (144.56 g). Aril percentage varied from 47.95% to 70.94% while as maximum aril/rind ratio was recorded in 20090265 (2.55) and minimum in Purple Heart (1.12). TSS content was maximum (15.87°B) in Purple Heart and minimum (9.93°B) in Ovadan. Titratable acidity varied from 2.26% to 0.66%. Wide variability in terms of total sugar content were also observed which ranges from 7.55% (Ovadan) to 14.13% (Purple Heart). Genotype Ovadan (30.60 mg/100 ml) have highest anthocyanins content whereas Hakubotan (3.23 mg/100 ml) have lowest anthocyanin content. Maximum phenols from the juice was obtained in Al-sirin-nar (981.24 mg/100 g), whereas it is minimum in Alk Pust Ghermez Saveh (308.03 mg/100 ml). Dewey, Green Globe, Podarok and Loulou are most suitable for use as a cultivars directly being big size of fruit, medium to soft seeded and high yield potential or in used for future breeding programme for further improvement in local cultivars.

Key words: Evaluation, Fruit quality, Pomegranate, Variability

Pomegranate (*Punica granatum* L.) is a favourite table fruit of the tropical and subtropical regions of the world. Pomegranate is liked for its cool refreshing juice and valued for its medicinal properties. Epidemiological studies have suggested that consumption of red fruit juice, such as grape, berry and pomegranate juices, correlates with reduce risk of coronary heart disease, stroke, certain types of cancers and aging (Malik *et al.* 2006). Pomegranate can be grown throughout India but due to its better adaptability towards arid climate, the commercial cultivation is being done in Maharashtra, Karnataka and Rajasthan. Other states, where it is grown to lesser extent are Uttar Pradesh, Himachal Pradesh, Punjab, Haryana, Tamil Nadu and Andhra Pradesh. There is a vast scope to augment pomegranate production through its cultivation in non-conventional areas to meet the demand of not only fresh market but also to meet the need of agro-processing units. Pomegranate has found great potential for diversification and commercial cultivation in Himachal Pradesh in recent years despite of the fact that the varietal array favouring cooler climate is narrow. Although a few cultivars, viz. Kandhari, Bedana, Dholka and Spin Danedar were recommended for Himachal Pradesh (Anonymous 2000) but increase in area under commercial pomegranate cultivation is very low. The total area under pomegranate cultivation in Himachal Pradesh is 1 709 hectare with the production of 749 MT during 2011-12 (*http:// hphorticulture.nic.in/database.htm)*. Several pomegranate varieties have appeared on world pomegranate map which needs to be tasted under mid-hills condition for the purpose of varietal diversification by bringing into cultivation new genetically improved cultivars in the changed climatic scenario.

Several types of pomegranate distinguished by shape of the fruit, colour and thickness of the skin and taste and colour of seed are grown throughout the world. However, few studies were made to classify or identify types with desirable botanical and agronomical characteristics and their suitability under different ecosystems (Bunkar and Prasad 1992). Characterization of the available germplasm is a prerequisite for their commercial utilization as well as future breeding programmes. Keeping in view the aforesaid facts, there is need to characterize and evaluate the promising type of genotypes specific to mid-hills zones of Himachal Pradesh.

MATERIALS AND METHODS

The present investigations were carried out in the Department of Fruit Science, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (HP) during 2013. The experimental area is located at an altitude of 1 220 m

