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Studies on physico-chemical parameters of cashew (*Anacardium occidentale* L.) apple for value addition

M. Mirdha, K. Sethi*, P.K. Panda, S.K. Mukherjee, P. Tripathy and D.K. Dash

All India Coordinated Research Project on Cashew,
Directorate of Research, Orissa University of Agriculture and Technology, Bhubaneswar-751 003, Odisha, India.
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ABSTRACT

The cashew apple production in India is estimated to be 65 lakh tones per year but less than 10% of it is processed inspite of possessing all nutritional and medicinal properties. Although the nutritional and economic importance of cashew apple has been acknowledged by many researchers, but no systematic research has been taken yet for proper utilization of large quantities of cashew apples which are being wasted every year. The present investigation was therefore, carried out at Cashew Research Station, All India Coordinated Research Project on Cashew, during the year 2017-18 to evaluate the fifteen diverse cashew genotypes for their physico-chemical parameters as well as value addition of cashew apple juice. The experiment was laid out following the statistical design RBD with two replications. The tested cashew genotypes revealed variations with respect to physico-chemical parameters of cashew apple as well as prepared RTS. Cashew genotype, Kankadi revealed superiority for physical parameters such as cashew apple length (9.2cm), cashew apple breadth (both at wider (5.17cm) and narrower point (4.35cm)), specific gravity (1.21), juice recovery (72.91%) and apple to nut ratio (15.41). Cashew apple weight was recorded maximum in genotype VTH-711/4(118.71g). Genotype, Dhana exhibited superiority for total cashew apple yield (19.35kg plant^{-1}), titrable acidity(0.35%) and ascorbic acid content(254.54mg 100g^{-1}) among the tested genotypes. Total soluble solids was recorded maximum in genotype D-19 (15.52 ^{0}brix). Reducing sugar and total sugar was recorded maximum in genotypes, NRCC Sel-2(9.90%) and BPP-8 (10.53%) respectively. Minimum amount of tannin was recorded in genotype Bhubaneswar-1(1.76mg ml^{-1}). The organoleptic evaluation of prepared RTS revealed wide variations and recorded organoleptic values ranged between 3.50 to 5.00 for colour, 3.00 to 5.00 for appearance, 2.00 to 4.80 for flavour, 2.00 to 4.00 for taste, 2.00 to 4.50 for sweetness and 2.00 to 4.25 for overall acceptability on 5 point hedonic scale. The genotype, Bhubaneswar-1 recorded highest score for all the organoleptic parameters such as colour (5.00), appearance (5.00), flavour (4.80), taste (4.00), sweetness (4.50) and overall acceptability (4.25). Thus, the genotype, Bhubaneswar-1 may be commercially exploited for RTS preparation owing to its low tannin and consumer acceptability.

Key words: Cashew, Physico-chemical parameters, RTS, Organoleptic evaluation.

INTRODUCTION

Cashew (*Anacardium occidentale* L.), belongs to family *Anacardiaceae*, is native of Brazil. It is an exotic horticultural crop brought to India by Portuguese in 16th Century but now adopted well in Indian conditions. It is grown along the coastal regions of Maharashtra, Goa, Karnataka and Kerala in the West Coast and Tamil Nadu, Andhra Pradesh, Odisha and West Bengal in the East Coast. It is spreading in non-traditional areas such as Bastar region of Chhattisgarh and Plain regions of Karnataka, Gujarat, Jharkhand, Assam, Meghalaya, Manipur and Tripura. Cashew is commercially grown for its kernel, although uses of CSNL and cashew apple are gaining momentum. Cashew apple is a thick receptacle or pseudo fruit develop from peduncle of the cashew tree, to which the cashew nut is attached. About 10 to 15 tonnes of cashew apples are obtained as a by-product for every tonnes of cashew nuts produced. According to Food and Agriculture Organisation of the United Nations (FAO,2017), the world production of cashew apples in 2016 amounted to 2,001.301 MT. Cashew apple contains substantial quantity of vitamin C (240mg100gm^{-1} juice) which is 3 to 6 times higher than that of orange juice and about 10 times more than that pineapple juice (Adou *et al.*, 2011 and Saroj *et al.*, 2014). It also contains amino acids like thiamine, niacin and riboflavin in addition to minerals such as copper, zinc, sodium, potassium, calcium, iron, phosphorus and magnesium (Lower and Agyente-Badu, 2009). Total polyphenols and tannin content vary between 120 to 304 and 108 to 266 mg 100ml^{-1}, respectively. About 65% to 80% of the juice can be recovered from the cashew apple depending upon maturity, variety and process of extraction. The main problem of cashew apple juice utilisation is astringency. This can be clarified by cassava, starch, gelatine powder, PVP (Poly Vinyl

