The Pharma Innovation Journal 2022; 11(7): 3059-3063

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 3059-3063

www.thepharmajournal.com
Received: 09-05-2022
Accepted: 12-06-2022

Sumitra Poyam
College of Horticulture and Research Station, Jagdalpur, Chhattisgarh, India

GP Nag
College of Horticulture and Research Station, Jagdalpur, Chhattisgarh, India

Bhagwat Kumar
College of Horticulture and Research Station, Jagdalpur, Chhattisgarh, India

DP Singh
SG, College of Agriculture and Research Station, Jagdalpur, Chhattisgarh, India

Soumya Dewangan
College of Agriculture, Raipur, Chhattisgarh, India

Corresponding Author:
Sumitra Poyam
College of Horticulture and Research Station, Jagdalpur, Chhattisgarh, India

Physico-chemical properties of custard apple (*Annona squamosa* L.) genotypes of Bastar Plateau

Sumitra Poyam, GP Nag, Bhagwat Kumar, DP Singh and Soumya Dewangan

Abstract
A laboratory experiment was conducted at College of Horticulture and Research Station, Jagdalpur, IGKV, Chhattisgarh during the year 2021 to study the physico-chemical properties of custard apple ten genotypes collected from Bastar Plateau. The experiment was designed in Completely Randomized Design with three replications. The fruit has a short shelf life, there is a growing demand for custard apple to be preserved and processed into suitable value-added products. The physico-chemical properties of fruit are very important in the development of quality value added products, which also imparting good nutritional value of value added products. The physical properties of custard apple genotypes observed *i.e.* fruit weight, fruit length, fruit breadth, fruit thickness, seeded pulp weight, de-seeded pulp weight, peel weight, seed weight, fruit to pulp ratio and pulp to seed ratio. The significantly highest fruit weight and peel weight was recorded in IGCUST-LKHR-21, highest fruit length and seed weight observed in IGCUST-CHRM-21, highest fruit breadth, thickness, seeded and de-seeded pulp weight in IGCUST-KNK-21. The chemical properties *i.e.* pH, TSS and ascorbic acid was found significantly highest in IGCUST-KNK-21, highest total sugar, reducing sugar and phenol content observed in IGCUST-LKHR-21. Non-reducing sugar was found significantly highest in IGCUST-BDJ-21 and significantly highest acidity in IGCUST-LMGD-21 was observed.

Keywords: Custard apple; physical properties; chemical properties, genotypes

Introduction
Custard apple (*Annona squamosa*) one of India's most widely grown fruits. It is a member of the Annonaceae family and originated in the tropical region of the West Indies (Porwal *et al*., 2011) [16]. In India, the custard apple is also known as sugar apple, sitaphal, sweet sop and Sharifa (Ghawade *et al*., 2018) [8].

It is a tropical fruit that is widely grown throughout the West Indies, South and Central America, Ecuador, Peru, Brazil, India, Mexico, the Bahamas, Bermuda and Egypt (Kumar *et al*., 2021) [13]. The production of custard apple in India is 347 metric tonnes. Maharashtra is the largest producer state of custard apple in India, followed by Gujarat, Madhya Pradesh, Chhattisgarh, Telangana, Karnataka, Andhra Pradesh, Rajasthan, Kerala and Tamil Nadu (Anonymous, 2020). Chhattisgarh produces 53.01 metric tonnes of custard apple. Only Kanker district has natural biodiversity of the custard apple, which is spread across the Jagdalpur, Beejapur, Dantewada, Kanker, Dhamtari, Rajnandgaon, Durg, Jashpur, Surguja and Bilaspur districts (Anonymous, 2021) [2].

Custard apple has a calorific value of 105 Kcal/100g and contains approximately 28-55 per cent edible portion consisting of 73.30% moisture, 1.60% protein, 0.30% fat, 0.70% mineral matter, 23.90% carbohydrates, 0.20% calcium, 0.40% phosphorous, 1.00% iron, 12.4-18.15% sugar, 0.26-0.65% acidity and 12.4-18.15% sugar. Custard apple is a tasty fruit that many people enjoy eating because of its pleasant flavour, mild aroma and sweet taste (Pilania *et al*., 2010) [15]. Fruits are processed in the form of pulp, beverages, fermented liquor, milk shake and ice-cream (Pawar *et al*., 2007).

