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Short communication

Evaluation of germplasm for cashew apple processing industry

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ABSTRACT

Physico-chemical properties of apple of the 28 cashew genotypes were evaluated to identify the suitable germplasm for cashew-apple processing industry. Vengurla-6 and Vengurla-4 appeared ideal for cashew-apple processing under red and laterite zones of West Bengal. These genotypes can be successfully utilized for preparation of industrial products such as soft drinks, squash, RTS, beverages *etc.* and various other value-added products. These genotypes yielded 70 l/tree juice or 4000 gallons/ha.

Key words: *Anacardium occidentale* L., cashew apple, processing traits.

Cashew apple is not a true fruit but the fleshy pedicel growing into the colourful juicy, sweet when ripe and also fibrous cashew apple. Usually the apple is 5-10 times heavier than the nut at ripe stage. The apple is not practically utilized industrially in any of the cashew growing tracts in India except Goa. Cashew apple production is also increasing simultaneously with nut yield in India. Cashew apples are quite nutritious and contain sugars, amino acids, tannins, ascorbic acid (vitamin C) and fibre. Nair *et al*. (3) reported the existence of yellow apples tended to be heavier, softer and less astringent than red apples. It means that the biochemical as well as physical characteristics of cashew apple varies in different genotypes. Therefore, an attempt has been made to determine the physical as well as biochemical characteristics of cashew apple of different cashew germplasm, so that it can be helpful in identifying the genotypes for utilizing cashew apples for making different industrial food products.

The investigation was carried out at the Regional Research Station of Bidhan Chandra Krishi Viswavidyalaya, Jhargram, West Bengal. The germplasms studied were namely BPP-1, BPP-3, BPP-5, BPP-8 (H-2/16), Vengurla-2, Vengurla-3, Vengurla-4, Vengurla-6, VRI-2 (M-44/3), VRI-3 (M-26/2), Kanaka (H-1598), Dhana (H-1608), NRCC-1, NRCC-2, Madakkathara-1, Anakkayam-1, Jhargram-1, Priyanka (H-1591), H-1600, H-1610, VTH-59/2, VTH-30/4, H-2/15, T.No. 40, T.No. 129, M-33/3, Ullal-3 and KGN-1.

While physical characteristics were recorded the biochemical characters such as TSS, acidity, total sugars and vitamin C content were also determined as per the standard methods (AOAC, 1). The juice recovery from a tree and availability of juice from a unit area of cashew plantation were calculated. The experiment was laid out in completely randomized design with 28 treatments and 5 replications. The data obtained were statistically analyzed by the analysis of variance method as suggested by Panse and Sukhatme (4).

Among the 28 genotypes, 19 were conical to obovate, 12 were cylindrical, 3 were conical and 4 were pyriform (Table 1). There are three different colours commonly found, *i.e.*, red, yellow and pink. Apart from these three colours, there are overlapping of yellow and red in different proportions. Out of 28 genotypes, 8 had red apples, 16 had yellow apples, three had pink apples and one had a mixture of yellow and red apples (Table 1). Attachment of nut to apple had also been observed and classified as loose (7 genotypes), tight (6 genotypes) and intermediate (15 genotypes).

Among the various genotypes studied, KGN-1 had the longest (8.5 cm) and broadest (5.83 cm) followed by Dhana (7.8 cm length and 5.5 cm breadth, respectively) (Table 2). KGN-1 had also heaviest apples (93.33 g) followed by Dhana (85.67 g), Kanaka (78 g) and Vengurla-6 (67 g). Lenka *et al*. (2) evaluated 13 cashew varieties for the apple characters and found significant variations in length, breadth and weight of apple. Sapkal *et al*. (5) compared apple characters of nine cashew and found significant difference among the genotypes. Compared to their observations, it is clear that the characteristics of cashew apples vary depending on the climate.

The highest TSS was recorded in H-1610 (22.47°Brix). Five genotypes, *viz*., KGN-1, VRI-3,

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Table 1. Physical characteristics of cashew apple in different genotypes.

