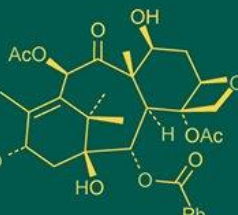
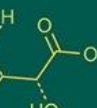
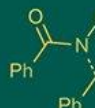


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; SP-10(9): 222-226
www.biochemjournal.com
Received: 28-07-2026
Accepted: 01-09-2026

WR Shinde
M.Sc. Scholar (Fruit Science),
Department of Fruit Science,
Dr. P.D.K.V, Akola,
Maharashtra, India

SR Patil
Professor, Department of Fruit
Science, Dr. PDKV, Akola,
Maharashtra, India

DM Panchbhai
Director of Instruction and
Dean, Faculty of Agriculture,
Dr. PDKV, Akola,
Maharashtra, India

GG Jadhav
Deputy Director, Central
Research Station, Dr.
P.D.K.V. Akola, Maharashtra,
India

MS Janbandhu
Ph. D. Scholar, Department of
Fruit Science, Dr. P.D.K.V,
Akola, Maharashtra, India

Apeksha B Kamble
Ph. D. Scholar, Department of
Fruit Science, Dr. P.D.K.V,
Akola, Maharashtra, India

Corresponding Author:
WR Shinde
M.Sc. Scholar (Fruit Science),
Department of Fruit Science,
Dr. P.D.K.V, Akola,
Maharashtra, India

Evaluation of custard apple genotypes for biochemical characterization under Vidarbha conditions

WR Shinde, SR Patil, DM Panchbhai, GG Jadhav, MS Janbandhu and Apeksha B Kamble

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9Sc.9838>

Abstract

A field investigation was conducted during 2025-26 at the Western Block, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The present investigation was undertaken to evaluate forty custard apple seedling originated genotypes for variability in important fruit biochemical characteristics. Considerable variation was observed among the genotypes for total sugars, reducing sugars, non-reducing sugars, total soluble solids (TSS) and titratable acidity. Total sugars ranged from 12.99 to 19.96 per cent, while reducing and non-reducing sugars varied from 10.20 to 16.77 and 1.87 to 3.56 per cent, respectively. The highest total and reducing sugar contents were recorded in AKCA-24, whereas AKCA-35 exhibited the highest non-reducing sugars content. TSS varied from 20.38 to 29.25 °Brix, with AKCA-17 recording the maximum value. Titratable acidity ranged from 0.22 to 0.80 per cent, with the lowest value recorded in AKCA-16. Genotypes AKCA-17, AKCA-10, AKCA-6 and AKCA-16 exhibited a desirable combination of high TSS and comparatively low acidity. The study identified considerable genetic variability for fruit quality traits and the superior genotypes may serve as valuable material for further evaluation, conservation and breeding programmes for improvement of custard apple fruit quality.

Keywords: Custard apple, biochemical traits

1. Introduction

Custard apple (*Annona squamosa* L.) belonging to the family Annonaceae, is an important tropical and subtropical fruit crop widely cultivated in India. It is popularly known as Sitaphal or Sharifa and is valued for its sweet, creamy pulp, nutritional properties and suitability for cultivation under dryland conditions. The fruit is rich in carbohydrates, dietary fiber, minerals, vitamin C and antioxidants and is consumed mainly as a fresh fruit and also used in the preparation of ice cream, beverages and other processed products.

Custard apple is a hardy fruit crop capable of growing under marginal soils and relatively drought-prone conditions, making it particularly important for resource-constrained farmers. A wide range of variability exists in custard apple for important biochemical TSS, acidity, different sugars. Such variability provides an important opportunity for the identification and selection of superior genotypes. However, only a limited number of varieties are commercially cultivated in India, indicating considerable scope for varietal improvement and genetic resource utilization (Janbandhu *et al.* 2018)^[6].

Systematic characterization and evaluation of available custard apple genotypes are essential for identifying promising genotypes and utilizing them in future breeding and crop improvement program.

2. Material and Methods

The experiment was conducted during 2025-26 in a five-year-old custard apple orchard at the Western Block, Central Research Station, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The site had medium, well-drained soil. Forty seedling-origin custard apple genotypes, designated AKCA-1 to AKCA-40 were evaluated. The plants were spaced at 4 × 3 m. The experimental was laid out in RBD framework with single-plant analysis. Biochemical attributes including TSS, titratable acidity, reducing sugars, non-reducing sugars and total sugars were also evaluated.