Materials and Methods
The experiments were consisting of ten locally collected custard apple genotypes from different villages of Bastar Plateau. The names of these villages are Narharpur (IGCUST-NHR-21), Charama (IGCUST-CHRM-21), Kanker (IGCUST-KNK-21), Lakhanpuri (IGCUST-LKHR-21), Korar (IGCUST-KOR-21), Murdogari (IGCUST-MURD-21), Badanji (IGCUST-BDJ-21), Lamdaguda (IGCUST-LMGD-21), Loahandiguda (IGCUST-LHGD-21) and Mukhend (IGCUST-MUKHD-21).

Physical properties of custard apple fruits

The physical properties of the custard apple fruits were investigated. Healthy, matured yellowish green colour and ripe fruits of uniform size were selected. The following parameters were determined: length, width, thickness, average weight, seeded pulp weight, de-seeded pulp weight, peel weight, seed weight, fruit to pulp ratio and pulp to seed ratio. The pulp was manually removed with a spoon and the rind and seeds were separated and weighted separately. All linear measurements and weight were taken with a Vernier caliper and electronic weighing balance respectively.

Chemical properties of custard apple pulp

To analyze the chemical properties of the custard apple pulp, the fruit had been broken and the pulp, seed and pericarp of the fruit were separated. The chemical properties such as pH, TSS, acidity, ascorbic acid, total sugar, reducing sugar, non-reducing sugar and phenol content were measured.

1. pH

The pH of pulp was determined by using a digital pH meter. 10 g pulp mixed with 10 ml distilled water and dipping an electrode directly into the mixture.

2. Titrable acidity

The acidity was determined by titrating a known volume of sample against 0.1 N NaOH with phenolphthalein as an indicator. The appearance of light pink was taken as an end point (Ranganna, 1986).

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

3. Total soluble solids

The total soluble solid (TSS) in pulp was determined using a hand refractometer. (AOAC, 1990) [1]

4. Ascorbic acid

The ascorbic acid content of fruit pulp was determined using a 2-6 dichlorophenol-indophenol (dye) visual titration method slightly modified from that described by Ranganna (1986).

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

5. Total sugar

The total sugar content was estimated using Hage and Hoffreiter's (1962)

6. Reducing sugar

The reducing sugar was estimated using by dinitrosalicylic method (Miller, 1959) [17].

7. Non reducing sugar

The value of non-reducing sugars was calculated by subtracting the reducing sugars from the total sugars in the sample.

8. Phenol content

Total phenolic content was calculated using Folin Ciocalteu's methodology (Bhalodia *et al*., 2011) [6].

Results and Discussion

The observations were recorded on five samples for each genotype in three replications physico-chemical traits were evaluated on the basis of their mean performance. Presented in Table 1 and 2 respectively

Table1: Physical parameters of custard apple genotype

S. No.	Genotypes	Fruit weight (gm)	Fruit length (mm)	Fruit breadth (mm)	Fruit thickness (mm)	Seeded pulp weight (gm)	De-seeded pulp weight (gm)	Peel weight (gm)	Seed weight (gm)	Fruit to pulp ratio	Pulp to seed ratio
1	IGCUST-LHGD-21	206.48	71.60	78.23	74.90	111.50	91.50	94.98	20.00	2.26	4.57
2	IGCUST-CHRM-21	248.78	74.36	83.01	77.73	148.86	125.62	99.92	23.24	1.98	5.40
3	IGCUST-MUKHD-21	208.19	65.13	79.49	76.04	110.89	90.77	97.30	20.12	2.29	4.51
4	IGCUST-MURD-21	180.50	67.39	79.30	67.36	78.52	67.10	101.98	11.42	2.69	5.88
5	IGCUST-KOR-21	205.65	61.86	82.19	70.02	109.20	101.05	96.45	8.15	2.04	12.40
6	IGCUST-BDJ-21	210.78	74.24	81.24	59.04	108.78	95.36	101.99	13.43	2.21	7.10
7	IGCUST-LMGD-21	201.43	65.50	84.83	68.56	108.22	95.88	93.21	13.34	2.11	7.19
8	IGCUST-LKHR-21	277.24	74.01	82.68	79.30	159.86	144.56	117.38	15.30	1.92	9.45
9	IGCUST-KNK-21	276.89	64.29	88.29	82.88	171.86	153.96	105.04	17.90	1.80	8.60
10	IGCUST-NHR-21	215.29	66.55	81.22	73.56	105.46	96.62	109.83	8.84	2.23	10.93
	SEm±	10.91	3.53	3.46	2.99	6.33	5.59	3.56	0.52	0.07	0.36
	CD at 5%	32.18	NS	NS	8.83	18.67	16.49	10.51	1.52	0.20	1.07
	CV%	8.47	8.94	7.30	7.11	9.04	9.11	6.06	5.89	5.48	8.24

