Variability in Aonla (*Emblica officinalis* Gaertn.) Accessions Collected from Panna Forests of Madhya Pradesh

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ABSTRACT

Explorations were conducted in north and south Panna forest areas and adjoining villages of Madhya Pradesh to identify superior aonla genotypes with good fruit quality during the years 2004-2005 and 2005-2006. A total number of thirty five genotypes of aonla having economically important horticultural traits were identified. Observations on the physico-chemical parameters of fruits were recorded. These genotypes showed considerable variability with respect to morphological and physico-chemical characters. Analysis of fruits revealed fruit weight from 10.27-48.90g; fruit length from 2.53 to 3.83 cm; fruit diameter from 2.57 to 4.63 cm; TSS from 8.67to 17.0°Brix; acidity from 1.38 to3.33%; vitamin C content from 292.72 to 750.12 mg/100g pulp; tannin contents from 2.59 to 6.76%; reducing sugars from 2.29 to 4.62%; total sugars from 4.06 to 6.94%; TSS : acid ratio 3.22 to 7.35 and sugar : acid ratio from 1.51 to 4.17. As regards mineral contents of fruits, nitrogen content from 0.56 to 2.24%; phosphorous from 0.12 to 1.72%; potassium from 0.39 to 1.09%; calcium from 0.067 to 0.280%; magnesium from 552.10 to 1153.00 ppm; copper from 1.31 to 4.66 ppm; manganese from 4.91 to 35.14 ppm; sodium from 19.13 to 1291.00 ppm; zinc from 2.80 to 26.40 ppm and iron from 11.14 to 97.00 ppm were recorded in different germplasm accessions collected. On the basis of overall assessment, it was concluded that natural aonla trees in Panna forests have good amount of variability with respect to physico-chemical traits. Seven aonla genotypes, viz. T_5, T_7, T_{11}, T_{15}, T_{24}, T_{33} and T_{34} were found most promising and these might be used either as superior trees for clonal multiplication or as superior gene source in further breeding programmes.

Key words: *Aonla, variability, germplasm*

Aonla or Indian gooseberry (*Emblica officinalis* Gaertn.) has been known and grown in India for last more than 3500 years. Due to its hardy nature, ability to survive in various kinds of wasteland (arid, semi-arid, salt affected, coastal lands, ravines), high productivity per unit area (15-20 ton/ha.), nutritive and therapeutic values and its suitability for preparing various products such as value added food items, cosmetic products and ayurvedic medicinal preparations), aonla has now become an important fruit during current century (Pathak and Pathak, 2001). The Panna forest area and adjoining villages have rich natural diversity of aonla. The aonla genotypes available in this region have relatively high contents of vitamin C and total phenols. Sometimes, traces of anthocyanin, cause of red colour in aonla fruits, are also present which makes the fruits attractive. Hence, the explorations were conducted in these unexplored areas to identify superior aonla trees with high vitamin C and phenols content besides other desirable attributes.

An extensive survey was conducted during the year 2004-06 by a team of scientists from Central Institute for Subtropical Horticulture, Lucknow in coordination with Forest Department of Madhya Pradesh in the areas of north and south Panna and adjoining village areas to identify promising aonla trees for selection. Efforts were made to select only regular and prolific bearing aonla trees with good fruit size, dwarf stature, excellent fruit quality especially high vitamin C and phenols (tannin) and tolerance to biotic (pest and disease) and abiotic (frost and drought) stresses. A total of thirty five genotypes having desirable fruit characters with good bearing performance were marked *in-situ*. The method of random sampling from a population and biased sampling after gathering information about a particular genotype was followed (Sinha, 1981). Fifteen to twenty fruits were randomly collected from all the directions in each genotype to record the physical attributes like fruit weight, fruit length and fruit diameter using standard procedures. Total soluble solids (TSS) were estimated in terms of degree Brix with the help of hand refractometer (0-32 °B). Titrable acidity was estimated by titrating 10 ml juice against 0.1 N NaOH using phenolphthalein as indicator (AOAC, 1960). Reducing sugars and total sugars were estimated by volumetric method as suggested by Lane and Eynon (1923). Vitamin C content of fruits was determined using standardized 2, 6, dichlorophenol indophenol dye and expressed as mg per 100 g pulp. The tannin content of fruit was determined by the method suggested by Rangana (1984). The macro and micro nutrients of the fruit