2.1. Total sugars (%)

Total sugars were determined by Dubois method (Dubois *et.al.*, 1951)^[2]. In this method, 5 per cent phenol and 96 per cent concentrated H₂SO₄ was used to carry out analysis.

$$\text{Total sugar (\%)} = (\text{reading of graph}) \times \frac{1}{1000000} \times \frac{100}{1} \times \frac{50}{1} \times \frac{100}{\text{weight of sample}}$$

2.2. Reducing sugars (%)

The Reducing sugars content were estimated by Spectrophotometric method as described by Somogyi (1952)^[10]. One gram of the mature fruit was weighed and macerated with 5 ml of hot 80% ethanol and supernatant were collected. Then it was evaporated in water bath at

Absorbance of the sample was noted at 490 nm and graph values were put in the following formula to estimate the final value of total sugar.

80°C. The residue was dissolved in 5 ml distilled water to make extract in different volume, the absorbance was recorded at 620 nm in spectrophotometer and compared against standard glucose solution. Reducing sugars was calculated by using the following formula.

$$\text{Reducing sugars (\%)} = (\text{reading of graph}) \times \frac{1}{1000000} \times \frac{100}{1} \times \frac{100}{1} \times \frac{1}{\text{weight of sample}}$$

2.3. Non-reducing sugars (%)

The content of non- reducing sugars was calculated using the following formula (Ranganna, 1986)^[9].

$$\text{Non reducing sugars (\%)} = \text{Total sugars (\%)} - \text{Reducing sugars (\%)}$$

2.4. TSS (°B)

Total Soluble Solids (TSS) of fruit was recorded by using hand refractometer. Drop of extracted aonla juice was put on the hand refractometer prism (Atago India instrument Pvt.Ltd, Mumbai) and reading was recorded and expressed in terms of degree °B. Five readings were taken in each replication of treatment and their average value was calculated.

2.5. Titratable acidity (%)

Titratable acidity of the extracted juice was determined by titrating it against 0.1 N NaOH solution using phenolphthalein as an indicator and expressed as percentage in terms of citric acid (AOAC, 1990)^[1].

$$\text{Titratable acidity (\%)} = \frac{\text{Titre value} \times \text{Equivalent weight of Citric acid} \times 100}{\text{Volume of sample} \times 1000}$$

3. Results and Discussion

The biochemical analysis of the forty custard apple genotypes for total sugars, reducing sugars and non-reducing sugars are presented in Table 1. A substantial degree of variation was recorded among the genotypes for all the sugar- related parameters, indicating the presence of considerable genetic diversity with respect to fruit quality.

3.1. Total sugars (%): The total sugar content of the evaluated genotypes ranged from 12.99 to 19.96%, with an overall mean of 16.04%. The maximum total sugars content (19.96%) was observed in AKCA-24, followed by AKCA-35 (19.31%), AKCA-4 (18.41%), AKCA-26 (18.29%), AKCA-23 (18.27%), AKCA-32 (18.16%), AKCA-7 (17.99%), AKCA-12 (17.91%), AKCA-17 (17.35%), AKCA-8 (17.32%), AKCA-22 (17.15%) and AKCA-31 (17.04%). These genotypes were characterized by relatively higher sugars accumulation and may therefore be regarded as superior for fruit sweetness.

Genotypes such as AKCA-3, AKCA-5, AKCA-6, AKCA-9, AKCA-10, AKCA-14, AKCA-16, AKCA-18, AKCA-20, AKCA-21, AKCA-25, AKCA-27, AKCA-28, AKCA-30, AKCA-33, AKCA-36, AKCA-39 and AKCA-40 exhibited intermediate levels of total sugars (15.00-17.00%). Lower total sugars content (below 15.00%) was recorded in AKCA-1(14.71%), AKCA-2(14.12%), AKCA-11(13.21%), AKCA-13(13.69%), AKCA-15(13.18%), AKCA-19(12.99%), AKCA-29(13.33%), AKCA-34(14.41%), AKCA-37(13.32%) and AKCA-38(13.48%). The coefficient of variation (3.93%) indicated that the experimental observations were highly reliable with minimum environmental variation. The similar results were also found from the experiments of George and Nissen (1987)^[4], Jalikop (2007)^[5], Patel *et al.* (2011)^[8], Ghawade *et al.* (2018)^[3] and Kumar *et al.* (2017)^[7] who also documented substantial genetic variability in total sugar constituents among custard apple germplasm and highlighted their importance as key determinants of fruit quality.