*Corresponding author's e-mail: kabita2273@yahoo.com

Pyrolidone) and microfiltration. In India Goa is the only state where cashew apple is utilised for the preparation of cashew 'Feni' a fermented beverage from cashew apple (Augustin, 2001). Although the nutritional and economic importance of cashew apple has been acknowledged by many researchers, but no systematic research has been taken yet for proper utilization of large quantities of cashew apples which are being wasted every year. Hence, keeping all these facts in view the present investigation was taken to characterized cashew apple of fifteen cashew genotypes (both physical and biochemical) and to identify cashew genotype(s) suitable for value addition.

MATERIALS AND METHODS

The present investigation was carried out at Cashew Research Station (CRS), All India Coordinated Research Project on Cashew, Ranasighpur, Bhubaneswar under orissa university of Agriculture and Technology during the year 2017-18.The trial was laid out during the year 2014 following statistical design RBD with fifteen genotypes replicated twice. Cashew apple of 2017-18 fruiting season was selected for the present study. Observations were recorded in various physical(weight of apple, length of apple, girth both at widest and narrowest point of cashew apple, specific gravity, apple to nut ratio),bio-chemical (TSS (°brix), acidity (%),reducing sugar, total Sugar (%),ascorbic acid(mg), % juice recovery) and organoleptic parameters (appearance, colour, flavor, taste, sweetness and overall acceptability) of cashew apple during the period of investigation. Weight of cashew apple was recorded using the digital balance whereas length and breadth (at wider and narrower point of cashew apple) were recorded using slide caliper. Specific gravity was measured by water displacement method. Screw type juice extractor was used for extraction of juice from cashew apple. The total soluble solid (°brix) of fruit juice was determined with the help of digital refractometer. Titrable acidity (%) was estimated by titrating the pulp extract with N/10 NaOH as per the standard procedure suggested by Ranganna, 1986. Similarly, the method of AOAC, 1975 was followed for determination of total sugar and tannin content in cashew apple. 2, 6 dichlorophenol indophenols titration method described by Ruck, 1963 was used for estimation of ascorbic acid content. For RTS preparation the fully ripe cashew apple without any bruises were collected and juice was extracted using screw type juice extractor. The fresh juice was clarified by adding sago@ 5g litre^{-1} of juice. The RTS was prepared and evaluated as per the guideline received from the Directorate of Cashew Research, Puttur, Karnataka. The recorded observations were analyzed statistically using analysis of variance (Panse and Sukhatme, 1978).

RESULTS AND DISCUSSION

Cashew apple of selected genotypes revealed significant variations for various physical and bio-chemical parameters during the period of investigation. The results obtained on various parameters are discussed below.

Physical parameters of cashew apple: A perusal of Table 1 revealed significant variations for physical parameters of cashew apple among the fifteen tested genotypes. Cashew apple length, breadth, weight, apple to nut ratio, specific gravity and cashew apple yield per plant are important physical parameters which contribute to production of cashew apple juice of a particular cashew genotype. Genotype, Kankadi revealed superiority for physical parameters such as cashew apple length (9.2cm), cashew apple breadth (both at wider (5.17cm) and narrower point

Table 1: Physical parameters of selected cashew apple.

