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Short communication

Genetic variability in acid lime accessions from central Gujarat

D. S. Mishra*, Sanjay Singh, A. K. Singh and Vikas Yadav

Central Horticultural Experiment Station, Vejalpur (Godhra), Panchmahals 389 340, Gujarat

ABSTRACT

Study of genetic variability in available germplasm is essential for the development of improved cultivars through planned breeding programmes. In view of this, 27 acid lime accessions collected from different locations of central Gujarat were evaluated for various leaf morphological and fruit physico-chemical characters. Results of study reveal that the acid lime accessions varied widely for their leaf blade length, width, shape, margin, petiole wing width and shape. Individual fruit weight ranged between 25.99-65.66 g; fruit length 3.30-5.73 cm; fruit width 3.13-5.17 cm; fruit length:width ratio 0.96-1.17; juice content 44.05-55.37 %; peel thickness 1.03-2.23 mm; peel percentage 13.57-26.36 %; number of seeds 5.33-12.33; seed weight fruit^{-1}0.34-1.21 g; seed length 6.07-9.61 mm and width 2.98-5.60 mm. Similarly, the chemical quality attributes also varied significantly among different accessions. The total soluble solids content varied between 7.73-10.59 °B; acidity 5.63-10.36 %; juice pH 1.22- 2.13; reducing sugars 0.79-3.67 %; non-reducing sugar 0.14-2.30 %; total sugars 1.20-5.69 %; total phenolic content in fruit juice 0.21-0.55 mg GAE ml^{-1}; antioxidant activity 22.46-64.91 % and ascorbic acid 34.30-124.03 mg 100 ml^{-1} juice. Wide range of variation in physico-chemical characters of acid lime accessions can be used for individual plant selection and future genetic improvement programme based on these parameters.

Key words: *Citrus aurantifolia,* genotypes, physico-chemical characters.

Acid lime *(Citrus aurantifolia Swingle)* is a third most important tropical and sub-tropical citrus fruit crop of India next to sweet orange and mandarins among all citrus species. It is native to north eastern India and areas having dry climate and low rainfall are best suited for growing limes (Ghosh *et al*. 4). This species is also well adapted to the dry and wet tropical conditions in the South and Central Pacific regions of Mexico. A well drained soil with a pH of 6.5 to 7.0 is ideal for better growth and yield of limes. Vitamin C rich acidic fruits of acid lime have various applications in food industry. It is used as fresh fruit or for the preparation of pickles and beverages (Dubey *et al*., 3). Acid lime is cultivated largely in Andhra Pradesh, Gujarat, Maharashtra, Madhya Pradesh, Tamil Nadu, Rajasthan, Bihar and to a limited extent in other states. Amongst lime producing states, Gujarat is the 2nd largest producer after Andhra Pradesh, and Mehsana, Kheda, Anand, Vadodara and Surendranagar are major lime growing districts of the Gujarat. At present, lime and lemons are grown on an area of 0.29 m ha with a total production of 2.84 mt and national average productivity is 9.90 t/ha. Gujarat alone produces 0.45 mt of lime/lemon from an area of 0.041 m ha with an average productivity of 10.90 t/ha (Anonymous, 1). Considerable variation among *Citrus* species have been observed which is due to pollination adaptation in the genus, frequent bud mutations, inter and intraspecific hybridization, apomixis, a long history of cultivation, seed propagation and human selection (Penjor *et al*., 12 and Zandkarimi *et al*., 15). A high percentage of fruit juice, acidity content, thin fruit peel and seedless features are the most suggested desirable commercial characteristics of lime (Zandkarimi *et al*., 15).

A rich genetic diversity of 'acid lime' exists in rain fed semi-arid areas of Gujarat (Singh and Singh, 13). To generate information on genetic variability is of great importance for crop improvement programme. Greater the variability in a population, greater the chance of effective selection for desirable types (Hazarika *et al*., 6). The acid lime prefers warm and dry climate with low rainfall for better growth and production. Therefore, climatic conditions of central Gujarat is considered to be ideally suitable for growing acid lime on commercial scale. Majority of collected accessions from this area are from seedling origin, therefore they showed wider variation in their morphological and fruit quality traits. However, the information on the extent of genetic variation among acid lime accessions for different morphological and physic-chemical characters from central Gujarat is not available, an attempt is essentially required. Acid lime exhibits great form of variability for plant type and fruit physico-chemical characters (Dubey *et al*., 3). Introduction and selection is one of the most widely used breeding methods in citrus which involves identification of promising types from the existing population. Therefore, it is essential to identify superior strains of lime for their collection, conservation, evaluation and utilization

*Corresponding authors's Email: dsmhort@gmail.com

in future breeding programme and expansion of area under commercial cultivation in this region. In absence of identification, conservation and utilization of indigenous citrus accessions, there is a chance of losing such variable accessions in future. In the view of these facts, an attempt has been made to elucidate the genetic variability of acid lime accessions with respect to various morphological and physico-chemical characteristics of the fruits.