Table 1: Performance of custard apple genotypes based on Total sugars, Reducing sugars and Non-reducing sugars.

Genotypes	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)
AKCA-1	14.71	12.06	2.70
AKCA-2	14.12	11.89	2.23
AKCA-3	16.31	14.08	2.71
AKCA-4	18.41	14.55	3.20
AKCA-5	15.02	12.25	3.01
AKCA-6	16.52	14.01	2.51
AKCA-7	17.99	15.68	2.24
AKCA-8	17.32	14.07	3.09
AKCA-9	15.16	12.44	2.72
AKCA-10	15.69	12.92	3.00
AKCA-11	13.21	10.66	2.79
AKCA-12	17.91	14.85	2.96
AKCA-13	13.69	10.57	3.12
AKCA-14	16.53	14.35	2.03
AKCA-15	13.18	10.30	2.88
AKCA-16	16.04	13.04	3.00
AKCA-17	17.35	13.96	3.26
AKCA-18	16.42	13.59	3.10
AKCA-19	12.99	10.57	2.39
AKCA-20	15.11	12.11	3.00
AKCA-21	16.77	13.84	2.99
AKCA-22	17.15	14.81	3.07
AKCA-23	18.27	15.32	2.92
AKCA-24	19.96	16.77	3.09
AKCA-25	16.47	14.24	2.23
AKCA-26	18.29	15.23	3.06
AKCA-27	16.86	13.90	2.97
AKCA-28	16.38	13.24	3.21
AKCA-29	13.33	10.28	2.97
AKCA-30	15.59	13.29	2.18
AKCA-31	17.04	13.79	3.36
AKCA-32	18.16	15.00	3.14
AKCA-33	16.33	13.57	2.87
AKCA-34	14.41	11.35	3.08
AKCA-35	19.31	15.30	3.56
AKCA-36	16.21	14.32	1.87
AKCA-37	13.32	10.20	3.11
AKCA-38	13.48	11.28	2.44
AKCA-39	15.31	11.33	2.84
AKCA-40	15.25	12.22	3.05
Range	12.99 to 19.96	10.20 to 16.77	1.87 to 3.56
General Mean	16.04	13.18	2.85
S.D.	0.45	0.49	0.23
Variance	3.23	2.91	0.14
S.E.(m) $\pm$	0.32	0.35	0.16
C.V.	3.93	5.30	11.54

3.2. Reducing sugars (%): Reducing sugars content varied from 10.20 to 16.77% with an average value of 13.18%. The highest concentration (16.77%) was recorded in AKCA-24, followed by AKCA-7 (15.68%), AKCA-23 (15.32%), AKCA-35 (15.30%), AKCA-26 (15.23%), AKCA-32 (15.00%), AKCA-12 (14.85%), AKCA-22 (14.81%), AKCA-4 (14.55%), AKCA-14 (14.35%), AKCA-36 (14.32%), AKCA-25 (14.24%), AKCA-3 (14.08%), AKCA-8 (14.07%) and AKCA-6 (14.01%).

Moderate reducing sugar levels (12.00-14.00%) were found in AKCA-5 (12.25%), AKCA-9 (12.44%), AKCA-10 (12.92%), AKCA-16 (13.04%), AKCA-17 (13.96%), AKCA-18 (13.59%), AKCA-20 (12.11%), AKCA-21 (13.84%), AKCA-27 (13.90%), AKCA-28 (13.24%), AKCA-30 (13.29%), AKCA-31 (13.79%), AKCA-33 (13.57%) and AKCA-40 (12.22%), whereas AKCA-1 (12.06%), AKCA-2 (11.89%), AKCA-11 (10.66%), AKCA-

13 (10.57%), AKCA-15(10.30%), AKCA-19 (10.57%), AKCA-29 (10.28%), AKCA-34 (11.35%), AKCA-37 (10.20%), AKCA-38 (11.28%) and AKCA-39 (11.33%) contained comparatively lower amounts of reducing sugars. The coefficient of variation (5.30%) reflected acceptable experimental precision for this character. The present result is consistent with earlier findings reported by George and Nissen (1987) ^[4], Jalikop (2007) ^[5], Patel *et al.* (2011) ^[8], Ghawade *et al.* (2018) ^[3] and Kumar *et al.* (2017) ^[7], who also documented substantial genetic variability in reducing sugars constituents among custard apple germplasm and highlighted their importance as key determinants of fruit quality.