Table 2: Chemical parameters of custard apple genotype

S. No.	Collection	PH	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100g)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Phenol content (mg/100g)
1	IGCUST-LHGD-21	5.12	19.87	0.26	18.45	18.90	14.50	4.40	2.43
2	IGCUST-CHRM-21	5.18	21.56	0.38	18.84	21.65	18.30	3.35	3.24
3	IGCUST-MUKHD-21	5.24	21.47	0.30	16.94	21.84	17.90	3.94	2.30
4	IGCUST-MURD-21	5.22	21.74	0.33	20.02	20.20	16.02	4.18	2.45
5	IGCUST-KOR-21	5.15	22.30	0.38	17.65	19.80	15.32	4.48	1.98
6	IGCUST-BDJ-21	5.25	22.66	0.28	20.54	22.40	16.88	5.52	4.06
7	IGCUST-LMGD-21	5.24	20.44	0.40	21.15	20.55	15.48	5.07	1.90
8	IGCUST-LKHR-21	5.14	24.28	0.35	21.50	24.72	21.02	3.70	4.20
9	IGCUST-KNK-21	5.28	24.50	0.36	22.10	23.51	18.84	4.67	3.15
10	IGCUST-NHR-21	5.20	20.22	0.35	19.76	21.48	17.20	4.28	2.56
	SEm±	0.54	0.48	0.01	0.24	0.60	0.35	0.28	0.05
	CD at 5%	1.62	1.40	0.03	0.71	1.78	1.03	0.84	0.13
	CV%	4.20	3.76	4.63	2.12	4.86	4.94	4.98	2.80

Physical properties in custard apple genotype

Fruit weight

Considerable variation was recorded for fruit weight among the genotypes ranging from 180.50 gm to 277.24 gm with a grand mean of 223.13 and the statistically higher fruit weight was observed in IGCUST-LKHR-21 (277.24 gm) which was statistically at par with the genotype IGCUST-KNK-21 (276.89 gm) whereas, the significantly lowest fruit weight was recorded in IGCUST-MURD-21 (180.50 gm). Maximum fruit weight in genotypes IGCUST-LKHR-21, IGCUST-KNK-21 and IGCUST-CHRM-21 could be due the higher canopy spread which help to the accumulation of higher photosynthates in fruit for obtaining optimal fruit size. The variation in fruit weight is correlated with the length and width of the fruit, which aids in obtaining a good fruit size. The results were in general agreement with the obtained for custard apple fruit by Chandel *et al*, (2018) [7], which ranged from 365.78- 155.86 gm. Kumar *et al*., (2018) [12] reported the fruit weight of custard apple at ripe stage was 187-98.8 gm. Bhatnagar *et al*., (2012) recoded the weight of custard apple ranging from 89.5 to 149.8 gm.

Fruit length

The fruit length was non- significant difference among the ten genotypes varied from 61.86 to 74.36 mm with an overall mean of 68.49. The higher fruit length was obtained in IGCUST-CHRM-21 (74.36 mm) and lowest fruit length was observed in IGCUST-KOR-21 (61.86 mm). Several factors influenced fruit size variation, including the number of fruits on the tree, the production of optimum photosynthates, soil moisture status and soil fertility. These factors may play an important role in the production of optimal fruit size. The results were in close conformity with the findings of Kad *et al*. (2016) [11] and Ghawade *et al*., (2018) [8] the reported fruit length ranged from 6.56 to 21.11 cm. Chandel *et al*., (2018) [7] studied collection and evaluation of custard apple genotypes. The maximum length was attained by 7.53 cm and minimum length was recorded the 11.76 cm. Kumar *et al*., (2018) [12] carried out a fruit morphology and quality parameter studied of global custard apple germplasm.