The diversity rich areas of central Gujarat especially different areas of Panchmahals, district were surveyed extensively to identify elite acid lime accessions during the fruiting season of 2016- 2017. These areas are characterized by hot semi-arid climate. Matured fruits were collected from selected trees to study the physico-chemical characteristics. Mature leaves along with their twigs were collected from adult trees to study the morphological variation in the leaves of different accessions in terms of leaf blade length (L), width (W), L:W ratio, shape, margin, petiole wing width, shape and spine length. From each accession, twenty fruits were randomly selected from all the directions for recording the data and brought to the laboratory of Central Horticultural Experiment Station, Vejalpur, Panchmahal (Godhra), Gujarat. Morphological characterization of leaves, fruits and seeds was done using the descriptors developed for *Citrus* by International Plant Genetic Resources Institute (IPGRI), Rome, Italy (IPGRI, 7). TSS of fruits was measured with the help of hand refractrometer while titratable acidity, ascorbic acid and sugar contents were determined by AOAC (2) methods. The pH of fruit juice was measured by using pH meter. Antioxidant activity (AoA) of fruit juice was determined by the DPPH (2,2-diphenyl-1picryldrazyl) method given by Moon and Terao (10) using the following equation: AoA (%) = (1-A sample (517 nm)/A control (517 nm) × 100 while total phenolic content in the fruit juice was estimated according to the procedure of Folin-Ciocalteu reagent (Singleton *et al*., 14). The total phenol content was estimated from a standard curve of gallic acid and results were expressed as mg gallic acid equivalents (GAE) ml^{-1}. The quantitative data of leaves and fruits were statistically analyzed as per method of Gomez and Gomez (5).

Perusal of the data on the variability in leaf characters of acid lime accessions revealed a wide variability in leaf blade length, width, length:width ratio, shape, margin, apex and leaf petiole wing characters (Table 1). The maximum leaf blade length was recorded in GL-1 (9.13 cm) followed by GL-15 (9.03 cm) and GL-12 (8.77 cm) and it was minimum in GL-27 (5.50 cm). The width of leaf blade varied from 2.70 to 4.90 cm being maximum in GL-1 (4.89 cm) followed by GL-15 (4.89 cm), while it was recorded minimum in GL-27 (2.70 cm). However, Length:Width ratio was found maximum in GL-21 (2.31) followed by GL-23 (2.28) and GL-27 (2.07), whereas, it was observed minimum in GL-6 (1.64). Among the studied accessions, the leaf shape was observed ovate, obovate, elliptic and orbicular, whereas leaf margin was observed as crenate, sinuate, dentate and entire. Variation in leaf apices were also observed amongst different lime accessions (Table 1). Penjor *et al*. (12) also recorded variation in leaf morphological characters of acid lime accessions under Bhutan conditions. Variation in plant growth characters in any form in different collections is a genetic feature of individual genotype (Pandey *et al*., 11). Among leaf traits, petiole wing shape and size may be used for distinguishing the particular acid lime genotype. Data pertaining to petiole width and shape showed wide range of variability (Table 1). The petiole wing width from narrow to medium and broad while shape varied as linear in GL-4, GL-10, GL-17, GL-21and GL-24; obcordate in GL-7, GL-20, GL-26 and in rest of the accessions either obdeltate or obovate petiole wing shape was observed. Genotypic variations for leaf petiole wing characters have also been reported by Penjor *et al*. (12) in acid lime accessions of Bhutan. Morphological characterization of *Citrus* species by Malik *et al*. (9) indicated the presence of sizable variability within collected accessions for leaf characters. Presence of large spines on the branches hinders the intercultural operations and harvesting. The minimum spine length was recorded in GL-7 (2.33 mm), followed by GL-8 (2.66 mm) and the largest spine was obtained in GL-21 (9.33 mm), followed by GL-26 (8.33 mm). However, in most of the accessions comparatively short spine length was observed on the mature branches. The results are in agreement with the findings of Ghosh *et al*. (4).

