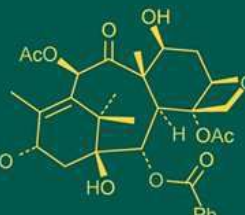
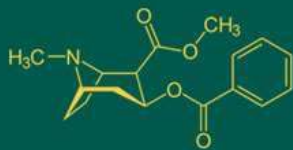


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Chemical evaluation of different custard apple (*Annona squamosa* L.) genotypes in Bastar district of Chhattisgarh, India

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Abstract

A laboratory experiment was conducted at K.D. College of Horticulture and Research Station, Jagdalpur, MGUVV, Sankra-Patan, Durg, Chhattisgarh, during the year 2022-23 to study the chemical properties of 16 custard apple genotype collected from Bastar districts. The results showed that the chemical evaluation of *in-situ* custard apple genotypes under Bastar district. The variations in Titrable acidity (%) (0.21-0.38%), Total Soluble Solids ($^{\circ}$ Brix) (19.28-24.63 $^{\circ}$ Brix), Total sugar (%) (19.43-25.37%), Reducing sugar (%) (15.77-21.61%), Non- reducing sugar (%) (3.66-4.73%), Ascorbic acid (mg/100 g) (16.39-25.28 mg/100 g) and Pulp texture soft and granular, recorded in different custard apple genotypes. All genotypes BCA-10, BCA-7, BCA-3, and BCA-5 recorded highest desirable characters.

Keywords: Custard apple, genotypes, *in-situ*, Titrable acidity, total soluble Solids ($^{\circ}$ Brix), total sugar, reducing sugar, ascorbic acid

Introduction

Custard apple (*Annona squamosa* L.) also known as Sharifais, sweet sop and Sitaphal as importance fruit crop of tropical and sub-tropical fruit crop are grow in India as well as over all tropical and sub-tropical world. Custard apple belonging to *Annonaceae* family.

The pulp is delicious, beautifully scented and golden with white undertones. The thick, creamy-white flesh that surrounds the concolorous, relatively juicy segments is slightly gritty and custard-like in texture. Each carpel has a single, square, smooth, 1.3–1.6 cm long, firm, smooth, glossy, dark-brown or black seed (Nath *et al.* 2008) ^[16], 55 to 60 actual seed counts have been discovered. Custard apple fruits are used to make ice cream because they have a central core that is pointed, fibrous and linked to a stout stem more than halfway through the fruit (Maurya and Singh, 2006) ^[13]. It provides different vitamins and minerals.

There has been a lot of awareness about the intake of custard apples around the world since the above nutritional and therapeutic features of dietary importance were identified. Eating custard apple is helpful in curing many diseases and disorders. It is full of vitamin-A and C anti-oxidants, which helps to combat many diseases and also enhances the immune system. Custard apple contains about 28-55% of edible portion consisting of 73.30% moisture, TSS of 16 to 25° Brix, pH of 5.6 and 0.5% tannins, 1.60% protein, 0.30% fat, 0.70% mineral matter, 23.90% carbohydrates, 0.20% calcium, 0.40% phosphorous, 1.0% iron, 12.4-18.15% sugar, 0.26-0.65% acidity and with a calorific value of 105 Kcal/100g. Custard apple is one of the delicious fruits relished by many for table purposes due to its pleasant flavor, mild aroma and sweet taste (Pilania *et al.* 2010) ^[17]. The main sugars have been reported as glucose and fructose (80-90%) (Kumar *et al.* 2015) ^[9, 10]

Materials and Methods

Chemical analysis of fruits was done in the Quality Laboratory, K.D. College of Horticulture & Research Station, Dharmapura-02, Jagdalpur (Bastar), (C.G.).

Titration acidity (%)

The acidity of the 10 g pulp sample was measured by titrating with 0.1 N NaOH while using phenolphthalein as an indicator after diluting an aliquot of the sample with distilled water. The final point has a light pink colour (Ranganna, 1986) ^[19].

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$$\text{Titration Acidity (\%)} = \frac{\text{Titre X Normality of NaOH X volume made up X Eq. Wt. of acid X 100}}{\text{Volume of aliquot taken for estimation X Wt. / Volume of sample taken X 1000}}$$

Total Soluble Solids (°Brix)

All genotypes of custard apple pulp's Total Soluble Solids (TSS), which is measured in °Brix and based on the total refraction principle, were measured using a hand Refractometer at 20 °C.

Total sugar (%)

The total sugar content was estimated using Hage and Hoffreiter's (1962) [16].

Reducing sugar (%)

The reducing sugar was estimated using by dinitrosalicylic

method (Miller, 1959) [14].

Non- reducing sugar (%)

The value of reducing sugar was eliminated from total sugar to determine the value of non-reducing sugar. A percentage was used to indicate the non-reducing sugar. Non-reducing sugar (%) = Total sugar (%) - Reducing sugar (%).