Fruit width

The fruit width was non- significant difference among the ten genotypes varied from 78.23 to 88.29 mm with an overall mean of 82.05. The higher fruit width was recorded in IGCUST-KNK-21 (88.29 mm) and lowest fruit width was observed in IGCUST-LHGD-21 (78.23 mm). The fruit size and quality were influenced by climatic and edaphic conditions. Maximum fruit width could also be due to the accumulation of the higher seeds in the fruit's horizontal plain. The results are in agreement with the findings of Kumar *et al*., (2018) [12] fruit morphology and quality parameter studied of global custard apple germplasm. They observed fruit width varied from 5.77 to 7.13 cm. Kad *et al*., (2016) [11] and Ghawade *et al*., (2018) [8].

Fruit thickness

Fruit thickness among the ten genotypes varied from 59.04 to 82.88 mm with an overall mean of 72.94. The data reveals that the genotype IGCUST-KNK-21 (82.88 mm) was found significantly highest fruit thickness which was at par with genotype IGCUST-CHRM-21 (77.73 mm), IGCUST-MUKHD-21 (76.04 mm) and IGCUST-LHGD-21 (74.90 mm) whereas, least significantly lowest fruit thickness was recorded in genotype IGCUST-BDJ-21 (59.04 mm).

Seeded pulp weight

Considerable variation was recorded for seeded pulp weight among the genotypes ranging from 78.52 to 171.86 gm with a grand mean of 121.32 and the statistically higher seeded pulp weight was observed in IGCUST-KNK-21 (171.86 gm) which was statistically at par with the genotype IGCUST-LKHR-21 (159.86 gm) whereas, the significantly lowest seeded pulp weight was recorded in IGCUST-MURD-21 (78.52 gm).

De-seeded pulp weight

De-seeded pulp weight among the ten genotypes varied from 67.10 to 153.96 gm with an overall mean of 106.24. The data reveals that the genotype IGCUST-KNK-21 (153.96 gm) was found significantly highest de-seeded pulp which was at par with genotype IGCUST-LKHR-21 (144.56 gm) and IGCUST-CHRM-21 (125.62 gm) whereas, least significantly lowest de-seeded pulp weight was recorded in genotype IGCUST-MURD-21 (67.10 gm).

Peel weight

The significantly highest peel weight was studied in IGCUST-LKHR-21 (117.38 gm) which was at par with genotype IGCUST-NHR-21 (109.83gm) whereas, significance lowest peel weight was found in IGCUST-LMGD-21 (93.21 gm). The results are in agreement with the findings of Chandel *et al*., (2018) [7] and they recorded minimum peel weight was 75.85 gm and maximum peel weight was 162.58 gm.

Seed weight
Seed weight among the ten genotypes varied from 8.15 to 23.24 with an overall mean of 15.17 gm. The significantly and the highest seed weight was recorded in the genotype IGCUST-CHRM-21 (23.24 gm) whereas, the significantly lowest seed weight was recorded in IGCUST-KOR-21 (8.15 gm). The results are in agreement with the findings of Chandel *et al*., (2018) [7] and they recorded minimum seed weight was 15.00 gm and maximum seed weight was 23.00 gm.

Fruit to pulp ratio
Fruit to pulp ratio among the ten genotypes varied from 1.80 to 2.69 with an overall mean of 2.15. The significantly and the highest fruit to pulp ratio was observed in IGCUST-MURD-21 (2.69) whereas, the significantly lowest fruit to pulp ratio was recorded in IGCUST-KNK-21 (1.80).

Pulp to seed ratio
The results on pulp to seed ratio revealed that there were significant differences among the various genotypes. The pulp to seed ratio ranged from 4.51 to 12.40 with a grand mean of 7.06. The genotype IGCUST-KOR-21 (12.40) was recorded significantly highest pulp to seed ratio (12.40) while, significantly lowest pulp to seed ratio was recorded in the genotype IGCUST-MUKHD-21 (4.51). The variation in pulp to seed ratio is correlated with weight of pulp and seed which help is attaining the good fruit size. If the weight of pulp is high than weight of seed is decreases which influence the weight of pulp and seeds due to reason we found the variations in pulp to seed ratio. The results were in close conformity with the findings of Kad *et al*., (2016) [11] and they recorded the pulp to seed ratio was 8.18. Kumar *et al*., (2018) [12] fruit morphology and quality parameter studied of global custard apple germplasm and observed maximum pulp to seed ratio 10.26 gm and minimum pulp to seed ratio 3.69 gm.

