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Collection and evaluation of custard apple landraces from Nandurbar (MS), India

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Abstract
Present investigation entitled "Collection and evaluation of elite custard apple (*Annona squamosa* L.) genotypes from Dhadgoan tehsil of Nandurbar district" was carried out during April-November 2022, on the basis of physical and qualitative characters. Dhadgoan tehsil in Satpuda hills is known for rich biodiversity of custard apple, which was undertaken to explore and evaluate the elite custard apple genotypes. Selected twenty five custard apple genotypes are evaluated for distinct fruit characters. These genotypes revealed wide variability in physical characters *viz*, fruit weight (157.9 g to 412 g), pulp weight (42.7 to 226 g.), pulp percentage (24.73 to 69.33%), seed weight (4.7 and 23 g), seed percentage (2.5 to 8.66%), pulp: seed ratio (4.52 to 17.5), seed: pulp ratio (0.05 to 0.22).

Keywords: Custard apple, genotype, variability, physical and qualitative characters

Introduction
Custard apple (*Annona squamosa* L.) is an important dryland fruit crop in India, commonly known as Sitaphal or Sharifa. It is a member of the "Annonaceae" family. *Annona squamosa* originated in Central America and spread to Mexico and Tropical America (Popenoe, 1974) [14]. It is commonly known as sugar apple, sweetsop, and custard apple and is found throughout Asia and America. In India, custard apples are the most popular Annonaceous fruit. Custard apples are short-season fruits with significant nutritional and medicinal properties. It is considered to be useful for disorders like cancer, diabetes, hyperthyroidism, and heart problems. Based on 100 g of fruit pulp it includes carbohydrate (23.5 g), moisture (73.30%), protein (16.6 g), mineral (0.9 g), fiber (3.1 g), calcium (17 mg), phosphorus (47 mg), iron (1.5 g) and vitamin-C (37 mg) Gopalan *et al* (1987) [14]. The fruit yields approximately 40% pulp with 26.4 ºBrix (TSS), 5.5 pH and 0.5% tannins. Ancorine is an alkaloid extracted from custard apple that has insecticidal properties. This keeps the trees free of insects, pests, disease and keeps cattle and goats from eating them. Custard apple has partially granular, creamy yellow or white, sweet flesh with good flavour and low acidity, making it the sweetest annona fruit (FAO, 1990) [5]. These fruits are often used fresh and they can be made alone or in combination with other fruits to make custard powder. It is also used in the making of ice cream. Custard apple is grown on an estimated 45,000 ha with production of 3, 90,000 MT in India (Annon. 2021). It is primarily grown in the Indian states of Andhra Pradesh, Uttar Pradesh, Maharashtra, Bihar and Assam. In Maharashtra over 7,000 hectares of land, 1, 20,880 tonnes of fruits were produced. This fruit is primarily grown in Vidharbha, Western Maharashtra and Marathwada. The majority of the research work was done in the districts of Nagpur, Pune, Solapur, Dhule, Ahamednagar, Aurangabad and Beed. The custard apple genotypes from Dhadgoan tehsil in Satpuda hills vary in various physical and quality characteristics. However, there have been very few systematic studies conducted in this area. Thus, custard apple genetic development has enormous potential through the selection of desirable genotypes from seedling progenies. In view of the preceding, the current study was undertaken with the main objective of investigating the physical features of collected custard apple genotypes.

Materials and Methods
Present investigation entitled "Collection and evaluation of elite custard apple *(Annona squamosal)* genotypes from Dhadgoan tehsil of Nandurbar district" was carried out during April -November 2022.Different twenty-fivefully grown healthy and vigorous custard apple plants aged between 10 to 15 years were selected from 40-50 km radius of different villages and forest areas of Dhadgaon tahsil in Satpuda hills for investigation.

After conducting survey, healthy and vigorous twenty-five genotypes were selected and marked. The geographic location of each genotype was noted down along with detailed information for further investigation. These were assigned the accession number as Dhadgoan Custard Apple (DCA-1 to 25). Ripened fruit collection was done during the period on October2nd weekto October 3rd week–2022, for physical analysis. Physical analysis was carried out at Laboratory, Horticulture Section, College of Agriculture, Nandurbar (Maharashtra). Evaluation of selected twenty-five custard apple genotypes for different physical characteristics in terms of fruit weight, pulp weight, pulp percentage, seed weight, seed percentage, pulp: seed ratio, seed: pulp ratio. Weight of the fruits harvested from marked genotypes, were taken with the help of electronic balance and expressed in gram. Weight of the pulp and seed separated by using spoon from fruits were taken with the help of electrical balance and expressed in terms of grams.