Genotype	Shape	Colour	Ridges on cashew apple	Apex of cashew apple	Grooves on cashew apple base	Cavity at cashew apple base	Peel of cashew apple	Shape of cashew apple base	Attachment of apple to nut
Anakkayam-1	Conical to obovate	Red	Broken	Oblique	Shallow	Deep	Rough & Dull	Obliquely flattened	Loose
BPP-1	Conical to obovate	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Flattened	Intermediate
BPP-3	Cylindrical	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Intermediate
BPP-5	Conical to obovate	Yellow red	Entire	Oblique	Absent	Shallow	Smooth & Glossy	Obliquely flattened	Intermediate
BPP-8	Conical to obovate	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Loose
Dhana	Cylindrical	Yellow	Entire	Oblique	Deep	Shallow	Smooth & Glossy	Rounded	Tight
H-1600	Conical	Red	Entire	Oblique	Shallow	Shallow	Rough & Dull	Obliquely flattened	Intermediate
H-1610	Conical	Yellow red	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Flattened	Intermediate
H-2/15	Pyriform	Yellow	Broken	Oblique	Absent	Shallow	Smooth & Glossy	Obliquely flattened	Loose
Jhargram-1	Cylindrical	Yellow	Broken	Oblique	Deep	Deep	Smooth & Glossy	Obliquely flattened	Intermediate
Kanaka	Conical to obovate	Yellow	Entire	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Tight
KGN-1	Cylindrical	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Rounded	Tight
M-33/3	Pyriform	Red	Entire	Oblique	Deep	Deep	Smooth & Glossy	Rounded	Loose
Madakkathara-1	Conical to obovate	Yellow	Broken	Oblique	Absent	Deep	Smooth & Glossy	Flattened	Loose
NRCC-1	Cylindrical	Yellow red	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Intermediate
NRCC-2	Cylindrical	Red	Broken	Oblique	Absent	Shallow	Smooth & Glossy	Obliquely flattened	Tight
Priyanka	Pyriform	Pink	Broken	Oblique	Absent	Shallow	Smooth & Glossy	Pointed	Intermediate
T.N. 129	Cylindrical	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Loose
T.N. 40	Pyriform	Yellow	Entire	Oblique	Deep	Shallow	Smooth & Glossy	Flattened	Intermediate
Ullal-3	Conical to obovate	Pink	Broken	Oblique	Absent	Shallow	Smooth & Glossy	Obliquely flattened	Intermediate
Vengurla-2	Conical to obovate	Red	Entire	Oblique	Shallow	Deep	Smooth & Glossy	Flattened	Intermediate
Vengurla-3	Cylindrical	Yellow	Broken	Oblique	Shallow	Shallow	Smooth & Glossy	Obliquely flattened	Tight
Vengurla-4	Cylindrical	Pink	Entire	Oblique	Deep	Deep	Rough & Dull	Obliquely flattened	Intermediate
Vengurla-6	Cylindrical	Yellow	Broken	Oblique	Absent	Deep	Smooth & Glossy	Flattened	Tight
VRI-2	Conical to obovate	Pink	Entire	Oblique	Shallow	Shallow	Smooth & Glossy	Angular	Intermediate
VRI-3	Cylindrical	Red	Entire	Oblique	Shallow	Shallow	Smooth & Glossy	Flattened	Loose
VTH-30/4	Conical to obovate	Red	Entire	Oblique	Shallow	Deep	Smooth & Glossy	Obliquely flattened	Intermediate
VTH-59/2	Cylindrical	Red	Entire	Oblique	Shallow	Deep	Smooth & Glossy	Angular	Intermediate

Table 2. Physico-chemical parameters of cashew apple in different genotypes.