Variability recorded for physico-chemical characters in 27 accessions of acid lime revealed significant differences in all the collected accessions (Table 2 & 3). The maximum fruit length was observed in GL-13 (5.73 cm), followed by GL-2 (5.44 cm), GL-27 (5.23 cm) and GL-12 (5.17 cm). However, GL-16 recorded the minimum fruit length (3.30 cm). Among the different accessions, GL-12 (5.17) recorded the maximum fruit diameter. It was followed by GL-13 (5.0 cm) and GL-2 (4.99 cm) and the minimum was recorded in GL-16 (3.13 cm). The variation in fruit size might be due to different genetic makeup of the accessions (Hazarika *et al*., 6). Fruit length:width ratio is the parameter that indicates fruit shape. Fruits with a high length:width ratio are longer than those with a lower value are spherical. Among the accessions, GL-5 had the highest fruit length:width

Table 1. Leaf characters of acid lime accessions.

Accessions	Leaf blade						Petiole wing		Spine length (mm)
	Length (cm)	Width (cm)	L/W	Shape	Margin	Apex	Width	Shape	
GL-1	9.13	4.90	1.87	Ovate	Crenate	Acute	Narrow	Obdeltate	4.00
GL-2	8.76	4.41	1.98	Obovate	Sinuate	Acute	Broad	Obovate	5.00
GL-3	7.60	3.80	2.00	Ovate	Dentate	Acute	Medium	Obdeltate	6.33
GL-4	6.83	3.53	1.93	Obovate	Crenate	Acuminate	Medium	Linear	5.66
GL-5	6.73	4.16	1.65	Elliptic	Crenate	Obtuse	Narrow	Obdeltate	5.00
GL-6	7.26	4.40	1.64	Obovate	Sinuate	Rounded	Medium	Obovate	4.00
GL-7	6.73	3.26	2.06	Obovate	Sinuate	Obtuse	Broad	Obcordate	2.33
GL-8	7.46	3.93	1.89	Obovate	Sinuate	Obtuse	Narrow	Obovate	2.66
GL-9	7.80	3.86	2.02	Elliptic	Sinuate	Obtuse	Medium	Obdeltate	4.33
GL-10	6.40	3.46	1.85	Elliptic	Crenate	Obtuse	Narrow	Linear	6.66
GL-11	7.86	4.40	1.79	Obovate	Sinuate	Obtuse	Medium	Obovate	6.33
GL-12	8.77	4.30	2.04	Elliptic	Crenate	Obtuse	Medium	Obdeltate	4.00
GL-13	7.26	3.36	2.16	Ovate	Crenate	Obtuse	Medium	Obovate	9.31
GL-14	7.70	3.83	2.00	Elliptic	Crenate	Obtuse	Narrow	Obovate	5.33
GL-15	9.03	4.89	1.84	Ovate	Crenate	Rounded	Narrow	Obdeltate	6.33
GL-16	6.93	3.97	1.75	Obovate	Dentate	Obtuse	Narrow	Obovate	4.00
GL-17	6.36	3.63	1.75	Obovate	Sinuate	Rounded	Narrow	Linear	5.00
GL-18	7.33	3.66	2.01	Ovate	Sinuate	Acuminate	Medium	Obovate	4.33
GL-19	6.76	3.83	1.77	Orbicular	Sinuate	Obtuse	Medium	Obdeltate	5.66
GL-20	5.63	2.90	1.98	Ovate	Dentate	Acuminate	Medium	Obcordate	5.33
GL-21	6.46	2.80	2.31	Elliptic	Dentate	Acute	Narrow	Linear	9.33
GL-22	7.87	4.20	1.87	Obovate	Sinuate	Obtuse	Medium	Obdeltate	5.00
GL-23	8.13	3.56	2.28	Ovate	Crenate	Obtuse	Narrow	Obovate	5.00
GL-24	6.77	3.30	2.05	Ovate	Crenate	Acute	Narrow	Linear	5.33
GL-25	7.33	4.03	1.81	Elliptic	Sinuate	Acuminate	Medium	Obdeltate	5.00
GL-26	6.06	3.25	1.86	Ovate	Entire	Acuminate	Narrow	Obcordate	8.33
GL-27	5.50	2.70	2.07	Elliptic	Crenate	Obtuse	Medium	Obovate	4.00
$CD_{0.05}$	0.76	0.57	0.22	-	-	-	-	-	2.06