Genotypes	Length of apple(cm)	Breadth at widest point(cm)	Breadth at narrowest point(cm)	Weight of cashew apple (g)	Apple: Nut	Yield of cashew apple (kg plant^{-1})	Specific gravity	Juice recovery (%)
B-27	5.37	4.12	3.03	52.55	5.25	15.90	1.12	68.50
C-30	5.45	3.63	2.72	50.90	5.83	14.67	1.04	74.00
C2-6	5.15	4.02	3.10	30.45	5.12	14.88	1.07	61.35
D-19	5.92	3.80	2.43	36.75	7.53	19.35	1.06	73.75
BH-105	6.80	4.03	3.10	66.15	7.67	13.02	1.08	79.80
Bhubaneswar-1	6.42	3.62	2.68	23.00	3.45	8.93	1.07	62.65
RP-1	4.52	2.85	2.18	22.85	3.24	12.29	1.04	60.10
RP-2	4.25	3.62	2.67	25.75	4.30	14.27	1.03	66.50
M44/3	4.21	3.92	2.97	35.40	4.25	16.86	1.07	71.70
Kankadi	9.20	5.17	4.35	114.80	15.41	0.79	1.21	72.91
VTH711/4	8.62	5.05	3.57	118.71	13.47	0.76	1.18	82.19
NRCC Sel-2	5.11	4.27	3.58	48.45	6.65	12.28	1.05	68.50
H-320	5.50	3.00	2.47	44.35	6.24	7.20	1.04	60.85
Dhana	6.78	4.63	2.72	48.55	6.00	19.75	1.13	79.75
BPP-8	5.02	4.47	3.75	61.60	11.11	13.14	1.07	77.95
Grand mean	5.88	5.88	3.02	51.91	7.03	12.27	1.08	70.70
SEm(±)	0.18	0.18	0.16	1.00	0.24	0.61	0.006	1.42
CD(0.05%)	0.54	0.54	0.50	3.04	0.73	1.87	0.018	4.31

(4.35cm)), specific gravity (1.21), juice recovery (72.91%) and apple to nut ratio (15.41). The genotype, M 44/3 (4.21cm) recorded the significantly lowest length of cashew apple while genotypes, RP-1 recorded the lowest value for cashew apple breadth both at wider point (2.85cm) and narrower (2.18cm) point. The average weight of cashew apple varied from minimum 22.85g in RP-2 to maximum of 118.71g in VTH 711/4 during the period of evaluation.

Cashew apple to nut ratio (ANR) play a key role towards selection of superior types both for nuts as well as cashew apple utilization. Cashew apple to nut ratio (ANR) ranged from minimum 3.24 to maximum 15.41.Significantly maximum ANR was observed in Kankadi (15.41) followed by genotypes VTH 711/4 (13.47) and BPP-8(11.11). Genotype RP-1 exhibited significantly lowest ANR (3.24) among the tested genotypes. Specific gravity of tested genotypes ranged from minimum 1.03 (RP-2) to maximum 1.21 (Kankadi). Similar variations in physical parameters of cashew apple have been reported by Vilaschandran and Damodaran (1985) and Aravindakshan *et al.* (1986).

Yield of cashew apple tree^{-1} was recorded maximum in genotype Dhana (19.75 kg plant^{-1}) followed by genotype D-19 (19.35 kg plant^{-1}) which were statistically at par. The lowest yield of cashew apple per tree was recorded in genotype VTH 711/4(0.76 kg plant^{-1}). Poduval *et al.* (2015) reported similar variations in yield of cashew apple per tree while working with 28 tested genotypes under Jharagram condition.

Bio-chemical parameters: Biochemical parameters like, Juice recovery, TSS, acidity, reducing sugar, total sugar, ascorbic acid and tannin content of cashew apple determines the quantity and quality of processed product prepared from cashew apple juice. In the present experiment, 15 diverse cashew genotypes were tested for various biochemical parameters. A perusal of Table 2, revealed that juice recovery % was highest in VTH 711/4 (82.19%) followed by BH-105(79.80%), Dhana (79.75%) and BPP-8 (77.95%) which were statistically at par. Genotype RP-1 (60.10%) recorded lowest recovery of juice among the tested genotypes. However, the extent of juice production was proportional to the weight of cashew apple and total cashew apple production of a tree. Similar variation on juice recovery percentage was reported by Sivagurunathan, (2010) ,Naidu *et al.*, (2012)., Poduval *et al.*, (2015) and Tripathy *et al.*, (2015).

Total Soluble Solid (TSS) indicates the quality of the fruit for ready to eat and also for preparation of different beverages and processed products. TSS of the tested genotype ranged from minimum 10.15° brix (Kankadi) to maximum 15.52° brix (D-19). Genotypes D-19 (15.52°brix) recorded maximum TSS followed by RP-2 (15.17° brix), BPP-8 (15.05^{0}brix) and BH-105 (14.77° brix) which were statistically at par. Naka *et al.*, 2015 reported levels of TSS being higher (14.4 ± 0.10°brix) in yellow varieties than red variety (9.66 ± 0.28° brix). Similar variation in TSS of different cashew genotypes were reported by Poduval *et al.*, 2015 and Panda *et al.*,2015 and Tripathy *et al.*, 2015. Among the tested genotypes, significantly maximum total titrable acidity (TTA) was recorded in genotype, Dhana (0.35%) while the minimum was recorded in RP-2 (0.12%). This result indicates that the cashew apples used for the analysis were at optimal stages of maturity. This is due to the fact that as the degree of maturity of fruit is higher than the acid contact becomes lower. In this study, the levels of TTA found in cashew apple, correspond with those reported by Poduval *et al.*, (2015), Toppo *et al.*, (2015) and Tripathy *et al.*, (2015).