Genotype	Length of cashew apple	Breadth of cashew apple	Weight of cashew apple	Specific gravity	TSS. (°Brix)	Acidity (%)	Total sugars (%)	Vitamin C (mg/ml of juice)	Fibrous residue (%)	Sugar: acid
Anakkayam-1	6.63	4.15	41.66	0.743	16.10	1.180	9.76	4.360	23.70	8.27
BPP-1	6.17	4.97	51.33	0.910	14.73	0.733	9.76	2.833	21.30	13.32
BPP-3	6.77	4.67	55.00	1.060	14.13	0.550	8.40	3.163	14.08	15.27
BPP-5	5.50	4.40	34.33	0.953	14.13	0.450	9.06	2.990	14.30	20.13
BPP-8	5.93	4.40	40.33	0.943	15.37	0.467	9.09	4.140	15.30	19.46
Dhana	7.80	5.50	85.67	0.970	16.03	0.600	10.25	5.058	17.20	17.08
H-1600	6.77	4.57	45.00	1.127	17.37	0.650	11.08	3.347	28.40	17.05
H-1610	6.23	3.77	39.00	0.933	22.47	1.167	12.12	5.177	23.60	10.39
H-2/15	6.50	4.20	39.33	1.193	20.03	0.700	10.81	3.960	23.60	15.44
Jhargram-1	5.47	4.00	29.00	1.140	14.30	0.350	8.19	5.613	22.03	23.40
Kanaka	6.97	5.53	78.00	0.960	16.33	0.617	9.51	3.383	17.23	15.41
KGN-1	8.50	5.83	93.33	0.927	18.20	0.900	9.51	3.927	29.60	10.57
M-33/3	7.00	4.97	52.33	0.963	15.83	0.533	12.12	4.337	24.47	22.74
Madakkathara-1	6.03	4.47	38.00	0.975	15.10	0.517	11.76	5.147	20.43	22.75
NRCC-1	7.03	4.57	49.33	0.927	16.03	0.517	12.53	3.090	19.80	24.24
NRCC-2	5.40	5.00	42.00	0.913	15.80	0.537	10.54	5.107	21.83	19.63
Priyanka	7.57	4.13	36.00	0.747	16.10	1.183	9.76	5.571	37.43	8.25
T.N. 129	5.80	4.17	0.34	0.950	17.77	0.500	8.33	1.507	28.80	16.66
T.N. 40	6.53	4.17	39.00	0.980	18.40	0.783	10.49	2.747	33.27	13.40
Ullal-3	6.87	5.70	62.33	1.007	15.70	0.483	8.87	5.377	21.77	18.36
Vengurla-2	5.40	4.07	32.33	0.940	12.83	0.383	8.34	3.317	15.03	21.77
Vengurla-3	5.87	4.93	50.00	0.960	19.07	0.500	10.27	4.273	24.53	20.54
Vengurla-4	7.50	5.00	59.67	0.957	15.83	0.317	10.00	3.412	18.40	31.55
Vengurla-6	6.47	5.50	67.00	0.920	14.53	0.400	9.54	5.473	15.03	23.85
VRI-2	5.90	4.33	40.67	0.920	14.43	0.433	8.00	4.213	17.60	18.50
VRI-3	5.17	4.90	41.00	0.963	18.43	0.533	11.48	1.417	21.40	21.54
VTH-30/4	5.83	4.43	44.67	1.233	12.40	0.700	10.00	1.523	24.40	14.28
VTH-59/2	5.97	4.73	50.67	0.957	16.40	0.450	7.28	3.133	22.40	16.18
CD at 5%	0.158	0.147	0.582	0.009	0.042	0.022	0.014	0.268	0.191	

T.N. 40, H-2/15, Vengurla-3 had TSS content between 18-20°Brix. Acidity percentage is observed to range between (0.317 to 1.183%). Maximum acidity was recorded in variety Priyanka (1.183%) and the minimum was with Vengurla-4 (0.317%). A lower range of acidity was found with Jhargram-1 (0.351%), Vengural-2 (0.383%), Vengurla-6 (0.4%), VRI-2 (0.433%) & VTH-59/2. High sugar percentage combined with an acidity percentage ranging from 0.32 to 0.42 as maleic acid in cashew apple is desirable for the juice products like cashew apple juice, clarified juice, cloudy juice, caskola *etc*. It was noticed that NRCC-1 recorded highest sugar (12.53%) followed by M-33/3 and H-1610 (12.12%). Most of the genotypes studied had sugar contents over 8% except cv. VTH-59/2. Sugar: acid ratio depicts that Vengurla-4, NRCC-1, Vengurla-6, Jhargram-1, Madakkathara-1, M-33/3, Vengural-2, and Vengural-3 genotypes were having the desirable blending of sugar and acid, which is an important trait to suit the industrial purpose. The