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above mean sea level between 31°N latitude and 77°E longitude and charecterized as mild temperate zone. The germplasm accessions under study were introduced from USDA-ARS, National Clonal Germplasm Repository, UC, Davis (USA). Five years old pomegranate accessions namely Parfyanets, Saharnyi, Loulou, Nusai, Cloud, Green Globe, Podarok, Crab, Al-sirin-nar, Purple Heart, Kaim-anar, 20090265, Gulyalek, Haku-botan, Alk Pust Ghermez Saveh, Eve, Dewey, Ovadan, Sogdiana and Orange planted in randomized block design replicated thrice 15 representative fruits were taken in three replicates each at optimum maturity. The fruit and aril characters were described as following the descriptor (*www.plantauthority.gov.in/pdf/DPomegranate.pdf*). The surface colour and blush colour of the fruit was observed by comparing it with the colour chart of the Royal Horticultural Society, London. The rind was separated from fruit and its thickness was measured at four to five different places with Vernier Callipers. The average rind thickness was calculated for each accession. Aril percentage in each accession was determined as: Aril recovery per unit of fruit weight × 100. Length and breadth of arils in each accession was taken with help of digital Vernier callipers. The weight of arils of 15 representative fruits under three replications of each genotypes were recorded and the average arils weight per fruit was calculated. The weight of 100 arils taken from fruits under three replications of each accession was recorded and the average 100 arils weight per fruit was calculated. Aril/rind ratio was determined by taking 15 representative fruits (three fruits per replication) of each accession and was determined by dividing aril weight by rind weight of individual fruit and then average for each accession was determined. Aril colour was observed in each accession by comparing it with colour charts of the Royal Horticulture Society, London. The presence/absence of shoulders was observed visually. The presence of shoulders was categorized as a) slightly shouldered b) shouldered and c) markedly shouldered. Mellowness of seeds were assessed by chewing the arils and on this basis the fruits were characterized as soft seeded, medium soft seeded and hard seeded. The number of fruits cracked was periodically counted at the end of each month and per cent fruit cracking was calculated as under:

$$\text{Per cent fruit cracking} = \frac{\text{Total number of fruits cracked}}{\text{Total number of fruit set}} \times 100$$

Optimum time of maturity in each accession was determined by observing the changes in skin colour and by tapping the fruits. A metallic sound while tapping gives the indication of fruit maturity. Numbers of days were counted from the date of full bloom to the date of maturity. The average yield/plant was calculated in each accession in terms of kilograms per plant. Juice percentage in each accession was determined as juice recovery per unit aril weight × 100. The total soluble solids content of fruits was determined with digital pocket refractometer (Pal-Atago, Japan). Lane and Eynon's volumetric method (AOAC 1970) was used for the estimation of sugars. Total soluble solids were divided with per cent acidity to find out the TSS/acidity ratio. Total anthocyanins present in all the samples were determined by the method given by Ranganna (2009). The total phenols content in pomegranate juice were determined by Folin Ciocalteu procedure given by Singleton and Rossi (1965). Statistical analysis was done as per the procedures given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Physical characteristics

Data pertaining to physical characteristics of fruits of pomegranate accessions are presented in Table 1. Heaviest fruits (296.3 g) were found in Green Globe and minimum fruits were observed in genotypes 20090265 (144.56 g). Fruit length varied from 55.19 mm in Eve to 76.35 mm in Green Globe. Maximum fruit breadth (94.13 mm) was observed in Green Globe while as minimum fruit breadth (64.27 mm) was recorded in Gulyalek. Our results are in conformity with the findings of Mir *et al*. (2010) who have also observed wide genetic variability in the various pomegranate genotypes. Rind thickness was maximum in Hakubotan (3.56 mm) and minimum in Dewey (2.14 mm) in different pomegranate accessions under present study. Similar variation in rind thickness in different pomegranate accessions were reported by various workers (Varasteh *et al*. 2009, Zaouay *et al.* 2012, Gadze *et al*. 2012, Ismail *et al.* 2014)

In the present study, number of aril/fruit varied from 286.87 to 881. Maximum arils/fruit were recorded in Haku-botan and minimum in Alk Pust Ghermez Saveh (Table 1). Islam *et al*. (2009) reported seed number/fruit ranging from 103 to 597 in pomegranate fruits grown in eastern Black Sea Region while Wetzstein *et al.* (2011) have also recorded total number arils/fruit between 201 to 985 in different pomegranate cultivars. However, aril percentage for all the accessions ranged between 47.95% (Loulou) and 70.94% (Dewey) under present study. Akbarpour *et al.* (2009) also recorded wide variation in aril percentage in Iran.

