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Genetic variability in wood apple (*Feronia limonia*) from Gujarat

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ABSTRACT

Considering the wide genetic diversity in wood apple (*Feronia limonia*) in terms of fruit shape, size, colour and qualitative characters, an extensive survey of diversity rich area of Gujarat was made and twenty five genotypes in the form of fruits were collected from the different locations during 2015-16 to identify elite genotypes having desirable horticultural traits. All the existing trees are of seedling origin which offer a great scope for selection of suitable genotypes of high yield potentiality with good fruit quality traits having precocity in bearing, less spine intensity and other desirable characters. Variations in morphological characters were noticed in the naturally grown trees at their locations, whereas chemical analysis was done in laboratory of the station. Fruits of genotype, viz. GW-1, GW-4, GW-12, GW-14, GW-16, GW-18, Gw-20 and GW-24 were observed to be round, whereas flattened round in GW-2, GW-5, GW-6, GW-8, GW-9, GW-10, GW-13, GW-17, GW-21and GW-23; triangular in GW-7 and GW-11, and oblong in GW-3, GW-15, GW-19, GW-22 and GW-25 fruit shape was observed. Physico-chemical analysis of fruits divulged that the fruit weight ranged between 156.45-432.93g, while fruit length and width between 5.25-9.46 cm and 5.10-9.29 cm, respectively. Shell thickness, shell weight, pulp weight, number of seeds per fruit and seed weight per fruit ranged between 0.31 to 0.47cm, 67.94-109.77g, 80.04 to 319.32g, 132.34 to 525.81 and 2.36 to 7.93g, respectively. Results of study revealed that the different genotypes exhibited wide range of variability in qualitative characters, viz. total soluble solids (11.07-19.36 ^{0}Brix), acidity (3.23-6.86%), ascorbic acid (7.08-19.60mg/ per100 g), potassium (1.29-1.86%), phosphorus (0.037- 0.078%), calcium (0.11- 0.39%), magnesium (3.18-5.92 %), sodium (3.07-7.54%) and pectin content (1.39-1.65%), among all the genotypes studied for their qualitative characters.

Key words: Genotype, Physico-chemical attributes, Variability, Wood apple

Wood Apple (*Feronia limonia*) belongs to the family Rutaceae. It is also called as monkey fruit, curd fruit and kathbel. The plant is native of India and Sri Lanka and grows throughout South India. The tree is subtropical and it prefers dry climatic conditions during flowering and fruit setting. It is one of the very hardy trees and found growing all over the semi-arid and arid regions of India. The different parts of plant (leaf, stem, bark, fruit, and seed) have been used for curing various diseases (Joshi *et al*. 2011 and Sharma *et al*. 2012). The fruits contain a myriad of phytochemicals such as polyphenols, phytosterols, saponins, tannins, coumarins, triterpenoids, vitamins, amino acids, tyramine derivatives, etc. (Dar *et al*. 2013). The fruit is used for curative properties, which make the tree one of the useful medicinal plants of India. The diverse pharmacological properties of the fruit include anti-diabetic (Gupta *et al.* 2009), anti-ulcerative (Mishra *et al.* 2009), hepatoprotective (Jain *et al.* 2011), wound healing (Ilango and Chitra 2010), anti-tumour (Saima *et al.* 2000), anti-microbial activity (Senthilkumar and Venkatesalu 2013). It has high medicinal value, astringent properties and has beneficial effect on cardiovascular system. The ripe fruit pulp makes excellent chutney and it is also consumed as fresh along with sugar. The tree exudes a gum from trunk and branches which resembles gum Arabic in properties. Information regarding the area of wood apple in India is not available, because it is seldom found in the form of an orchard, and generally large number of trees with great diversity is found in wild, roadside, in homestead garden, and it is still under unexploited condition because of lack of awareness regarding its significance with respect to their nutritional and therapeutical values. Keeping above points in view and perspective of climate change; an attempt was made to identify suitable genotypes and also to establish these elite genotypes for further evaluation and improvement.

MATERIALS AND METHODS

The present study was carried out at the laboratory of Central Horticultural Experiment Station (ICAR-CIAH), Vejalpur, Panchmahals (Godhra), Gujarat which is characterized by hot semi-arid climate. The diversity rich places of Central Gujarat, viz. Panchmahals, Anand, Dahod