were calculated as per procedures laid down by Tandon (1993). The data were analyzed statistically as per method given by Gomez and Gomez (1984).

The data pertaining to physical attributes of aonla fruits showed significant differences and high degree of variability in all the studied characters (Table 1). The fruit weight varied from 10.27 g in T_{21} to 48.90 g in T_{15} genotype. Higher fruit weight is a preferred character in aonla for processing particularly for preparation of *murrabba* and candy. The genotypes viz., T_4, T_7, T_8, T_{10}, T_{13}, T_{14}, T_{15}, T_{16}, T_{18}, T_{32}, T_{33}, T_{34}, T_{35} had higher fruit weights, i.e. > 30 g. The fruit length ranged from 2.53 to 3.83 cm, while fruit diameter varied from 2.57 to 4.63 cm among the different accessions collected. Maximum fruit length and diameter of 3.83 cm and 4.63 cm was recorded in T_{15} accession. The higher diameter of fruits suggests that the fruit is of round shape, while higher length of fruit suggests that fruit is of roundish oblong shape. Higher fruit weight is an important criterion for selection of new aonla genotypes. Krishna had the highest fruit weight i.e. 40.5 g/fruit among the existing aonla cultivars while the collected accessions, viz. T_8, T_{14}, T_{15}, T_{33}, and T_{34} had higher fruit weight than Krishna. Variation in aonla genotypes with regard to above characters were earlier reported from Faizabad, U.P. (Pathak *et al.,* 1989), Tamil Nadu (Chehiyan and Shanmugasundaram, 2003), Rajasthan (Lal *et al.*, 2004), Meghalaya (Chandra *et al.,* 1998) and Vindhyan hills and parts of central U.P. (Shukla *et al.*, 2006).

The chemical parameters viz., TSS, acidity, vitamin C, tannin and sugars showed wide variation among the genotypes studied (Table 1). TSS content varied from 8.67 °B in T_{25} to 17.00 °B in T_{21}. The genotypes T_6, T_{17}, T_{22} had higher TSS content (> 14 °B). The titrable acidity was found to be minimum 1.38% in T_{15} and maximum 3.33% in T_{21}. Similar variations in above parameters were also recorded in aonla germplasm collected from Vindhyan hills and parts of eastern U.P. (Shukla *et al.,* 2006). The TSS : acid ratio ranged from 3.22 7.35 in selected genotypes. The maximum ratio was noted in T_8 and minimum in T_{18} genotypes. Reducing sugars were maximum (4.62%) in T_{21} followed by T_{31}, T_{22} minimum (2.29%) in genotype T_1. The total sugars were recorded highest in T_9 (6.71%), while they were the lowest in T_{18} (4.06%). The sugar : acid ratio also showed great variability in studied genotypes and ranged from 1.51 in T_{17} to 4.17 in T_{34}.

The tannin content in aonla fruit ranged from 2.59% in T_{18} to T_{21} (6.76%). The genotypes viz., T_3, T_8, T_9 were having higher tannin content (> 5.0%). The higher tannin content is a desired character as it reduces the degradation of vitamin C during storage and processing. The antioxidant property of aonla is chiefly due to vitamin C and tannin (total phenols) content. Kumar and Singh (2002) evaluated ten aonla cultivars under Faizabad conditions and recorded 2.3 to 3.4% total tannin contents. The vitamin C content was recorded highest (750.12 mg/100 g) in T_{11} and lowest (292.72 mg/100 g) in T_{25}. The genotypes T_5 (702.10 mg/100 g), T_6 (653.45 mg/100 g), T_{13} (688.67 mg/100 g), T_{21} (634.95 mg/100 g), T_4 (634.56 mg/100 g) had higher content of vitamin C i.e., (> 600 mg/100 g pulp). The higher content of vitamin C is a preferred character and aonla is mainly consumed for intake of vitamin C.