Ascorbic acid (mg/100 g)

A 2-6 dichlorophenol-indophenol (dye) visual titration method, somewhat modified from that described by Ranganna (1986) [19], was used to assess the ascorbic acid concentration in fruit pulp.

$$\text{Ascorbic acid (mg/100 gm)} = \frac{\text{Titre value X dye factor X volume made up X 100}}{\text{ml of aliquot taken for estimation X wt. / vol. of sample taken for estimation}}$$

Pulp texture

It was observed as granular, smooth, cloudy soft and granular.

Results and Discussion

Titration Acidity (%)

The data for the titratable acidity have been recorded different custard apple genotypes and are shown in table 1. The range of minimum and maximum acidity percentage was 0.21 to 0.38%. The highest Titratable acidity% BCA-10 (0.38%) at par BCA-4 (0.35%), BCA-7 and BCA-8 are show similar result had the lowest percentage of Titratable acidity, though (0.21%) at par BCA-6 (0.22%) and BCA-13 and Madhur (check) are showed similar result (0.24%), respectively. Different kinds of organic acids and the extent of their concentration play an important role in the flavoring of a fruit. The acidity of the fruits may also be impacted by other climatic variables like temperature, humidity and sun exposure during fruit growth. In the case of custard apple pulp, similar findings were also made by Mathakar (2005) [12], Bhatnagar *et al.* (2012) [2], Hashmi and Pawar (2012) [5] and Poyam *et al.* (2022) [18], respectively.

Total soluble solid (°Brix)

Data pertaining to TSS (°Brix) are depicted in table 1 depicted and revealed that the genotypes varied significantly for TSS (°Brix). The range of TSS 19.28 to 24.63 (°Brix). The maximum TSS (24.63 °Brix) was recorded in genotypes BCA-7 which was found significantly highest among investigated custard apple genotypes at par which was BCA-14, Madhur (check), BCA-2, BCA-10 (24.34, 22.90, 22.53 and 22.40 °Brix). Whereas, the minimum TSS (°Brix) was obtained in BCA-1 19.28 (°Brix) and which is at par BCA-9, BCA-15, BCA-5, BCA-6, BCA-8 and BCA-11 (19.73, 20.20, 20.26, 21.34, 21.34 and 21.53 °Brix), respectively. Maximum TSS (°Brix) is one of the important indicators of the quality of a dessert because it indicates fruits with high sugar content. The increase in TSS (°Brix) might be due to conversion of starch and their insoluble carbohydrate into soluble form of sugar which is responsible for increasing the TSS (°Brix) content as also reported by Ghosh *et al.* (2001) [4], Hashmi and Pawar (2012) [5], Nag (2017) [15], Bhatnagar

and Singh (2018) [1] and Poyam *et al.* (2022) [18] in custard apple.

Total sugar (%)

The significant differences in the total sugar (%) were also noted amongst the custard apple genotypes (Table 1). The percentage of total sugar (%) varied from 19.43 to 25.37%. The highest percentage of total sugars (%) was recorded in BCA-3 (25.37%) was at par with BCA-4 (25.28%), BCA-3 (24.72%) and BCA-2 (23.05%) while it was found significantly lowest in BCA-8 (19.43%), respectively. The variation observed in total sugar (%) might be as a consequence of existing variability in genotypes, inheritance and influence of agro climatic conditions. These results are in agreement with the reports of Mathakar (2005) [12], Nag (2017) [15] and Chandel (2017) [3] in custard apple.

Reducing sugar (%)

The data regarding reducing sugar are presented in Table 1. The reducing sugar (%) of various custard apple genotypes under study ranged from 15.77 to 21.61%. Maximum value for reducing sugar (%) was recorded in genotypes BCA-3 (21.61%) which was significantly higher among the genotypes which is were at par BCA-4 (21.28%) and BCA-5 (20.66%), while minimum reducing sugar (%) (15.77%) was noted in BCA-8, which were at par Madhur (check), BCA-7, BCA-10, BCA-13, BCA-9, BCA-11, BCA-6, BCA-15, BCA-1 and BCA-12 (16.08, 16.25, 16.50, 16.55, 16.68, 16.71, 16.82, 17.85, 17.93 and 18.03%), respectively. The reducing sugar of fruits from different genotypes varied due to difference in genetic makeup of the genotypes. High reducing sugar in custard apple genotypes BCA-3 might be attributed to presence of more monosaccharide and disaccharides like glucose and fructose in these genotype's fruits during maturity. Similar findings were also reported by Ghosh *et al.* (2001) [4], Nag (2017) [15], and Poyam *et al.* (2022) [18] in custard apple.

Non-reducing sugar (%)

Table 1 lists the observations about non-reducing sugar (%) among the different genotypes of custard apples under investigation. The range of non reducing sugar (%) is 3.66 to 4.73%. The custard apple genotypes BCA-2 recorded the

maximum non-reducing sugar% (4.73%), which were at par BCA-12 (4.29%) whereas genotype BCA-8 and BCA-11 (3.66%) are similar BCA-3 (3.76%), BCA-6 (3.86%) recorded the lowest non-reducing sugar.