Results and Discussion

Physical characteristics

Fruit weight (g)

Data related to the fruit weight presented in Table.1. It showed wide variation among different genotypes. The range of fruit weight from157.9 g to 412 g. DCA-10 had highest fruit weight (412 g), which was distantly followed by DCA-4 (320.6 g), DCA-1 (310.4 g), DCA- 2 (302.8 g) and DCA-22 (300 g), while DCA-15 had lowest fruit weight (157.9 g) which is at par with DCA-14 (167.8 g),DCA-13 (170.6 g) and DCA-11 (172.6 g).The genotypes indicated by the higher fruit weight are due to larger canopy area. The larger canopy spread in genotypes may have helped to the accumulation of more photosynthates in fruit to achieve optimum fruit size. Also the genotypes which is proximity to a sorghum field was observed with larger fruits. That seems to be a great opportunity for pollination. Apart from that, age of the plant, vigor and ecological conditions can all have an impact on fruit weight. Ghosh *et al*. (2001) [6] and Singh *et al*. (2006) [3, 18] observed similar conditions, which validates the current findings. Abdul Khadar and Jaypal (1977) [1]. reported that custard apple fruit ranged from 126-483 g depending upon cultivar and environmental condition.

Pulp weight (g)

The information on average pulp weight presented in Table.1. DCA-10 had the highest pulp weight (226 g), which is at par with DCA-22 (208 g) followed by DCA-4 (145.6 g), DCA-1 (126.5 g)and DCA-11 (42.7 g) which is at par with DCA-13 (51.5 g) and DCA-12 (57.6 g).More pulp weight and fewer seeds are desirable characteristics in custard apples from the perspective of consumer desire. Many factors contribute to higher pulp weight, including fruit weight, fruit size and lesser seeds. These findings correspond with the results reported by Mathakar (2005) [12], Dikshit *et al*. (2008) [4] in custard apple and Meena *et al*. (2013) [13] in guava.

Seed weight (g)

The information about the average seed weight (g) of the several custard apple genotypes is shown in Table.1. The range of seed weight was found to be between 4.7 and 23 g. DCA-13 had the smallest seed weight (4.7 g) followed by DCA-12 (5.4 g), DCA-15 (5.5 g) DCA- 8 (6.6 g) which was equal with DCA-1. DCA-6 variety had the highest seed weight (23 g), which is at par with DCA-22 (21.6 g), DCA-4 (20.8 g), DCA-2 (20.3 g). The deposition of less photosynthates into the seed leads to the low seed weight. An excellent criterion for choosing the best genotypes was the combination of minimum seed weight and maximum pulp weight. The results showed that seed weight increased with fruit size but this was not always the true. In custard apple, our findings correspond with the findings reported by Mathakar (2005) [12], Dikshit *et al*. (2008) [4], Rao and Subramanyam (2011) and Bhatnagar *et al.* (2012) [16, 3.].

Pulp (%)

Pulp percentage of custard apple genotypes shown in Table.1. The range of pulp percentage varied from 24.73-69.33%. DCA-22 had the highest pulp percentage (69.33%), which was significantly more than the rest of genotypes studied, followed by DCA-10 (54.85 %), DCA-7 (54.26 %) and DCA-21 (50.98 %). DCA-11 had the lowest pulp percentage (24.73%) followed by DCA-13 (30.18 %), DCA-12 (30.58 %) and DCA-23 (35.58 %).The higher pulp percentage is associated with maximum pulp weight and minimum skin and seed weight.According to Abdul Khadar and Jaypal (1977) [1], the proportion of pulp in custard apple and cherimoya was 42. 4 percent and 66.4 percent.

Seed (%)

The data on seed percentage of custard apple genotypes is presented in Table.1. The range of seed percentage varied from 2.5 to 8.66%.DCA-8 had the lowest seed percentage (2.5%) which is at par with DCA-13 (2.75%), DCA-12 (2.86%) followed by DCA-15 (3.48%) and DCA-14 (3.93%). DCA-6 and DCA-7 had the maximum seed percentage (8.66%), followed by DCA-22 (7.2%).Fruit weight and pulp percentage have a significant affection on seed percentage. If pulp percentage is higher, seed percentage is unquestionably lower and vice versa. The results suggested that the weight of the seeds rises as the size of the fruit increases, although this wasn't always the case. These results are consistent with research on custard apples by Mathakar (2005) [12], Dikshit *et al.* (2008) [4], Rao and Subramanyam (2011) [16] and Bhatnagar *et al.* (2012) [3].