The data with regard to macro and micro nutrient contents in aonla pulp on dry weight basis are presented (Table 2). The data showed that the N content varied from 0.56% in T_{15} to 2.24% in T_{31}, P content from 0.12% (T_2) to 1.72 (T_{15}) and K content from 0.39% (T_{20}) to 1.09% (T_1) among the different accessions evaluated. The genotypes viz., T_2, T_{22}, T_{23}, T_{26} and T_{34} were having higher nitrogen content whereas genotype T_5, T_6, T_{11}, T_{14}, T_{16}, T_{30} P content and genotypes T_1, T_5, T_6, T_9 and T_{19} K contents in their pulp. The calcium content ranged from 671.15 to 2750.00 ppm; Mg 552.0 to 1153 ppm; Cu 1.31 to 4.66 ppm; Mn 4.91 to 35.14 ppm; Na 19.13 to 1291.80 ppm; Zn 0.32 to 26.40 ppm and Fe 1.89 to 97.30 ppm among the different genotypes evaluated. From the data, it is evident that aonla is a rich source of macro and micro nutrients and this is one of the reason of having higher medicinal and therapeutic value.

In the end, it can be stated that the natural wealth of aonla available in Panna forests of Madhya Pradesh has great diversity in physico-chemical traits of aonla fruits, which offers unique scope of further improvement of aonla through selection of superior genotypes, especially with higher vitamin C and tannin contents. On the basis of overall assessment, seven aonla genotypes viz., T_5, T_7, T_{11}, T_{15}, T_{24}, T_{33} and T_{34} were selected as most promising. These genotypes have immense potential to be used either for clonal multiplication, further evaluation and selection as a commercial variety or as superior gene source in future aonla hybridization programmes for combining useful traits.

Table 1: Physico-chemical attributes of aonla accessions collected from Panna forests.