Table 2: Biochemical parameters of selected cashew apple.

Genotypes	TSS (°Brix)	Total titrable acidity (%)	Reducing sugar (%)	Total sugar (%)	Ascorbic acid (mg 100g^{-1})	Tannin (mg ml^{-1})
B-27	13.02	0.20	8.26	9.70	218.18	2.81
C-30	13.17	0.19	8.69	9.90	163.63	1.81
C 2-6	11.40	0.13	7.35	8.26	145.45	2.33
D-19	15.52	0.19	8.33	8.62	141.36	1.99
BH-105	14.77	0.17	9.09	10.00	177.72	2.25
Bhubaneswar-1	11.37	0.25	9.17	9.43	190.59	1.76
RP-1	10.55	0.23	7.63	8.77	163.63	3.40
RP-2	15.17	0.12	9.09	9.61	209.09	1.80
M 44/3	11.72	0.25	9.34	9.90	127.36	3.17
Kankadi	10.15	0.22	8.19	9.43	185.59	4.26
VTH711/4	13.41	0.19	7.69	9.00	182.40	2.49
NRCC Sel-2	14.27	0.19	9.90	10.31	162.72	4.92
H-320	13.70	0.32	8.19	8.47	200.00	4.22
Dhana	14.27	0.35	9.09	10.20	254.54	3.26
BPP-8	15.05	0.32	8.26	10.53	145.45	3.34
Grand mean	13.01	0.22	8.55	9.40	177.84	2.92
SEm(±)	0.28	0.01	0.09	0.10	6.49	0.27
CD (0.05%)	0.86	0.13	0.29	0.31	19.60	0.82

Reducing sugar (%) and total sugar (%) are important biochemical parameters of cashew apple which directly related to quality of processed product. High sugar percentage combine with an acidity % ranging from 0.32 to 0.42 as mallic acid is desirable for the juice products like cashew apple juice, clarified juice, cloudy juice, caskola etc. (Msoka *et al*., 2017). Most of the genotype studied had desirable blending of sugar and acid which is an important trade to suit the industrial use. In the present experiment reducing sugar ranged from minimum 7.35% in genotype C 2-6 to maximum 9.90% in NRCC Sel-2. However, percentage of total sugar was recorded highest in genotype, BPP-8 (10.53%) while lowest in genotype C2-6 (8.26%). These variations may be attributed by the environmental and genotypic factors as well as hydrolysis of polysaccharides into simple sugar during ripening stages (Naka *et al*., 2015). Similar variation in reducing sugar and total sugar were also reported by Lenka *et al*., (1988), Attri and Singh, (1999), Sivagurunathan *et al*., (2010), Naidu *et al*., (2012) and Panda *et al*., (2015), Poduval *et al*., (2015), Tripathy *et al*., (2015).

Ascorbic acid content also varied significantly among the tested cashew genotypes. From the results Table 2, it is confirm that cashew apple juice if an excellent source of ascorbic acid (Vitamin C). High ascorbic acid content in cashew apple juice strongly support the needs for it exploitation and its increased utilization. The genotypes, Dhana had the highest ascorbic acid content (254.54mg$100g^{-1}$) followed by genotype B-27 (218.18mg$100g^{-1}$), H-320 (200.00mg$100g^{-1}$) and RP-2(209.09mg$100g^{-1}$). Significantly minimum 'ascorbic acid' was recorded in genotype M 44/3 (127.36mg$100g^{-1}$). Variations in ascorbic acid content may be due to environmental and soil factors, interaction between these factors and individual variety (Geddeda and Belal, 2014). The variation may be also due to storage of juice at low temperature after harvest and prior analysis. Ascorbic acid value obtain in this study were much higher compared to other tropical fruits like orange, grape, pineapple, mango and lemon which contain average values of 54.70, 45.00, 14.70, 30.90 and 33.7 mg $100ml^{-1}$ ascorbic acid respectively. This support the potentially of cashew apple as the major source of ascorbic acid as compare to other tropical fruits.