Ascorbic acid (mg/100 g pulp)

The data on ascorbic acid (mg/100 g pulp) in the different genotypes of custard apple (Table 1.) showed that the genotype BCA-5 (25.28 mg/100 g pulp) had the highest percentage of ascorbic acid, followed by BCA-4 and BCA-8 (22.78 mg/100 g pulp) are show similar result, while minimum ascorbic acid was recorded in BCA-2 (16.39 mg/100 g pulp) which were at par BCA-1, BCA-12 and BCA-4 (17.22, 17.50 and 18.33 mg/100 g pulp), respectively. Variation in ascorbic acid in different custard apple genotypes is greatly influenced by genetic makeup of different genotypes. The increase in ascorbic acid content in custard apple genotypes might be due to rapid increase in

total sugar as the fruit synthesizes ascorbic acid from hexose sugar precursor in custard apple, Similar results were also reported by Hashmi and Pawar (2012) ^[5], Kumar (2015) ^[9], Kad *et al.* (2016) ^[7], Nag (2017) ^[15] and Poyam *et al.* (2022) ^[18] in custard apple.

Pulp texture

The grittiness of pulp was recorded as soft and granular and presented under Table 1 Out of 16 custard apple genotypes 8 custard apple genotypes viz., BCA-1, BCA-2, BCA-3, BCA-4, BCA-7, BCA-11, BCA-14 and BCA-15 had granular texture and 8 genotypes viz., BCA-5, BCA-6, BCA-8, BCA-9, BCA-10, BCA-12, BCA-13 and Madhur (check) had soft texture. Genetic makeup and climatic factors are the primary factors of the fruit's pulp texture. Similar findings were also obtained by Mathakar (2005) ^[12], Nag (2017) ^[15] and Chandel (2017) ^[3] in custard apple.

Table 1: Qualitative parameters of *in-situ* custard apple genotypes Titrable Acidity (%), Total Soluble Solid (°Brix), Total Sugar (%), Reducing Sugar (%) and Non- Reducing sugar (%)

Treatments	Genotypes	Titrable Acidity (%)	TSS (°Brix)	Total Sugar (%)	Reducing Sugar (%)	Non-Reducing Sugar (%)	Ascorbic acid (mg/100 g pulp)	Pulp texture
T ₁	BCA-1	0.29	19.28	21.98	17.93	4.05	17.22	Granular
T ₂	BCA-2	0.25	22.53	23.05	18.32	4.73	16.39	Granular
T ₃	BCA-3	0.31	22.28	25.37	21.61	3.76	20.28	Granular
T ₄	BCA-4	0.35	22.28	25.28	21.28	4.00	22.78	Granular
T ₅	BCA-5	0.31	20.26	24.72	20.66	4.06	25.28	Soft
T ₆	BCA-6	0.22	21.34	20.68	16.82	3.86	19.44	Soft
T ₇	BCA-7	0.21	24.63	20.20	16.25	3.95	22.50	Granular
T ₈	BCA-8	0.21	21.34	19.43	15.77	3.66	22.78	Soft
T ₉	BCA-9	0.32	19.73	20.60	16.68	3.91	20.28	Soft
T ₁₀	BCA-10	0.38	22.40	20.54	16.50	4.04	19.44	Soft
T ₁₁	BCA-11	0.26	21.53	20.37	16.71	3.66	20.56	Granular
T ₁₂	BCA-12	0.27	20.61	22.33	18.03	4.29	17.50	Soft
T ₁₃	BCA-13	0.24	22.33	22.02	18.13	3.90	20.56	Granular
T ₁₄	BCA-14	0.26	24.34	20.39	16.55	3.85	18.33	Granular
T ₁₅	BCA-15	0.31	20.20	21.92	17.85	4.06	19.72	Granular
T ₁₆	Madhur (Check)	0.24	22.90	20.10	16.08	4.02	20.78	Soft
	S.E. m±	0.011	0.799	0.88	0.918	0.173	0.765	
	C.D.at 5%	0.033	2.311	2.546	2.655	0.5	2.214	
	C.V. (%)	7.107	6.36	6.986	8.916	7.51	6.547	

Conclusion

The current study's observations, which include those related to acidity, T.S.S. and sugars, indicate diversity in biochemical characteristics. The different custard apple genotypes are available in different type of chemical characters of fruits. On the basis of chemical evaluation, custard apple genotypes BCA-4, BCA-5 and BCA-8 can be developed as custard apple varieties in future and can be used for commercial cultivation. Essentially, this work serves as a foundation for the biochemical characterisation of genotypes of custard apples and the assessment of genetic variation within them. BCA-10, BCA-7, BCA-3, and BCA-5 recorded highest desirable characters. While TSS, acidity and reducing sugars are desired biochemical characteristics found in all four genotypes BCA-10, BCA-7, BCA-3 and BCA-5, there is a large variation in the genotypes of custard apples under investigation for biochemical properties.

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