Treatment	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	TSS (°B)	Acidity (%)	Vitamin C (mg/100g)	Tannin (%)	Reducing sugar (%)	Total Sugar (%)	TSS : acid	Sugar : acid
T_1	14.43	2.60	3.21	9.13	2.47	583.72	2.76	2.29	5.13	3.70	2.08
T_2	27.10	3.23	3.67	11.53	2.75	452.29	4.57	3.64	5.30	4.20	1.93
T_3	28.23	3.23	3.70	13.97	3.30	483.36	5.38	3.78	6.82	4.24	2.07
T_4	31.37	3.50	3.77	10.30	3.12	634.56	4.54	3.12	6.48	3.30	2.08
T_5	32.07	3.57	3.77	12.50	2.80	702.10	4.65	4.11	6.37	4.47	2.28
T_6	24.87	3.23	3.50	14.00	3.09	653.45	4.07	4.08	6.71	4.53	2.17
T_7	38.17	3.30	4.20	13.47	2.26	348.22	4.26	3.91	6.24	5.97	2.77
T_8	45.37	3.47	4.51	13.20	2.30	538.50	5.47	4.28	6.41	5.73	2.78
T_9	16.20	2.60	3.13	11.80	2.96	477.46	5.05	3.04	6.94	3.98	2.34
T_{10}	33.00	3.67	3.77	10.73	2.85	473.64	4.29	3.77	5.03	3.77	1.77
T_{11}	26.17	3.60	3.53	11.40	2.63	750.12	4.38	4.21	6.30	4.34	2.40
T_{12}	29.53	3.23	3.90	12.47	2.83	521.09	4.54	4.24	5.65	4.40	2.00
T_{13}	31.03	3.27	3.83	12.70	3.02	688.67	3.88	4.51	5.51	4.20	1.82
T_{14}	45.27	3.60	4.43	9.60	2.06	430.53	2.89	3.93	4.41	4.67	2.15
T_{15}	48.90	3.83	4.63	10.17	1.38	595.17	2.72	3.91	4.51	7.35	3.26
T_{16}	39.43	3.50	4.20	9.87	1.49	466.29	3.14	4.07	5.34	6.62	3.58
T_{17}	24.97	3.13	3.53	15.60	2.95	405.29	3.93	4.44	4.44	5.29	1.51
T_{18}	39.20	3.33	3.93	8.80	1.95	428.57	2.59	3.67	4.06	4.50	2.08
T_{19}	20.63	3.17	3.17	10.87	2.64	406.97	4.04	3.47	5.04	4.12	1.91
T_{20}	22.73	2.80	3.40	11.73	2.85	634.95	5.05	3.90	4.88	4.13	1.72
T_{21}	10.27	2.53	2.57	17.00	3.33	535.15	6.76	4.62	6.75	5.11	2.03
T_{22}	12.13	2.67	2.80	14.27	3.00	569.27	6.38	4.54	6.67	4.75	2.22
T_{23}	21.83	3.10	3.57	10.67	2.52	491.43	4.24	3.41	5.35	4.23	2.12
T_{24}	23.70	3.27	3.43	10.20	2.65	564.08	4.11	3.09	5.95	3.86	2.25
T_{25}	20.23	3.20	3.37	8.67	2.69	292.72	3.48	2.82	5.65	3.22	2.10
T_{26}	24.20	2.97	3.53	11.67	2.67	480.75	4.55	3.20	6.56	4.38	2.46
T_{27}	26.47	3.33	3.73	11.20	2.32	410.24	4.40	3.58	5.89	4.83	2.54
T_{28}	27.00	3.23	3.77	10.47	2.58	405.97	3.74	2.72	6.22	4.06	2.41
T_{29}	21.10	2.77	3.40	10.33	2.39	388.87	3.73	3.16	6.30	4.34	2.65
T_{30}	27.90	3.27	3.67	12.73	2.24	444.43	4.05	4.12	6.08	5.73	2.73
T_{31}	15.60	3.10	2.97	12.60	2.02	435.88	3.94	4.56	5.98	6.27	2.98
T_{32}	31.07	3.17	3.83	13.13	2.04	379.99	3.53	4.62	6.32	6.44	3.10
T_{33}	41.87	3.43	4.30	10.47	1.98	418.79	2.82	3.91	6.55	5.29	3.30
T_{34}	44.93	3.77	4.33	10.73	1.51	388.87	2.80	3.64	6.26	7.13	4.17
T_{35}	32.67	3.30	4.07	10.93	2.03	397.42	2.70	4.09	6.27	5.40	3.10
Mean	28.56	3.23	3.69	11.68	2.50	493.68	4.10	3.78	5.84	4.82	2.42
CD (p=0.05%)	1.359	0.236	0.299	0.453	0.127	24.900	0.211	0.278	0.274	0.393	0.227

Table 2: Macro and micronutrient contents of aonla accessions.