3.3. Non-reducing sugars (%): The non-reducing sugars content showed noticeable differences among the genotypes, ranging between 1.87 and 3.56% with an average of 2.85%.

The highest value (3.56%) was recorded in AKCA-35, followed by AKCA-31 (3.36%), AKCA-17 (3.26%), AKCA-28 (3.21%), AKCA-4 (3.20%), AKCA-32 (3.14%), AKCA-13 (3.12%), AKCA-37 (3.11%), AKCA-18 (3.10%), AKCA-8 (3.09%), AKCA-24 (3.09%), AKCA-34 (3.08%), AKCA-22 (3.07%), AKCA-26 (3.06%) and AKCA-40 (3.05%).

The lowest non-reducing sugars content (1.87%) was observed in AKCA-36, followed by AKCA-14 (2.03%), AKCA-30 (2.18%), AKCA-2 (2.23%), AKCA-25 (2.23%), AKCA-7 (2.24%), AKCA-20 (2.39%), AKCA-38 (2.44%) and AKCA-6 (2.51%). The coefficient of variation (11.54%) suggested comparatively higher variability for this biochemical trait than for total and reducing sugars.

The observed differences in sugars composition among the custard apple genotypes are primarily attributed to genetic variation influencing carbohydrate synthesis, translocation and accumulation during fruit growth and ripening. Sugar composition plays a vital role in determining sweetness, flavour, processing quality and consumer preference. Genotypes possessing higher concentrations of total and reducing sugars are generally considered desirable for fresh consumption as well as industrial processing.

Among the evaluated genotypes, AKCA-24 proved superior for total and reducing sugar content, whereas AKCA-35 exhibited the highest level of non-reducing sugars. These genotypes therefore represent valuable genetic resources for quality improvement and may be effectively utilized in future breeding programmes aimed at developing superior custard apple cultivars.

The present observations are consistent with earlier findings reported by George and Nissen (1987) [4], Jalikop (2007) [5], Patel *et al.* (2011) [6], Ghawade *et al.* (2018) [3] and Kumar *et al.* (2017) [7], who also documented substantial genetic variability in sugar constituents among custard apple germplasm and highlighted their importance as key determinants of fruit quality.

3.4 Total Soluble Solids (°Brix)

The observations on total soluble solids (TSS) recorded for the forty custard apple genotypes are presented in Table 2. A substantial variation in TSS was evident among the genotypes with values ranging from 20.38 to 29.25 °Brix and an overall mean of 24.03 °Brix. The highest TSS (29.25 °Brix) was recorded in AKCA-17, followed by AKCA-10 (28.83 °Brix), AKCA-6 (28.80 °Brix), AKCA-16 (28.15 °Brix), AKCA-31 (27.88 °Brix), AKCA-21 (27.85 °Brix), AKCA-27 (27.80 °Brix), AKCA-18 (27.75 °Brix), AKCA-24 (27.15 °Brix), AKCA-23 (26.98 °Brix) and AKCA-26 (26.25 °Brix). On contrast, the lowest TSS was observed in AKCA-37 (20.38 °Brix), followed by AKCA-15 (20.58 °Brix), AKCA-28 (21.13 °Brix), AKCA-29 (21.15 °Brix), AKCA-11 (21.18 °Brix) and AKCA-13 (21.25 °Brix).