Considerable variation in weight of arils/fruit was recorded that varied from 73.00 g to 186.27 g in different pomegranate accessions (Table 1). Maximum weight (186.27 g) of arils per fruit was recorded in Al-sirin-nar and minimum in Crab (73 g). Aril: rind ratio varied from 1.12 to 2.55. Maximum aril: rind ratio was recorded in genotype 20090265 and minimum in Purple Heart. Tehranifar *et al*. (2010) and Hamouda *et al.* (2014) also observed variation in different aril characters). Maximum aril length was recorded in Green Globe (17.97 mm) and minimum in Saharnyi (9.70 mm). Aril breadth also varied from 5.50 mm in Nusai to 12.59 mm in Green Globe. The present findings are in consonance with the findings of Riyahi *et al*. (2011) and Martinez *et al.* (2006) who also reported variation in aril length and aril breadth while working on different pomegranate genotypes. Weight of 100 arils in different pomegranate accessions under present study varied between 12.51g and 41.11 g. Maximum weights of 100 arils/fruit

Table 1 Physical characteristics of fruits and arils of some pomegranate germplasm accessions

Germplasm accessions	Weight/ fruit (g)	Fruit Length (mm)	Fruit breadth (mm)	Fruit shape	Rind thickness (mm)	Number of arils /fruit	Aril (%)	Weight of arils /fruit (g)	Aril: rind ratio	Aril size (mm)		100-aril weight (g)	Mell-owness of seeds	Fruit base (shoulders)	Aril colour	Fruit colour		
										Length	Breadth					Ground colour	Blush colour	Fruit cracking) (%)
20090265	144.56	59.35	68.36	Round	2.18	483.33	64.09 (53.17)	92.67	2.55	11.87	6.40	19.04	MS	Absent	Red Group 38 A	Red Group 52 A	Absent	Absent
Alk Pust Ghermez Saveh	187.52	59.96	70.07	Round	2.16	286.87	63.30 (52.53)	118.74	1.96	12.33	7.10	41.11	MS	Absent	Red Group 42 A	Red Group 52 B	Yellow Green Group 53 D	Absent
Al-sirin-nar	275.84	62.45	74.61	Round	2.15	740.21	67.2 (55.06)	186.27	2.39	11.18	6.07	25.14	MS	Absent	Red Group 38 B	Red Group 52 B	Absent	Absent
Cloud	181.65	64.64	71.82	Round	2.55	390.33	63.51 (52.84)	113.43	2.01	11.73	7.50	29.23	MS	Absent	Red Group 38A	Green Group 52B	Yellow Green Group 153D	5.3
Crab	150.12	61.76	69.53	Round	2.17	403.43	48.32 (45.04)	73.00	1.61	11.23	6.23	17.91	HS	Absent	Red Group 38A	Red Group 52B	Absent	42.30
Dewey	272.67	69.55	78.60	Round	2.14	500.33	47.95 (44.83)	130.67	1.81	9.77	6.50	25.5	MS	Absent	Red Group 41 B	Green Group 142 A	Red Group 49 A	Absent
Eve	217.97	55.19	64.90	Round	2.35	327.33	57.24 (49.16)	124.88	1.56	11.40	5.93	37.92	HS	Absent	Red Group 38 A	Red Group 52 B	Absent	Absent
Green Globe	296.3	76.35	94.13	Round	3.37	42633	54.88 (47.80)	162.21	1.38	17.97	12.59	38.02	HS	Absent	Red Group 41 C	Yellow Green Group 149 A	Absent	Absent
Gulyalek	153.59	56.00	64.27	Round	2.35	326.23	59.23 (50.31)	91.05	1.57	12.20	7.10	27.61	HS	Absent Group	Red Group 41 A	Red 52 C	Absent	Absent
Haku-botan	204.45	63.52	80.30	Round	3.56	881.00-	54.11 (47.03)	110.10	1.32	12.30	6.50	12.51	MS	Absent	Yellow Group 42 C	Yellow Green Group 150 B	Yellow Orange Group 17 B	Absent
Kaim-anar	201.52	68.49	79.72	Round	3.50	391	61.29 (51.52)	124.24	1.88	12.37	6.50	31.17	MS	Absent	Red Group 38 A	Red Group 52 B	Orange Red Group 31 A	Absent

(*Continued*)