Treatment	N (%)	P (%)	K (%)	Ca (ppm)	Mg (ppm)	Cu (ppm)	Mn (ppm)	Na (ppm)	Zn (ppm)	Fe (ppm)
T_1	0.63	0.89	1.09	1710.00	981.90	3.39	13.44	461.30	8.07	80.38
T_2	0.91	0.12	0.95	1600.00	865.10	1.38	22.50	397.10	5.95	12.87
T_3	0.84	0.86	0.88	866.67	791.30	3.15	4.91	238.40	4.21	61.98
T_4	0.83	0.68	1.02	1210.00	689.50	2.22	8.73	1291.00	2.80	1.89
T_5	0.70	1.14	1.00	830.00	616.43	2.12	12.19	333.33	3.28	11.00
T_6	0.65	1.09	1.08	1000.00	678.50	1.80	7.46	203.73	0.32	10.00
T_7	0.86	0.70	0.90	913.33	665.40	1.78	8.76	480.90	3.76	30.90
T_8	0.77	0.80	0.63	1463.33	894.10	2.25	13.69	1060.00	8.16	20.02
T_9	0.70	0.52	1.00	1850.00	799.80	2.91	12.78	93.72	1.62	14.89
T_{10}	0.85	0.72	0.71	1563.33	724.90	2.66	8.37	28.15	2.94	36.39
T_{11}	0.84	1.06	0.74	1580.00	826.10	2.72	5.94	19.13	5.15	11.14
T_{12}	0.84	0.69	0.71	1113.33	609.60	4.66	17.59	192.90	5.57	77.11
T_{13}	0.70	1.25	1.00	1650.00	875.70	3.65	17.87	260.00	3.05	11.02
T_{14}	0.65	1.42	0.81	2750.00	1011.00	2.90	9.81	519.70	3.89	35.33
T_{15}	0.56	1.72	0.79	2646.67	1153.00	3.29	9.50	542.90	11.53	37.05
T_{16}	0.84	1.53	0.75	2600.00	1052.00	3.10	9.61	67.28	5.97	97.30
T_{17}	0.91	0.80	0.54	1030.00	743.37	1.60	12.67	245.20	3.19	4.75
T_{18}	0.91	1.14	0.77	1540.00	891.60	3.46	12.36	444.30	8.62	26.92
T_{19}	0.77	0.62	1.07	1230.00	924.50	3.00	35.14	220.60	6.07	14.36
T_{20}	0.84	0.41	0.39	1030.00	622.90	1.41	25.50	134.30	4.96	5.31
T_{21}	1.47	0.56	0.69	1343.33	920.30	1.96	28.25	309.70	5.09	20.88
T_{22}	1.40	0.66	0.62	1003.33	660.30	3.62	25.94	250.00	26.40	3.56
T_{23}	1.23	0.58	0.75	1001.00	764.10	2.05	9.86	312.30	4.40	17.23
T_{24}	0.91	0.68	0.89	1068.00	818.00	3.04	24.32	222.23	4.58	12.76
T_{25}	0.91	0.68	0.63	879.23	569.00	1.77	15.93	199.70	3.68	3.49
T_{26}	1.96	1.03	0.77	1173.00	689.90	1.82	17.79	129.90	4.72	6.23
T_{27}	1.12	0.74	0.96	1492.00	807.70	2.25	15.77	233.20	7.75	12.48
T_{28}	0.84	0.69	0.74	671.15	630.40	2.21	5.58	143.60	4.21	6.50
T_{29}	0.91	0.59	0.82	1517.00	784.60	2.69	11.57	182.30	3.38	3.52
T_{30}	1.68	1.30	0.71	1414.00	773.20	4.54	11.08	311.50	5.17	3.07
T_{31}	2.24	0.53	0.52	1101.00	672.70	1.31	22.75	269.30	4.10	4.41
T_{32}	0.84	0.98	0.53	1045.00	726.30	1.37	13.41	222.20	4.52	3.75
T_{33}	0.77	1.22	0.66	2173.00	797.50	1.78	8.68	184.20	5.25	9.28
T_{34}	1.12	0.94	0.85	960.43	552.10	1.72	6.29	251.00	3.13	26.13
T_{35}	0.91	0.17	0.66	1000.00	672.70	1.31	11.00	241.20	4.12	8.10
Mean	0.97	0.84	0.79	1371.95	778.73	2.48	14.20	305.61	5.42	21.20
CD (p=0.05%)	0.051	0.070	0.056	73.774	141.576	0.071	0.315	111.446	0.286	2.159

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