Based on the magnitude of TSS, the genotypes were grouped into three categories. Genotypes possessing high TSS (>26.00 °Brix) included AKCA-6 (28.80°Brix), AKCA-10 (28.83°Brix), AKCA-16 (28.15°Brix), AKCA-17 (29.25°Brix), AKCA-18 (27.75°Brix), AKCA-21 (27.85°Brix), AKCA-23 (26.98°Brix), AKCA-24 (27.15°Brix), AKCA-26 (26.25°Brix), AKCA-27 (27.80°Brix) and AKCA-31 (27.88°Brix), indicating their superiority in terms of sweetness and overall fruit quality. The medium TSS group (23.00-26.00 °Brix) comprised AKCA-4 (25.25°Brix), AKCA-5 (23.03°Brix), AKCA-7

(25.55°Brix), AKCA-8 (24.20°Brix), AKCA-12 (23.95°Brix), AKCA-22 (25.95°Brix), AKCA-32 (25.63°Brix), whereas lower TSS group (<23.00 °Brix) comprised. The coefficient of variation (2.39%) indicated a high degree of experimental precision and limited environmental variation for this character.

Table 2: Performance of custard apple genotypes based on Total soluble solids and Titratable acidity

Genotypes	Total Soluble Solids (°Brix)	Titratable acidity (%)
AKCA-1	22.35	0.34
AKCA-2	22.68	0.53
AKCA-3	22.30	0.33
AKCA-4	25.25	0.60
AKCA-5	23.03	0.37
AKCA-6	28.80	0.24
AKCA-7	25.55	0.51
AKCA-8	24.20	0.64
AKCA-9	22.33	0.33
AKCA-10	28.83	0.25
AKCA-11	21.18	0.35
AKCA-12	23.95	0.64
AKCA-13	21.25	0.36
AKCA-14	22.45	0.35
AKCA-15	20.58	0.31
AKCA-16	28.15	0.22
AKCA-17	29.25	0.24
AKCA-18	27.75	0.38
AKCA-19	21.25	0.35
AKCA-20	22.70	0.80
AKCA-21	27.85	0.46
AKCA-22	25.95	0.47
AKCA-23	26.98	0.44
AKCA-24	27.15	0.47
AKCA-25	22.28	0.39
AKCA-26	26.25	0.45
AKCA-27	27.80	0.53
AKCA-28	21.13	0.34
AKCA-29	21.15	0.35
AKCA-30	22.20	0.33
AKCA-31	27.88	0.47
AKCA-32	25.63	0.55
AKCA-33	22.23	0.34
AKCA-34	21.50	0.34
AKCA-35	22.88	0.66
AKCA-36	22.13	0.33
AKCA-37	20.38	0.31
AKCA-38	21.43	0.36
AKCA-39	22.40	0.35
AKCA-40	22.38	0.34
Range	20.38 to 29.25	0.22 to 0.80
General Mean	24.03	0.41
S.D.	0.41	0.03
Variance	7.57	0.01
S.E.(m) ±	0.29	0.02
C.V.	2.39	9.91

Total soluble solids are widely recognized as one of the principal quality attributes of custard apple because they represent the concentration of soluble sugars responsible for sweetness, flavour and consumer acceptability. Genotypes with elevated TSS are generally preferred for fresh consumption as well as processing. The consistently high TSS recorded in AKCA-17, followed by AKCA-10 and AKCA-6, highlights their potential as promising genotypes for quality improvement and breeding programmes.

The findings of the present investigation are consistent with those of Ghawade *et al.* (2018) [3], who reported substantial diversity in TSS among custard apple genotypes. Comparable results have also been documented by George and Nissen (1987) [4], Jalikop (2007) [5], Patel *et al.* (2011) [8] and Kumar *et al.* (2017) [7], who concluded that TSS is primarily under genetic control and can be effectively utilized as a selection criterion for identifying superior quality genotypes.

3.5 Titratable Acidity (%)

The data relating to titratable acidity of the custard apple genotypes are presented in Table 2. Marked differences were observed among the forty genotypes, with acidity ranging from 0.22 to 0.80% and a general mean of 0.41%. The highest acidity (0.80%) was recorded in AKCA-20, followed by AKCA-35 (0.66%), AKCA-8 (0.64%), AKCA-12 (0.64%), AKCA-4 (0.60%), AKCA-32 (0.55%), AKCA-2 (0.53%), AKCA-27 (0.53%), AKCA-7 (0.51%), AKCA-22 (0.47%), AKCA-24 (0.47%), AKCA-31 (0.47%), AKCA-21 (0.46%), AKCA-26 (0.45%) and AKCA-23 (0.44%). The lowest acidity was observed in AKCA-16 (0.22%), followed by AKCA-6 (0.24%), AKCA-17 (0.24%), AKCA-10 (0.25%), AKCA-15 (0.31%) and AKCA-37 (0.31%).