genotypes Jhargram-1 had the highest vitamin C content (5.613 mg/ml of juice) followed by Priyanka (5.571 mg/ml of juice) and Vengurla-6 (5.473 mg/ml of juice). H-1610, NRCC-2, Ullal-3, Madakkathara-1 and Dhana had also more than 5.0 mg vitamin C / ml of juice. Priyanka recorded highest percentage of fibrous residue (37.43%) and lowest fibrous residue is found in case of BPP-3 (14.08%).

On perusal of Table 3, it is observed that juice recovery percentage was highest in the variety VRI-3 (82.4%) followed by Dhana (80.93%), Kanaka (75.47%), KGN-1 (74.87%), Vengurla-6 (74.73%) and Vengurla-4 (73.53%). The yield of cashew apple was highest with Vengural-6 variety (147.74 g/tree) followed by Vengural-4 (113.85 kg/tree), Kanaka (107.8 kg/tree). Estimation of juice recovery per tree & per hectare depicted that Vengurla-6, Vengurla-4, Kanaka and KGN-1 can supply more than 70 litres/ tree and 4,000 gallons/ha of juice for the cashew apple processing industry. The results indicate that the genotypes, *viz*., Vengurla-6 and Vengurla-4 had maximum juice yield and a suitable sugar: acid ratio, which is essential for making products from cashew apple juice. Other genotypes in order of preference are Kanaka, Ullal-3, Dhana *etc*., which can be utilized by addition of sugar with its juice.

Table 3. Estimation of juice recovery from different genotypes of cashew apple.

Genotype	Juice recovery (%)	Yield of cashew apple (kg/ tree)	Juice recovery (litre/ tree)	Juice availability/ha (gallons)
Anakkayam-1	67.20	63.16	42.44	2,483.59
BPP-1	69.03	76.99	53.15	3,110.34
BPP-3	67.53	57.80	39.03	2,302.18
BPP-5	58.70	55.68	32.68	1,912.43
BPP-8	51.93	50.85	26.41	1,545.51
Dhana	80.93	68.54	55.47	3,246.10
H-1600	57.77	54.60	31.54	1,845.72
H-1610	50.50	45.86	23.16	1,355.32
H-2/15	66.87	70.94	47.44	2,776.19
Jhargram-1	44.03	39.02	17.18	1,005.37
Kanaka	75.47	107.80	81.36	4,761.19
KGN-1	74.87	98.34	73.63	4,308.83
M-33/3	60.03	63.14	37.90	2,217.91
Madakkathara-1	55.07	57.84	31.85	1,863.86
NRCC-1	62.07	40.94	25.41	1,487.00
NRCC-2	52.83	32.34	17.09	1,000.11
Priyanka	58.63	65.82	38.59	2,258.29
T.N. 129	62.30	64.78	40.36	2,361.87
T.N. 40	51.20	37.43	19.16	1,121.24
Ullal-3	61.30	95.36	58.46	3,421.08
Vengurla-2	54.57	39.25	21.42	1,253.50
Vengurla-3	64.97	40.82	26.52	1,551.95
Vengurla-4	73.53	113.85	83.71	4,898.71
Vengurla-6	74.73	147.74	110.41	6,461.19
VRI-2	62.50	38.35	23.97	1,402.72
VRI-3	82.4	46.66	38.45	2,250.09
VTH-30/4	49.13	34.01	16.71	977.87
VTH-59/2	50.93	41.77	21.27	1,244.72
CD at 5%	3.318	4.021	3.412	

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