Table 1 *(Concluded)*

Germplasm accessions	Weight/ fruit (g)	Fruit Length (mm)	Fruit breadth (mm)	Fruit shape	Rind thickness (mm)	Number of arils /fruit	Aril (%)	Weight of arils /fruit (g)	Aril: rind ratio	Aril size (mm)		100-aril weight (g)	Mell-owness of seeds	Fruit base (shoulders)	Aril colour	Fruit colour		
										Length	Breadth					Ground colour	Blush colour	Fruit cracking) (%)
Loulou	189.67	67.52	70.36	Round	2.15	360.1	70.94 (57.05)	133.23	2.42	11.73	7.63	36.94	MS	Absent	Red Group 41 B	Green Group 142A	Orange Red Group 31 A	Absent
Nusai	223.67	71.41	67.60	Round and squarish	2.83	427.4	57.81 (49.49)	128.54	1.65	10.70	5.50	29.97	MS	Present	Red Group 41 B	Yellow Green Group 151 C	Red Group 43 C	Absent
Orange	198	67.54	77.41	Round	2.84	600.00	54.82 (47.71)	108.67	1.31	11.43	6.70	17.50	MS	Absent	Red Group 41 B	Green Group 142 A	Absent	Absent
Ovadan	229.47	60.30	68.73	Round	2.39	388.00	56.08 (48.49)	128.77	1.41	11.37	6.07	32.98	MS	Slightly present	Red Group 38 A	Red Group 52B	Absent	Absent
Parfyanets	201.16	61.23	70.49	Round	2.39	374.4	57.81 (50.58)	116.04	1.54	11.53	6.20	30.71	MS	Absent	Red Group 38 A	Red Group 52B	Absent	Absent
Podarok	177.56	68.39	68.22	Round	2.48	346.80	55.60 (49.22)	99.37	1.46	12.00	7.17	28.61	SS	Absent	Red Group 38 A	Red Group 52B	Absent	Absent
Purple Heart	221.20	71.58	90.07	Round	2.30	427.33	51.88 (46.08)	115.64	1.12	11.56	6.67	26.93	HS	Absent	Red Group 41 A	Red Group 52 B	Absent	Absent
Saharnyi	157.22	65.51	73.28	Round	3.40	310.67	50.81 (45.44)	80.04	1.61	9.70	6.80	25.63	MS	Absent	Red Group 50 A	Green Group 142 A	Orange Red Group 31 A	Absent
Sogdiana	171.45	69.23	68.283	Round	2.57	296.67	52.53 (48.49)	90.77	1.13	11.27	6.13	30.3	MS	Absent	Red Group 38 A	Red Group 52 C	Absent	12.5
Mean	200.22	66.66	72.613	2.6	399.87	57.42	116.42	1.69	6.51	19.31								
CD (P=0.05)	1.12*	2.94*	0.597*	-	0.04*	4.17*	1.02*	0.47*	0.05*	0.26*	0.44*	0.04*	-	-	-	-	-	

Table 2 Biochemical characteristics of fruits of pomegranates germplasm accessions