value (1.17), exhibiting the stretched appearance. GL-14 had the lowest fruit length:width value (0.96) followed by GL-7 (0.99), therefore both had round fruit shape (Zandkarimi *et al*., 15). The accessions varied significantly with respect to fruit weight. The highest fruit weight was observed in GL-13 (65.66 g), which was non-significantly followed by GL-12 (62.67 g) and GL-2 (61.34 g). GL-23 recorded lowest fruit weight (25.99 g), followed by GL-16 (29.36 g) and GL-14 (31.80 g). The fruit weight in acid lime is directly linked with the fruit size, which is considered to be an important parameter for attracting good price in the market (Ghosh *et al*., 4). The variation in fruit size and weight among the different acid lime accessions have been reported by various workers in lime and lemon (Dubey *et al*., 3; Zandkarimi *et al*., 15 and Penjor *et al*., 12). The juice content in the fruit showed considerable variation among the accessions, which was measured the highest in GL-2 (55.66 %), followed by GL-14 (55.37 %), GL-16 (54.26 %) and GL-13 (54.20 %) while the least juice content was observed in GL-10 (42.20 %). Among the accessions, GL-11 (12.33) recorded the maximum number of segments $fruit^{-1}$ and the same was least in GL-13 (9.66). The variation in number of segments may be due to size of fruits. Findings of Zandkarimi

Table 2. Fruit physical quality characters of acid lime accessions.

Accessions	Length (cm)	Width (cm)	Length: width	Wt. (g)	Juice (%)	No. of segment fruit^{-1}	Peel thickness (mm)	Peel (%)	No. of seed fruit^{-1}	Seed wt. fruit^{-1} (g)	Seed length (mm)	Seed width (mm)
GL-1	4.73	4.40	1.07	42.10	51.70	10.66	2.00	17.73	11.00	1. 21	9.61	5.52
GL-2	5.44	4.99	1.08	61.34	55.66	12.00	1.56	18.55	7.66	0.81	7.28	4.60
GL-3	4.06	3.86	1.05	38.88	50.32	11.00	1.20	14.40	12.00	0.95	8.73	2.98
GL-4	3.82	3.81	1.02	35.43	49.53	10.33	1.60	16.49	11.00	0.63	6.42	4.36
GL-5	4.23	3.61	1.17	37.31	50.23	10.66	1.33	13.57	11.00	0.65	6.87	4.58
GL-6	4.08	3.76	1.09	40.83	48.40	11.33	1.30	20.89	12.00	0.99	7.86	4.97
GL-7	4.31	4.33	0.99	44.90	51.66	12.00	1.16	21.52	10.00	1.10	9.31	5.60
GL-8	4.01	4.00	1.00	44.07	54.66	10.33	1.07	17.03	7.66	0.62	6.77	3.54
GL-9	4.07	3.63	1.12	41.30	48.66	11.33	1.17	20.71	10.66	1.04	9.12	5.56
GL-10	3.54	3.36	1.05	20.40	42.20	10.66	1.63	26.36	7.66	0.53	6.58	4.60
GL-11	4.79	4.38	1.09	50.42	50.28	12.33	1.10	14.07	11.00	0.61	6.83	4.94
GL-12	5.17	5.17	1.00	62.67	51.25	11.66	1.16	13.85	8.00	0.77	7.32	5.05
GL-13	5.73	5.00	1.14	65.66	54.20	9.66	1.21	14.22	9.33	0.91	9.11	5.70
GL-14	3.92	4.07	0.96	31.89	55.37	12.00	1.40	19.72	9.33	0.34	6.37	4.33
GL-15	4.53	4.30	1.05	39.74	44.50	11.00	1.20	24.05	9.66	0.56	6.93	4.75
GL-16	3.30	3.13	1.05	29.36	54.26	9.66	1.03	17.82	9.66	0.69	7.46	4.58
GL-17	3.96	3.56	1.11	38.73	53.82	11.33	1.23	21.18	10.66	0.68	7.61	4.73
GL-18	4.61	4.22	1.09	46.61	51.51	10.33	1.50	21.33	8.33	0.79	8.55	5.05
GL-19	4.75	4.47	1.06	56.42	52.54	11.66	1.17	22.42	7.66	0.44	6.07	4.60
GL-20	4.23	4.14	1.02	41.00	44.05	12.33	1.05	20.02	12.33	0.86	9.40	4.89
GL-21	4.65	4.25	1.09	45.82	50.07	11.66	1.50	26.71	8.00	0.48	6.29	4.20
GL-22	4.08	4.00	1.01	38.30	49.89	10.66	1.05	20.61	8.67	0.43	6.41	3.82
GL-23	3.64	3.56	1.02	25.99	50.52	11.66	1.26	24.06	11.66	0.69	8.21	4.71
GL-24	4.59	4.27	1.07	46.29	49.10	10.00	2.07	26.52	9.33	0.41	6.76	4.57
GL-25	5.03	4.45	1.12	50.35	50.08	11.66	2.23	22.94	5.33	0.40	7.43	2.98
GL-26	4.35	4.01	1.08	36.76	49.28	11.00	1.60	21.97	9.33	0.56	7.81	3.39
GL-27	5.23	4.71	1.11	51.83	53.20	11.66	1.37	20.86	6.00	0.35	6.43	3.61
$CD_{0.05}$	0.18	0.14	0.10	10.75	5.79	0.66	0.20	1.95	3.42	0.11	0.74	0.49