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and Vadodara districts were explored and collected fruits of 25 wood apple germplasm during 2015-16. Twenty fruits of wood apple were randomly selected from all the direction of marked genotypes, and the bulk of sample of all the selected trees from each site collected then kept into bags and tagged by the number and subjected to physico-chemical analysis in laboratory. The observation on three replicates of samples, each consisting of 20 fruits, the physical and morphological characters in terms of fruit shape, colour and seed shape and qualitative characters in terms of TSS, acidity, total phenolic content, pectin and fruits mineral content, viz. P, K and Ca were observed. Fruit length, diameter and breadth were measured using vernier callipers. The fruit weight was taken on electric weighing balance. Total soluble solids were determined by using a hand held refractometer and pH was measured by using pH meter. Acidity was determined by titratating the fruit juice against 0.1 N NaOH and expressed as per cent citric acid.The extent of variation in physico-chemical traits of fruits were analyzed and computed. Biochemical compositions like phenols, tannins, vitamin C, acidity and total sugar were determined by the methods outlined in AOAC (1980). The data were statistically analyzed as per method outlined by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Result on the physical and chemical characteristics of different genotypes of wood apple showed wide range of variability. The fruit shape was observed oblong, round flattened, round and triangular, whereas fruit colour as off white, creamy, light brown and dark brown were recorded among the different genotypes.

Physical attributes

The data presented in Table 1 showed that the fruit length and width ranged between 5.25-9.46 and 5.10-9.29 cm, respectively. The maximum fruit length was observed in the genotype GW-15 (9.46 cm) followed by GW-18 (9.30cm) and GW-16 (9.00 cm), whereas it was found minimum in GW-11 (5.25 cm) followed by GW-9 (5.70cm) and GW-1(5.78cm). The fruit width was recorded the maximum in the genotype GW-18 (9.29cm), followed by GW-16 (9.25 cm), GW-15 (9.17cm) and GW-17 (9.00cm), whereas the value of the same was minimum in GW-11 (5.10 cm) followed by GW-1 (5.65 cm) and GW-9 (5.72 cm) among the evaluated germplasm. The fruit girth was recorded maximum in GW-18 (29.77cm) followed by GW-15 (28.03 cm) GW-16(27.38cm) and GW-10 (27.25cm), and the same was minimum (20.14 cm) in GW-11 followed by GW-9 (20.43cm)

Table 1 Genetic variability in wood apple genotypes

Genotypes	Fruit shape	Fruit length (cm)	Fruit width (cm)	Fruit girth (cm)	Fruit weight (gm)	No. of seeds	Pulp weight (gm)	Seed weight (gm)	Shell weight (gm)	Shell thickness (cm)
GW-1	Round	5.78	5.65	21.43	188.43	330.70	098.62	6.46	078.40	0.39
GW-2	Flattened round	6.08	6.59	22.55	224.72	287.15	129.7 9	5.09	086.43	0.37
GW-3	Oblong	7.86	7.71	24.03	250.67	314.33	145.82	5.23	090.65	0.38
GW-4	Round	6.23	6.39	25.52	270.75	296.37	151.67	4.53	094.92	0.44
GW-5	Flattened round	6.41	6.47	22.85	283.38	275.48	185.87	3.90	084.80	0.31
GW-6	Flattened round	7.65	7.78	26.47	320.53	232.53	214.45	5.71	095.30	0.46
GW-7	Triangular	6.35	5.85	23.48	210.57	211.12	110.10	4.38	094.25	0.44
GW-8	Flattened round	6.40	6.92	24.79	216.84	219.35	118.72	5.43	090.82	0.41
GW-9	Flattened round	5.70	5.72	20.43	180.10	198.27	085.74	4.36	095.44	0.42
GW-10	Flattened round	7.74	7.78	27.25	314.83	223.48	213.63	5.20	094.81	0.47
GW-11	Triangular	5.25	5.10	20.14	156.45	145.12	80.04	2.79	072.83	0.38
GW-12	Round	6.41	6.50	25.17	248.50	132.34	176.75	2.36	070.52	0.32
GW-13	Flattened round	6.82	7.51	26.51	298.78	165.55	221.88	3.01	067.94	0.38
GW-14	Round	7.81	7.88	25.45	294.97	186.37	200.02	3.90	076.91	0.37
GW-15	Oblong	9.46	9.17	28.03	418.35	159.93	319.32	2.98	093.07	0.36
GW-16	Round	9.00	9.25	27.38	400.03	378.77	295.87	6.29	096.83	0.42
GW-17	Flattened round	8.22	9.00	26.74	384.50	423.15	270.55	6.87	100.05	0.43
GW-18	Round	9.30	9.29	29.77	432.93	417.33	317.74	6.27	105.02	0.39
GW-19	Oblong	7.05	7.46	25.18	264.33	489.05	146.38	7.92	107.05	0.44
GW-20	Round	7.57	8.55	25.97	266.61	292.82	159.62	5.06	097.80	0.39
GW-21	Flattened round	5.65	6.05	22.82	162.00	268.34	064.43	3.65	098.87	0.35
GW-22	oblong	7.01	7.77	24.65	222.75	485.67	125.45	5.87	089.90	0.38
GW-23	Flattened round	7.15	7.68	25.30	248.43	179.40	146.97	2.43	098.05	0.43
GW-24	Round	7.37	7.67	25.25	240.82	298.35	150.22	3.81	085.90	0.46
GW-25	Oblong	6.96	6.81	22.93	220.25	525.81	102.45	7.93	109.77	0.38
CD (P=0.05)		0.84	0.86	2.83	30.70	41.20	19.20	0.59	09.45	0.04