Germplasm accessions	Juice (%)	TSS (°B)	Acidity (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	TSS:Acidity ratio	Total anthocyanins (mg/100 ml)	Total phenols (mg/100 ml)
20090265	56.47 (56.47)	13.73 (3.71)	1.75 (1.32)	8.75 (2.95)	7.34 (2.73)	1.36 (1.22)	7.95	23.00	707.20
Alk Pust Ghermez Saveh	49.43 (62.43)	11.93 (3.45)	0.68 (0.82)	09.6 (3.09)	8.21 (2.82)	1.25 (1.15)	17.87	7.21	308.03
Al-sirin-nar	36.72 (62.57)	13.43 (3.67)	1.47(1.21)	8.85 (2.96)	7.43 (2.76)	1.34 (1.21)	9.40	12.70	981.24
Cloud	34.37 (34.37)	14.97 (3.87)	0.67 (0.81)	12.73 (3.57)	10.42(3.25)	1.77 (1.39)	23.30	3.89	538.26
Crab	34.60 (34.60)	14.43 (3.80)	1.72 (1.31)	8.18 (2.86)	6.73 (2.62)	1.34 (1.20)	8.43	28.31	916.68
Dewey	60.27 (67.27)	14.23 (3.77)	0.88 (0.94)	11.54 (3.39)	9.91(3.17)	1.50 (1.27)	16.67	7.40	344.14
Eve	34.52 (55.44)	13.43 (3.67)	1.76 (1.33)	8.53 (2.92)	7.37 (2.72)	1.41 (1.23)	7.71	11.39	654.07
Green Globe	62.39 (72.39)	15.50 (3.94)	0.73 (0.86)	13.65(3.70)	11.89(3.47)	1.63 (1.31)	21.33	24.10	901.36
Gulyalek	46.46 (67.46)	13.93 (3.73)	2.26 (1.50)	8.02 (2.83)	6.75 (2.63)	1.25 (1.16)	6.27	10.67	646.57
Haku-botan	35.70 (51.60)	15.57 (3.95)	2.15(1.47)	7.93 (2.82)	6.84 (2.66)	1.04 (1.05)	7.25	3.23	651.57
Kaim-anar	37.58 (61.77)	13.37 (3.67)	1.56 (1.25)	9.14 (3.02)	6.76 (2.7)	2.23 (1.52)	8.66	6.71	522.40
Loulou	55.43 (64.10)	14.53 (3.81)	0.66 (0.81)	12.07 (3.47)	10.33 (3.26)	1.66 (1.34)	22.19	15.41	511.41
Nusai	56.60 (56.60)	12.93 (3.60)	1.54 (1.24)	9.26 (3.04)	7.28 (2.710)	1.90 (1.44)	8.40	11.51	918.03
Orange	40.50 (57.43)	11.63 (3.41)	1.43 (1.20)	9.80 (3.13)	7.43 (2.7)	2.29 (1.59)	8.17	27.48	658.20
Ovadan	40.37 (57.37)	9.93 (3.15)	1.76 (1.33)	7.55 (2.74)	6.45 (2.58)	2.05 (1.51)	5.66	30.60	312.45
Parfyanets	53.63 (56.63)	13.10 (3.62)	1.65 (1.28)	9.33 (3.06)	7.27 (2.70)	2.08 (1.47)	8.07	10.19	659.92
Podarok	70.41 (56.41)	14.93 (3.86)	0.68 (0.82)	12.44 (3.52)	10.81 (3.31)	1.5 (1.26)	22.27	15.40	526.93
Purple Heart	60.70 (65.70)	15.87 (3.98)	1.04 (1.01)	14.13 (3.75)	12.51 (3.56)	1.52 (1.28)	15.40	15.33	336.78
Saharnyi	45.37 (55.37)	13.37 (3.66)	2.10 (1.45)	8.62 (2.95)	6.27 (2.51)	2.34 (1.56)	6.37	29.76	649.77
Sogdiana	41.36 (56.50)	14.23 (3.77)	2.11 (1.45)	7.93 (2.82)	6.63 (2.60)	1.25 (1.17)	6.73	10.46	646.90
Mean	47.64	13.75	1.43	9.93	8.23	1.64	11.91	15.24	619.6
CD (P=0.05)	0.3*	0.02*	0.04*	0.01*	0.07*	0.04*	2.61*	0.06*	3.11*

was recorded in Alk Pust Ghermez Saveh and minimum in Haku-botan. However, Rao and Subramanyam (2009) reported 100 aril weights ranging between 16.0 g and 20.6 g in four varieties of pomegranate The soft seededness and deep red aril colour is a main consideration for selecting a variety in pomegranate. In the present study, Crab, Green Globe, Gulyalek, Purple Heart and Eve were observed to be hard seeded. Parfyanets, Al-sirin-nar, Saharnyi, Loulou, Nusai, Cloud, 20090265, Alk Pust Ghermez Saveh, Dewey, Ovadan, Sogdiana, Kaim-anar, Haku-botan and Orange were medium soft seeded and Podarok as soft seeded (Table 1). Similar variation in mellowness of arils has also been reported by Jalikop and Kumar (1998) and Martinez *et al.* (2012) in different cultivars.

An aril colour in all the pomegranate accessions under study belongs to Red Group except Haku-botan in which aril colour belongs to Yellow Group. Variations in aril colour have also been reported by Hepaksoy *et al.* (2009). Aril characters have been found to be influenced by genetic make-up of the variety and the prevailing agro-climatic conditions (Anonymous 1988). Fruit base was absent in most of the accessions except Nusai. However, the accession Ovadan was slightly shouldered with respect to fruit base.