On the basis of titratable acidity, the genotypes were categorized into three groups. The high-acidity group (>0.50%) consisted of AKCA-2 (0.53%), AKCA-4 (0.37%), AKCA-7 (0.51%), AKCA-8 (0.64%), AKCA-12 (0.64%), AKCA-20 (0.80%), AKCA-27 (0.53%), AKCA-32 (0.55%) and AKCA-35 (0.66%). Most of the remaining genotypes fell within the moderate acidity range (0.35-0.50%), whereas AKCA-6 (0.24%), AKCA-10 (0.25%), AKCA-16 (0.22%) and AKCA-17 (0.24%) exhibited low acidity (<0.30%). The coefficient of variation (9.91%) indicated a moderate level of variability among the evaluated genotypes.

Titratable acidity is an important biochemical trait that contributes significantly to fruit taste, flavour balance and processing quality. Fruits possessing lower acidity in combination with higher TSS generally exhibit superior eating quality due to a more favorable sugar-to-acid ratio. In the present investigation, AKCA-17 (0.24%), AKCA-10 (0.25%), AKCA-6 (0.24%) and AKCA-16 (0.22%) combined high TSS with comparatively low acidity, making them highly desirable genotypes for fresh consumption and potential parental material in breeding programs aimed at improving fruit quality.

The present results are in accordance with earlier reports of George and Nissen (1987) [4], Ghawade *et al.* (2018) [3], Jalikop (2007) [5], Patel *et al.* (2011) [8] and Kumar *et al.* (2017) [7], who also documented significant variation in titratable acidity among custard apple germplasm. These studies emphasized that genotypes possessing higher TSS together with lower acidity are preferred because they offer improved flavour, enhanced consumer acceptance and better suitability for processing purposes.

Conclusion

The study revealed considerable variability among the forty custard apple genotypes for fruit quality and biochemical traits. AKCA-17 was superior for total soluble solids (29.25 °Brix), while AKCA-24 recorded the highest total and reducing sugars. AKCA-35 was superior for non-reducing

sugars. Genotypes such as AKCA-17, AKCA-10, AKCA-6 and AKCA-16 showed a desirable combination of high TSS and low acidity. These promising genotypes may be utilized for further evaluation, conservation and breeding programmes aimed at developing superior-quality custard apple cultivars.

References

1. AOAC. Official methods of analysis, 18th Edn. Association of Official Agricultural Chemists, Washington. 1990.
2. Dubois M, Gilles KA, Hamilton JK, Rebers PA, Smith F. A colorimetric method for the determination of sugars. *Nature*. 1951;168(4265):167.
3. Ghawade PM, Supe VS, Shete MB, Idate GM. Biochemical characterization of custard apple genotypes. *Journal of Pharmacognosy and Phytochemistry*. 2018;7(4):636-638.
4. George AP, Nissen RJ. The effects of day/night temperatures on growth and dry matter production of custard apple (*Annona cherimola* × *Annona squamosa*) cultivar 'African Pride'. *Scientia Horticulturae*. 1987;31(3-4):269-274.
5. Jalikop SH, Kumar SP. New fruit varieties for arid regions: pomegranate 'Ruby' and custard apple 'Arka Sahan'. *Indian Horticulture*. 2000;45(2):19-20.
6. Janbandhu MS, Mehta A, Beese S, Pandey SK, Singh B, Patel A, *et al.* Advances and emerging trends in horticultural production and management. *Journal of Experimental Agriculture International*. 2024;46(3):47-69.
7. Kumar R, Singh S, Sharma R. Evaluation of guava (*Psidium guajava* L.) genotypes for flowering and maturity behaviour. *Indian Journal of Horticulture*. 2017;74(2):203-207.
8. Patel N, Naik AG, Arbat SS. Response of post-harvest chemical treatments on shelf-life and quality of custard apple cv. Balanagar. *Indian Journal of Horticulture*. 2011;68(4):547-550.
9. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. 2nd ed. New Delhi: Tata McGraw-Hill Publishing Company Ltd.; 1986.
10. Somogyi M. A method for the preparation of blood filtrates for the determination of sugar. *Journal of Biological Chemistry*. 1952;86(1):21-22.