In the present experiment tannin contents on cashew apple ranged from 1.7 $mgml^{-1}$ to 4.26 mg ml^{-1}. Minimum tannin content was found in the Bhubaneswar-1(1.76 mg ml^{-1}) implying that this genotype is good for processing. This finding was closely related to the finding of Mohanty *et al*., 2006, Singh *et al*., 2008 and Vergara *et al*., 2010, Naidu *et al*., 2012. Since tannins are mostly responsible for the astringent taste of the cashew apple and its juice, hence low preference and consumption especially where the processing technologies are not well advanced.

Organoleptic evaluation: Ready to serve beverage prepared from fifteen diverse cashew genotypes revealed significant variation with respect to organoleptic evaluation (Table 3). The RTS prepared from different genotypes were subjected to organoleptic evaluation in the age group of 20 to 25 years. The genotypes recorded scoring values between 3.50- 5.00 for colour, 3.00-5.00 for appearance, 2.00- 4.80 for flavour, 2.00-4.00 for taste, 2.00-4.50 sweetness and 2.00-4.25 for overall acceptability on 5 point hedonic scale. The genotype Bhubaneswar-1 recorded highest score for all the organoleptic parameters such as colour (5.00), appearance (5.00), flavour (4.80), taste (4.00), sweetness (4.50) and overall acceptability (4.25).Other tested genotypes which recorded statistical parity with the genotype Bhubaneswar-1, were C-30 and M 44/3. However genotypes Bhubaneswar-1, C-30 and M 44/3 recorded moderate values for bio-

Table 3: Organoleptic evaluation of prepared RTS.

Genotypes	Colour	Appearance	Flavour	Taste	Sweetness	Overall acceptability
B-27	3.50	3.75	3.75	3.25	3.50	3.25
C-30	4.05	4.50	4.05	3.80	3.25	3.80
C 2-6	3.50	3 .00	3.00	2.00	3.00	2.50
D-19	4 .00	3.50	3.00	2.25	2.50	2.75
BH-105	4.25	4 .00	3.50	3.50	2.75	3.50
Bhubaneswar-1	5.00	5.00	4.80	4.00	4.50	4.25
RP-1	3.75	3.50	2.75	2.50	2.75	2.50
RP-2	5 .00	4.00	3.50	3.50	4.00	3.50
M 44/3	4.50	4.00	4.25	3.50	3.50	3.75
Kankadi	4.50	5.00	3.00	2.50	3.00	2.50
VTH 711/4	4 .00	5.00	2.00	2.50	2.00	2.00
NRCC Sel-2	4.00	5.00	2.75	2.25	2.50	2.75
H-320	3.75	4.25	2.75	2.75	3.50	3.25
Dhana	3.65	4.80	3.30	3.00	3.15	3.00
BPP-8	4.50	3.87	3.25	3.30	2.87	3.00
Grand mean	4.09	4.21	3.31	2.97	3.11	3.08
SEm(±)	0.28	0.34	0.39	0.30	0.25	0.25
CD (0.05%)	0.86	1.03	1.19	0.93	0.76	0.77

chemical parameters like TSS, acidity, reducing sugar, total sugar, ascorbic acid and tannin content. This finding corroborates with the finding of Jain and Khurdiya (2004), Sousa *et al*., (2013), Anand *et al*., (2012), Tripathy *et al*., (2015) and Poduval *et al*., (2015).

CONCLUSION

From the present study it is concluded that genotype, Kankadi revealed superiority for physical parameter of cashew apple while genotype, Dhana exhibited superiority for total yield of cashew apple plant^{-1}, ascorbic acid and total titrable acidity. Genotype, D-19 recorded maximum for total soluble solid (15.52°brix) among the tested genotypes. Minimum amount of tannin was recorded in genotype Bhubaneswar-1. The genotype, Bhubaneswar-1 recorded highest score for all the organoleptic parameters such as colour (5.00), appearance (5.00), flavour (4.80), taste (4.00), sweetness (4.50) and overall acceptability (4.25). Thus, the genotype, Bhubaneswar-1 may be commercially exploited for RTS preparation owing to its better biochemical parameters and consumer acceptability.

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