Table 2 Genetic diversity in different chemical attributes of wood apple genotypes

Genotype	TSS (°Brix)	Acidity (%)	Vitamin c mg/100g of pulp	P (%)	K (%)	Ca (%)	Mg (%)	Na (%)	Pectin(%)
GW-1	17.21	3.57	19.60	0.078	1.74	0.39	5.92	5.39	1.64
GW-2	16.92	4.90	14.90	0.044	1.39	0.34	3.98	4.53	*1.57*
GW-3	18.01	3.65	13.01	0.073	1.46	0.22	4.56	6.00	*1.45*
GW-4	17.53	5.98	11.92	0.078	1.78	0.17	3.89	4.82	1.39
GW-5	18.92	6.86	09.50	0.065	1.55	0.22	4.27	5.32	1.63
GW-6	15.65	4.27	07.08	0.072	1.36	0.17	3.19	3.89	1.57
GW-7	17.53	3.78	08.91	0.078	1.62	0.24	4.65	3.78	1.49
GW-8	14.32	4.98	13.70	0.038	1.76	0.37	3.79	3.16	1.43
GW-9	18.52	3.76	07.48	0.046	1.64	0.11	4.21	3.07	1.54
GW-10	19.05	4.18	13.20	0.058	1.76	0.28	3.76	4.86	1.51
GW-11	15.13	3.52	11.60	0.039	1.41	0.24	3.87	5.31	1.63
GW-12	19.36	3.23	15.07	0.037	1.29	0.17	4.25	4.53	1.58
GW-13	17.53	4.51	07.96	0.051	1.78	0.14	5.64	4.35	1.42
GW-14	14.67	5.12	13.94	0.062	1.34	0.34	4.12	3.78	1.56
GW-15	17.17	3.42	17.68	0.056	1.75	0.25	3.42	5.67	1.58
GW-16	13.83	4.11	12.57	0.043	1.76	0.28	3.18	3.74	1.47
GW-17	11.07	3.53	13.89	0.064	1.41	0.27	4.32	5.37	1.53
GW-18	16.83	4.27	14.78	0.074	1.59	0.29	4.85	6.83	1.46
GW-19	18.66	5.34	18.79	0.046	1.63	0.28	3.76	7.54	1.56
GW-20	17.62	3.78	17.67	0.057	1.85	0.26	3.74	3.42	1.57
GW-21	16.44	4.21	13.23	0.068	1.68	0.16	4.27	5.03	1.42
GW-22	17.93	3.46	16.43	0.078	1.73	0.18	3.53	4.85	1.65
GW-23	13.83	5.32	12.56.	0.039	1.55	0.19	3.65	3.27	1.48
GW-24	14.94	4.59	11.23	0.045	1.65	0.34	4.52	4.23	1.56
GW-25	18.94	3.82	11.46	0.053	1.86	0.28	3.81	4.78	1.46
CD (P=0.05)	01.65	0.42	01.38	0.007	0.17	0.02	0.39	0.59	0.14

and GW-1 (21.43cm). The highest fruit weight was measured in the genotype GW-18 (432.93g gm) followed by GW-15 (418.35g), GW-16 (400.03g) and GW-17 (384.50g), while the lowest fruit weight in the genotype GW-11 (156.45g) followed by GW-21 (162.00 g), GW-1(188.40g) and GW-7 (210.57g).The number of seeds/fruit was calculated between the 132.34- 525.83 being the highest in the genotype GW-25 (525.81) followed by GW-19 (489.05) and GW-22 (485.67) and same was found to be the least in the genotype GW-12 (132.34) succeeded by the genotype GW-11 (145.12) and GW-23 (179.40). The pulp content in fruits of different genotypes ranged between 80.04-319.32 g among all the studied genotypes. The genotype GW-15 contained highest pulp quantity (319.32g) than the rest of the genotypes which was followed by the genotypes GW-18 (317.74g) and GW-16 (295.87g), and the least quantity of fruit pulp was measured in the genotype GW-11 (80.04g) followed by GW-9 (85.74g) and GW-1 (98.62g). The total seed weight per fruit was recorded the maximum in the genotype GW- 25 (7.93g) followed by GW-19 (7.92g) and GW-17 (6.87g) whereas GW-12 had the minimum value (2.36g) followed by GW-23 (2.43g) and GW-11 (2.79 g). The maximum shell weight was measured in the genotype GW-25(109.77g) followed by GW-19 (107.05g), GW-18 (105.02g) and GW-17 (100.05g), while same was minimum in genotype GW-13 (67.94g) followed GW-12 (70.52) and GW-11 (72.83 g).The shell thickness was measured between 0.31-0.47cm being the maximum in the genotype GW-10 (0.47cm) followed by GW-24 and GW-6 (0.46cm) and GW-7 and GW-19 (0.44 cm), whereas the lowest shell thickness was observed in the genotype GW-5 (0.31 cm), GW-21 (0.35cm) and GW-15 (0.36).More or less similar results have been reported by Singh and Singh (2012 and 2005a) in jamun, Singh and Singh (2005b) in mahua, Singh *et al.* (2015) in aonla, Singh and Singh (2005c) in tamarind, Singh *et al.* (2014) in *Morinda* and Singh *et al.*(2014) in bael under semi-arid conditions of Gujarat.