Chemical parameters in custard apple genotype
pH
The results on pH revealed that there were significant differences among the various genotypes. The pH ranged from 5.12 to 5.28 with a grand mean of 5.20. The genotype IGCUST-KNK-21 was recorded significantly highest pH (5.28), which was statistically at par with the genotype IGCUST-BDJ-21 (5.25), IGCUST-LMGD-21 (5.24) and IGCUST-MUKHD-21 (5.24) respectively while, significantly lowest pH was recorded in the genotype IGCUST-LHGD-21 (5.12).

TSS (°Brix)
The significantly highest TSS was observed in IGCUST-KNK-21 (24.50 °Brix), which was at par with genotype IGCUST-LKHR-21 (24.28 °Brix) and IGCUST-BDJ-21 (22.66 °Brix) whereas; least significantly of lowest TSS was recorded in genotype IGCUST-LHGD-21 (19.87 °Brix). Kumar *et al*., (2018) [12] reported that the per cent content of TSS in fruit pulp varies from 23.93-25.74 °Brix across the custard apple genotype. Jalikop, (2010) [10] observed that TSS of custard apple ranged from 19.3 to 28.0 °Brix. Kumar *et al*., (2018) [12] studied fruit morphology and quality parameter studied of global custard apple germplasm

Acidity (%)
The significantly highest acidity was obtained in IGCUST-LMGD-21 (0.40%), which was at par with the genotypes IGCUST-KOR-21 (0.38%) and IGCUST-CHRM-21 (0.38%) while, least significant of lowest acidity was observed in IGCUST-LHGD-21 (0.26%).

Ascorbic acid (mg/100g)
The significantly highest ascorbic acid was obtained in IGCUST-KNK-21 (22.10 mg/100g), which was statically at par with the genotypes IGCUST-LKHR-21 (21.50 mg/100g) and IGCUST-LMGD-21 (21.15 mg/100g) whereas, the significantly lowest ascorbic acid was observed in IGCUST-MUKHD-21 (16.94 mg/100g). The results are in agreement with the findings of Kumar *et al*., (2018) [12] fruit morphology and quality parameter studied of global custard apple germplasm and they reported highest ascorbic acid was 4.39% and lowest ascorbic acid was 1.48%. Pareek *et al*., 2011 [14] recorded that the ascorbic acid varies from 9.22 to 60 mg/100 gm.

Total sugar (%)
The significantly highest total sugar was obtained in IGCUST-LKHR-21 (24.72%), which was at par with the genotypes IGCUST-KNK-21 (23.51%) and IGCUST-BDJ-21 (22.40%) whereas, the lowest total sugar was observed in IGCUST-LHGD-21 (18.90%).

Reducing sugar (%)
The significantly highest reducing sugar was obtained in IGCUST-LKHR-21 (21.02%), which was statistically at par with the genotype IGCUST-KNK-21 (18.84%) and IGCUST-CHRM-21 (18.30%) while, significantly lowest reducing sugar was observed in IGCUST-LHGD-21 (14.50%).

Non-reducing sugar (%)
The significantly highest non-reducing sugar was obtained in IGCUST-BDJ-21 (5.52%), which was statically at par with the genotypes IGCUST-LMGD-21 (5.07%) and IGCUST-KNK-21 (4.67%) while, the lowest non-reducing sugar was observed in IGCUST-CHRM-21 (3.35%).

Phenol content (mg/100g)
Phenol content among the ten genotypes varied from 1.90 to 4.20 mg/100g with an overall mean of 2.83. The significantly and the highest phenol content was observed in IGCUST-LKHR-21 (4.20 mg/100g), which was at par with the genotype IGCUST-BDJ-21 (4.06 mg/100g) and IGCUST-CHRM-21 (3.24 mg/100g) whereas, the significantly lowest phenol content was recorded in IGCUST-LMGD-21 (1.90 mg/100g).