et al. (15) is in agreement with the observations recorded in the present investigation. Among the different accessions, the minimum peel thickness was observed in GL-16 (1.03 mm) followed by GL-20 (1.05 mm), GL—8 (1.07 mm), GL-11 (1.11 mm) and GL-12 (1.16 mm). GL-25 (2.23 mm) recorded the thickest peel followed by GL-24 (2.07 mm) and GL-2 (2.0 mm). However, peel percentage varied from 13.57-26.52 % in GL-5 and GL-24 (26.52 %) respectively. In these accessions, GL-21 (12.33) had the highest average number of seeds fruit^{-1} while both GL-3 and GL-6 (12.0) ranked next. Seed weight fruit^{-1} was found maximum in GL-1 (1.21 g) and minimum in GL-27 (0.35 g). The seed length varied from 6.07 mm in GL-19 to 9.16 mm in GL-1, while seed width varied from 2.98 mm in GL-3 to 5.77 mm in GL-13 among lime accessions (Zandkarimi *et al*., 15). The seedless accessions included GL-25 (5.33) and GL-27 (6.0) while low seed content was recorded in GL-2, GL-8, GL-10, CHESL-19, GL-12 and GL-18. Fruits having low number of seeds is preferred by the consumers and processing industry. In citrus fruit a range of 1-6 seeds per fruit is determined as seedless while a range between 6-10 seeds per fruit is considered as low seed and fruits with higher than 10 seeds per fruit are marked as high seed (Khan, 8). There is earlier report of considerable variation in juice content, peel thickness, peel percentage

Table 3. Fruit chemical quality characters of acid lime accessions.

Accessions	TSS (°B)	Acidity (%)	pH	Ascorbic acid (mg 100 ml^{-1})	Reducing sugar (%)	Non reducing Sugar (%)	Total sugar (%)	Total phenolic content (mg GAE ml^{-1})	Antioxidant activity (%)
GL-1	9.03	8.53	2.02	43.75	2.87	1.65	4.52	0.46	31.02
GL-2	7.73	9.30	1.80	71.93	2.45	1.42	3.87	0.55	48.28
GL-3	9.40	8.80	2.10	37.17	3.02	1.70	4.72	0.41	40.18
GL-4	9.16	7.46	2.26	33.53	2.78	1.63	4.41	0.38	37.84
GL-5	10.59	10.36	2.20	42.29	2.83	1.81	4.64	0.42	37.32
GL-6	8.38	6.89	2.23	46.48	3.01	2.07	5.08	0.49	42.20
GL-7	8.16	7.78	2.13	50.70	2.88	1.70	4.58	0.39	44.13
GL-8	8.66	5.63	1.63	73.33	3.29	2.40	5.69	0.32	34.09
GL-9	10.49	10.01	2.26	46.99	2.30	1.09	3.39	0.38	39.33
GL-10	8.62	8.41	1.90	54.23	2.75	1.94	4.69	0.31	44.13
GL-11	8.63	8.50	2.13	73.88	2.62	2.02	4.64	0.40	64.91
GL-12	8.46	8.15	2.03	114.55	1.89	1.00	2.89	0.44	55.23
GL-13	9.33	7.21	1.22	124.03	1.61	0.47	2.08	0.33	60.81
GL-14	8.06	8.15	2.02	46.53	1.33	0.50	1.83	0.29	34.15
GL-15	9.21	8.47	2.10	53.07	0.95	0.48	1.43	0.31	33.08
GL-16	9.16	8.06	2.26	54.26	0.79	0.41	1.20	0.36	40.19
GL-17	10.00	6.25	1.84	73.53	1.29	0.14	1.43	0.43	47.39
GL-18	8.93	6.14	1.83	65.14	2.85	1.66	4.51	0.30	50.46
GL-19	8.20	7.75	2.00	77.56	3.02	1.77	4.79	0.46	53.18
GL-20	8.63	8.60	1.90	53.87	2.05	1.48	3.53	0.27	46.28
GL-21	8.73	8.56	1.98	73.33	2.67	1.60	4.27	0.25	41.94
GL-22	8.26	7.19	1.97	51.71	3.17	1.88	5.05	0.35	43.25
GL-23	8.53	7.30	1.85	101.87	3.23	2.09	5.32	0.37	32.47
GL-24	8.03	7.76	1.43	82.40	3.67	2.30	5.97	0.57	35.88
GL-25	8.56	9.08	2.13	34.30	2.67	1.65	4.32	0.24	37.36
GL-26	8.70	7.79	1.75	46.18	3.13	1.96	5.09	0.26	40.68
GL-27	9.09	6.24	2.50	43.01	3.20	2.38	5.58	0.21	22.46
$CD_{0.05}$	0.72	0.97	0.28	19.75	0.33	0.65	0.45	0.047	4.03