Pulp: Seed ratio

The pulp: Seed ratio of custard apple genotypes is shown in Table.1. The pulp: seed ratio ranged from 4.52 to 17.5. DCA-8 had the highest pulp: seed ratio (17.5) followed by DCA-10 (12.4), DCA-15 (12.2) and DCA-18 (11.1). Whereas DCA-6 had the lowest pulp: seed ratio (4.52) followed by DCA-11 (5.02), DCA-23 (5.3) and DCA-19 (5.4). Pulp: seed ratio is important criteria of genotype selection. High pulp and minimum seed fetch more market value. In relation to the pulp: seed ratio, Rodriguez Pleguezuelo *et al.* (2012) [17]. claimed that the greater the pulp: seed ratio, the more economically valuable the mango type.

Seed: Pulp ratio

The data for seed: pulp ratio of custard apple genotypes is shown in Table.1. The seed: pulp ratio ranged from 0.05 to 0.22. The lowest seed: pulp ratio (0.05) was found in DCA-8 which is at par with DCA-10, DCA-15, DCA-18 (0.08) followed by DCA-12 and DCA-13 (0.09). Maximum seed: pulp ratio was found in DCA-6 (0.22) followed by DCA-11 (0.19), DCA-19 and DCA-23 (0.18). However, the highest

seed: pulp ratio in genotype was due to high seed weight and low pulp weight, indicating that this genotype is unsuitable for processing or consumer liking.

Table 1. Physical and quality characters of custard apple genotypes

Genotype no.	Fruit weight (g)	Pulp weight (g)	Seed weight (g)	Pulp (%)	Seed (%)	Pulp: Seed ratio	Seed: pulp ratio
DCA-1	310.40	126.50	20.20	40.75	6.50	6.26	0.15
DCA-2	302.80	121.20	20.30	40.02	6.70	5.97	0.16
DCA-3	287.50	123.20	16.70	42.85	5.80	7.37	0.13
DCA-4	320.60	145.60	20.80	45.41	6.48	7.00	0.14
DCA-5	278.20	105.00	18.00	37.74	6.47	5.80	0.17
DCA-6	265.30	104.00	23.00	39.20	8.66	4.52	0.22
DCA-7	233.10	126.50	20.20	54.26	8.66	6.26	0.15
DCA-8	263.90	116.00	6.60	43.95	2.50	17.50	0.05
DCA-9	265.40	111.20	16.50	41.89	6.21	6.70	0.14
DCA-10	412.00	226.00	18.10	54.85	4.39	12.40	0.08
DCA-11	172.60	42.70	8.50	24.73	4.92	5.02	0.19
DCA-12	188.30	57.60	5.40	30.58	2.86	10.60	0.09
DCA-13	170.60	51.50	4.70	30.18	2.75	10.90	0.09
DCA-14	167.80	61.20	6.60	36.47	3.93	9.27	0.10
DCA-15	157.90	67.40	5.50	42.68	3.48	12.20	0.08
DCA-16	199.80	90.40	9.37	45.24	4.68	9.64	0.10
DCA-17	208.50	88.00	8.00	42.20	3.83	10.00	0.10
DCA-18	199.80	92.60	8.34	46.34	4.17	11.10	0.08
DCA-19	200.40	72.20	13.30	36.02	6.63	5.40	0.18
DCA-20	203.90	86.80	10.50	42.56	5.14	8.20	0.12
DCA-21	278.50	142.00	19.30	50.98	6.92	7.30	0.13
DCA-22	300.00	208.00	21.60	69.33	7.20	9.62	0.10
DCA-23	244.50	87.00	16.20	35.58	6.62	5.30	0.18
DCA-24	241.30	97.70	12.00	40.48	4.97	8.14	0.12
DCA-25	247.80	100.30	17.00	40.47	6.86	5.88	0.17
Range	157.9-412	42.7-226	4.7-23	24.73-69.33	2.5-8.66	4.52-17.5	0.05-0.22
Mean	244.83	106.02	13.86	42.19	5.49	8.33	0.12
SD	59.95	43.15	6.01	8.89	1.72	3.01	0.04
Variance	3594.21	1862.69	36.17	79.17	2.98	9.09	0.001
SE(m).±	11.99	8.63	1.20	1.78	0.34	0.60	0.008
CV (%)	24.48	40.70	43.36	21.07	31.32	36.19	32.96

Conclusions

From the above findings, there is significant variation has been observed in both physical and qualitative characters of custard apple genotypes, which can be exploit for making selection of elite types. Based on overall performance and considering all characters together genotypes DCA-3, DCA-9, DCA-4, DCA-1, DCA-2, DCA-10, and DCA-22 have been observed to be superior in terms of physical characteristics. These promising strains could be used in the next phase of custard apple selection and improvement. Genotypes DCA-15 and DCA-11 were found inferior in maximum traits. Superior genotypes in physical characters were found to be inferior characters. Adoption of modified horticulture approaches can help to overcome this barrier.

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