Conclusions
Based on the results of this study, it can be concluded that there is wide variation within genotypes based on physico-chemical properties. The genotypes IGCUST-KNK-21 followed by IGCUST-LKHR-21 were superior among all the genotypes therefore genotypes may be exploited for future breeding programme

Acknowledgments
We would like to thanks for Dr G. P. Nag, Assistant Professor, CHRS, Jagdalpur, Bastar, C. G. the guidance in physico-chemical properties of custard apple genotypes.

Author's Contribution

Bhagwat Kumar and D. P. Singh: Designed the experiments and trials for study.

Sumitra Poyam: Conducted the designed experiments and recorded observation data and wrote manuscript.

Soumya Dewangan: Helped in recording observations.

Competing interest

The authors declare that they have no competing interest.

References

1. AOAC. Official Methods of Analysis, 15th Edn. Association of Official Analytical Chemists, Washington, D.C., 1990, 113-127.
2. Anonymous, 2020. National Horticulture Board, Ministry of Farmers and Welfare, Government of India, Statistics, Area and Production of Horticulture Crops (2nd Estimates):1-3.
3. Anonymous, 2021. Directorate of Horticulture and Form Forestry, Chhattisgarh, Department of Agriculture, Govt. of C.G. Raipur, Horticulture Statistics, Area and Production District wise: 1-6.
4. Bhatnagar, P., Singh, J., Jain, M.C. and Singh, B. 2012. Evaluation of landraces of custard apple (*Annona squamosa* L.). Plant Archives, 12(2): 1045-1048.
5. Bhalodia N, Nariya P, Acharya R, Shukla V. Evaluation of *in vitro* antioxidant activity of flowers of *Cassia fistula* Linn. Int. J Pharm. Tech. Res. 2011;3(1):589-599.
6. Chandel SS, Dikshit SN, Sharma HG. Collection and evaluation of custard apple (*Annona squamosa* L.) genotypes in Chhattisgarh plains. Journal of Pharmacognosy and Phytochemistry. 2018;2:149-152.
7. Ghawade PM, Supe VS, Pimpalpalle LV, Tayade SA. Morphological characterization of custard apple genotypes. Journal of Pharmacognosy and Phytochemistry. 2018;7(1):1029-1032.
8. Hedge JE, Hofreiter BT. In: Carbohydrate Chemistry, 17 (Eds. Whistler R.L. and Be Miller, J.N.), Academic press, New York. Int. J Curr. Microbiol. App. Sci. 1962, 2018;7(10):1297-1311.
9. Jalikop SH. Tree and Fruit traits of progenies from the cross between (*Annona cherimola Mill. x A. squamosa* L.) x *A. reticulata* L. and approaches for the introgression of valuable genes from *A. reticulata* L. Euphytica. 2010;173:161-171.
10. Kad VP, Jadhav MS, Nimbalkar CA. Studies on physical, morphological and rheological properties of custard apple (*Annona squamosa* L). International Journal of Applied and Pure Science and Agriculture. 2016;2(4):140-147.
11. Kumar Y, Chandra AK, Dubey A, Gajara HP. Fruit Morphology and Quality Parameter Studies of Global Custard Apple (*Annona squamosa*) Germplasms. Int. J Curr. Microbiol. App. Sci. 2018;7(10):1297-1311.
12. Kumar M, Changan S, Tomar M, Prajapati U, Saurabh V, Hasan M, et al. Custard Apple *(Annona squamosa* L.) Leaves: Nutritional Composition, Phytochemical Profile and Health Promoting, Biological activities. Biomolecules, 2021;11:614.
13. Pareek S, Yahia EM, Pareek OP, Kaushik RA. Postharvest physiology and technology of annona fruits. Food res. Int. 2011;44:1741-1751.
14. Pilania S, Dashora LK, Singh V. Standardization of recipe and juice extraction method for preparation of ready-to-serve beverage from custard apple (*Annona squamosa* L.), Internat. J Proc. & Post-Harvest Technol. 2010;1(2):65-72.
15. Porwal M, Sharma K, Malik P. Anticovulsant Effect of *Annona squamosa* L. Leaves in mice. Pharmacology online. 2011;2:44-52.
16. Miller GL. Use of dinitrosalicylic acid reagent for determination of reducing sugar. Analytical Chemistary. 1959;31:426-428.
17. Ranganna S. Hand book of analysis and quality control for fruit and vegetable products. 2nd Edition, Tata McGraw- Hill Education, 1986, 1-1112.