Fruit colour was observed to be in Red Group (Parfyanets, Purple Heart, 20090265, Podarok, Crab, Alk Pust Ghermez Saveh, Eve, Ovadan, Al-sirin-nar, Kaim-anar, Gulyalek and Sogdiana) Yellow Green Group (Green Globe and Nusai) and Green Group (Saharnyi, Loulou, Dewey, Orange and Cloud). Several workers have worked on physical aspects of pomegranate fruits and reported considerable variation in fruit colours in different pomegranate cultivars. (Mir *et al*. 2007, Ak *et al.* 2009, Sarkhosh *et al*. 2009, Radunic *et al*. 2011, Wani *et al.* 2012, Patil *et al*. 2013). These fruit characters are detrimental in making any pomegranate variety acceptable to end user. Incidence of fruit cracking was found to be the highest in Crab (42.30%) and lowest in Nusai (5.3%). Fruit cracking in pomegranate is highly undesirable character, resulting huge economic loss to the farmers by enabling the fruits unfit for marketing. All the genotypes under study recorded no fruit cracking except Crab, Nusai and Sogdiana. Most of the introduced germplasms showed highly resistance to fruit cracking that may be used in future breeding programme and is good information to pomegranate breeders of India. Sepahvand *et al*. (2011) and Singh (2012) also reported considerable variation of cracking in pomegranate varieties.

Data recorded on various biochemical characteristics of pomegranate accessions are presented in (Table 2). Maximum juice content was 70.41% in Podarok and minimum was 34.37% in Cloud. Total soluble solids also varied from 9.93°B in Ovadan to 15.87°B in Purple Heart. Variations in juice content and TSS in pomegranate have also been reported by Mir *et al.* (2010), Radunic *et al.* (2011) and Zaouay and Mars (2011) in different genotypes. Higher TSS content in a genotype is considered as good character while exercising selection for table as well as processing purpose. Wide variability in fruit acidity was recorded that varied from 0.66% in Loulou to 2.26% in Gulyalek. The total sugars were found to vary from 7.55% to 14.13%. Purple Heart recorded the maximum total sugars and minimum in Ovadan. Total sugars content of different pomegranate cultivars have been found to vary from 9.77 to 13.15% under Rahuri conditions (Anonymous 1983). Meena *et al*. (2003) reported total sugars of pomegranate accessions ranging between 9.24% and 13.80%. Reducing sugars for different pomegranate accessions under present study ranged from 6.27% to 12.51%. Chundawat (1995) reported reducing sugar content of different pomegranate cultivars to be ranging from 7.8% to 13.7%. Wani *et al*. (2012) reported reducing sugars per cent in some promising selections of wild pomegranate in central Kashmir ranging from 6.00% to 10.12%. TSS/acid ratio serves as an index of sweetness in different pomegranate cultivars. Higher TSS/acid ratio indicates that the cultivars are sweet as compared to those having lower TSS/acidity ratio. The total soluble solids to acid ratio in different pomegranate accessions varied from 5.66 to 23.30 (Table 2). Total anthocyanins content ranged from 3.23 mg/100 ml to 30.60 mg/100 ml of juice. The highest values were recorded by Ovadan (30.60 mg/100 ml) and the lowest was recorded in Haku-botan (3.23 mg/100 ml). The present results are in agreement with those of Mir *et al.* (2007), Tehranifar *et al*. (2010) and Ismail *et al*. (2014), who reported similar variation for total anthocyanins in different sets of accessions under different agro-climatic conditions. The total phenols varied from 308.03 mg/100 ml to 981.24 mg/100 ml juice in different pomegranate accessions under study. Maximum total phenols were recorded in Al-sirin-nar and minimum in Alk Pust Ghermez Saveh (Table 2). Similar observations were also observed by several workers (Hepaksoy *et al.* 2009, Tehranifar *et al.* 2010, Zaouay and Mars 2011).

Finally, it can be concluded that the germplasm namely Dewey, Green Globe, Podarok and Loulou are most suitable for use as a cultivars directly being big size of fruit, medium to soft seeded and high yield potential or in used for future breeding programme for further improvement in local cultivars.

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