Chemical attributes

There were significant differences in the chemical attributes in all the genotypes. The total soluble solids were recorded the maximum in the GW-12 (19.36^0 brix) followed by GW-25 (18.94^0 brix) and GW-5 (18.92^0 brix), whereas same was minimum in the genotype GW-17 (11.07^0brix) followed by GW-16 and GW-23 having same value (13.83^0 brix) followed by GW-8 (14.32^0 brix) and GW-14 (14.67^0 brix).The highest acidity was determined in the genotype GW-5 (6.86%) followed by GW-4 (5.98%), GW-19 (5.34%) and GW-23 (5.32%), and it was estimated to be the lowest in the genotype GW-12 (3.23%) followed by GW-15 (3.42%) and

GW-22 (3.46%). The maximum vitamin C content per 100 g of pulp was estimated in genotype GW-1 (19.60mg) followed by GW-19 (18.79 mg), GW-15 (17.68 mg) and GW-20 (17.67 mg) while minimum vitamin C was measured in genotype GW-6 (7.08 mg) followed by GW-9 (7.48 mg) and GW-13 (7.96 mg). The phosphorus content in fruit pulp ranged between 0.037-0.078% having the maximum in GW-7 (0.078%), GW-1, GW-4 and GW-22 followed by GW-18 (0.074%) and GW-3 (0.073%), whereas it was minimum in GW-12 (0.037%) followed by GW-8 (0.038%) and GW-23 (0.039%). The value of K content ranged between 1.29 -1.86% being the highest in genotype GW-25 (1.86%) followed by GW-20 (1.85%), GW-4 and GW-13 (1.78), and the lowest value of it was observed in GW-12 (1.29%) followed by GW-14 (1.34%) and GW-6 (1.36%).The calcium content was measured the maximum in GW-1 (0.39 %) followed by GW-8 (0.37%),GW-24 (0.34%) and GW-18 (0.29%) while the minimum in the genotype GW-9 (0.11%) succeeded by GW-13 (0.14%) and GW-21 (0.16%).The magnesium content was observed the highest in the genotype GW-1(5.92%) followed by GW-13 (5.64%) and GW-7 (4.65) and the lowest was exhibited in GW-16 (3.16%) followed by GW-6 (3.19%), GW-23 (3.27%), GW-15 (3.42%), GW-22 (3.53%) and GW-23 (3.65%).The sodium content was observed the maximum in the genotype GW-19 (7.54%) followed by GW-18 (6.83%) and GW-3 (6.0%) and same was minimum in the genotype GW-9 (3.07%) followed by GW-8 (3.16%), GW-23 (3.27%) and GW-20 (3.42%).The pectin content was measured to be maximum in the genotype GW- 24 (1.65%) followed by GW-1 (1.64%), GW-5 (1.63%) and GW-12 (1.58%) which was minimum in the genotype GW-4 (1.39%) followed by GW-21 and GW 13 having similar value (1.42%), GW-8 (1.43%) and GW-3 (1.45%). Variation in physical and chemical fruit characters of wood apple may be due to differences in their genetic makeup and prevailing agro-climatic conditions, i.e. nutrient, soil, light, water and altitude under which the plants are growing. Similar kind of variability in physical characteristics has been reported in bael (Singh *et al*. 2012), jamun (Singh and Singh 2005a and 2012), *Morinda* (Singh *et al.* 2013), mahua (Singh and Singh 2005b, Singh *et al* 2005.), aonla (Singh *et al*. 2015) and tamarind (Singh and Singh 2005c).

Keeping in view the various observations, it may inferred from the study that the various genotypes, i.e. GW-6, GW-10, GW-13, GW-16, GW-15, GW-16, GW-17, GW-18 and GW-23 of wood apple varied widely for their morphological and qualitative traits which invites ample scope of evaluation for further improvement in the form of varieties for various desirable traits for its better prospects in changing climatic scenario and human well being. These genotypes have been established in field gene bank of wood apple through *in-situ* patch budding/soft wood grafting at the station for further evaluation and improvement.

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