and seed size, number and weight of seeds per fruit in acid lime accessions (Zandkarimi *et al*., 15 and Ghosh *et al*., 4).

The data presented in Table 3 showed significant variation in chemical quality attributes of fruit juice. In the present study, the TSS content of the fruit juice varied from 7.43 to 10.59 °B. The highest TSS was recorded in GL-5 (10.59 °B), followed by GL-9 (10.49 °B) and GL-9 (10.0 °B) and lowest was recorded in GL-2 (7.73 °B). Acidity content is one of the important fruit quality characters used for determining the superiority of acid lime accessions. GL-5 (10.36 %) recorded the highest acidity content followed by GL-9 (10.01 %) and GL-2 (9.30 %). Among all the accessions, GL-8 (5.63 %) showed the lowest acidity content followed by GL-18 (6.14 %). The magnitude of the TSS/acidity ratio indicates a characteristic fruit juice flavor. GL-17 (1.60) had the highest TSS/acidity value and therefore was less sour in taste. Among various accessions, GL-2, GL-25, GL-14, GL-20, GL-11, GL-21, GL-9 and GL-12 with a TSS:acidity ratio of 0.85, 0.95, 0.99, 1.0, 1.01, 1.02, 1.03 and 1.04 had the most souring taste respectively. The highest juice pH was observed in GL-27 (2.50) followed by GL-16 (2.26) and the least in GL-13 (1.22). Ascorbic acid content is also considered as one of the factors for determining the superiority of lime accessions. The maximum ascorbic acid content was recorded in GL-

13 (124.03 mg/100 ml), followed by GL-12 (114.55 mg/100 ml), while lowest ascorbic acid was recorded in GL-4 (33.53 mg/100 ml). It has been reported that higher TSS content also contribute to enhance the ascorbic acid content in fruit juice as the precursor of ascorbic acid is glucose-6-phosphate (Hazarika *et al*., 6). The percentage of reducing (3.29 %), non-reducing (2.40 %) and total sugars (5.69 %) were highest in GL-8 and lowest reducing (0.79 %) and total sugars (1.20 %) were recorded in GL-16. The minimum non-reducing sugar was observed in GL-17 (0.14 %). High level of antioxidant activity in fruit juice was recorded in GL-11 (64.91 %) followed by GL-13 (60.81 %), while lower level of antioxidant activity was observed in GL-27 (22.47 %). High level antioxidant activity in fruit juices of acid lime accessions has been reported by Zandkarimi *et al*. (15). Total phenol content in pulp ranged from 20.32 to 51.70 mg Gallic acid per 100 g dw in GL-25 and GL-8 respectively. Variation in chemical quality attributes of fruit juice of acid lime may be due to differences in their genetic makeup and prevailing edapho-climatic conditions (Pandey *et al*., 11). Zandkarimi *et al*. (15) and Hazarika *et al*. (6) reported variation in chemical quality attributes in different citrus accessions. The higher and lower values for all the characters studied showed inheritance, which can be used for finding the suitable accessions as per requirement (Pandey *et al*., 11).

Based on the our observations, among all the accessions collected from different locations of central Gujarat, GL-2, GL-11, GL-12, GL-13 and GL-19 having higher fruit size, juice percentage, acidity and less number of seeds indicated the scope for individual plant selection and their use in future improvement programme..

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