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Biochemical properties of some papaya genotypes under South Gujarat agro-climatic conditions

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Abstract
Experiment on biochemical properties of fifty papaya genotypes designated as Gujarat Papaya Genotype (GPG-1 to GPG-50). Among these genotypes, wide range of variation was observed for biochemical parameters. TSS ranged from 6.37 to 15.53 °B, total sugar 5.92 to 12.17%, reducing sugars 2.24 to 8.33%, non-reducing sugars 0.55 to 4.29%, ascorbic acid 58.44 to 61.40 mg/100 g, acidity 0.05 to 0.19%, pH 4.25 to 5.44, Vitamin A 0.64 to 4.86 mg/100 g and TSS to TTA ratio 55.17 to 270.00. The findings of this study can serve as a valuable resource for papaya improvement programs and further selection of superior genotypes leads to development of new varieties for commercial cultivation.

Keywords: Biochemical, genotypes, papaya, traits

Introduction

Papaya (*Carica papaya* L.), one of the most prominent and delicious fruit crops, is grown in tropical and sub-tropical regions of the world.

The major papaya producing states in India are Gujarat (19.82%), Andhra Pradesh (17.45%), Maharashtra (11.96%), Madhya Pradesh (10.59%), Chhattisgarh (6.84%), West Bengal (6.24%) and Karnataka (5.78%) having ideal climatic conditions for its growth and production. It occupies an area of 147.7 thousand hectares (2.09% of total fruit area) and 5353.62 thousand MT of production (4.72% of total fruit production) with average productivity is 42.33 MT per hectare. In Gujarat, it is cultivated on an estimated area of 18.27 thousand hectares with 1061.23 thousand MT of production and average productivity is 58.08 MT per hectare (Anon., 2024) [1].

Besides using its fruit for table purpose, it is also used for preparation of sauce, squash, pickles, jam, soft drinks, ice-cream, flavour and in syrup. Papaya has occupied a unique place in the diet of people worldwide because of striking nutritional and medicinal value. It contains moisture (89.6%), protein (0.5%), fat (0.1%), carbohydrates (9.5%), calcium (0.01%), phosphorus (0.01%), iron (0.4%), vitamin A (2020 IU/100 g), nicotinic acid (0.04 mg/100 g), riboflavin (250 mg/100 g) and calorific value (40/100 g) (Ram, 2005) [9]. Carotene, riboflavin, Vitamin C, and Vitamin A are among the many vitamins, minerals, and carbohydrates that are abundant in it. Carotene is usually linked to Vitamin A, however caricaxanthin, the yellow pigment found in papaya, is actually carotene. The Vitamin C content of papaya fruit progressively rises during development (Orr *et al.*, 1953) [8], peaking at fully ripe stage (Arriola *et al.*, 1975) [2]. This is an exception to the rule, which states that most fruits show a decline trend in vitamin C content during the time of ripening.

Hence, this study was focused on investigation of biochemical properties of some papaya genotypes. The outcomes of this study will help in the selection of superior papaya genotypes with the desired characteristics for commercial cultivation. It would also give useful information to the researchers to boost the production of papaya.

Materials and Methods

The present study was carried out during 2024-25 at Instructional farm, ASPEE College of Horticulture, Navsari Agricultural University, Navsari, Gujarat, India. The experiment was laid out with Descriptive study statistical tool Mean, Range, Standard deviation and CV (%).

The planting material (seed) collected from different region of India like, Orissa, Maharashtra, Karnataka, Bihar, Tamilnadu, Manipur, Uttar Pradesh and Gujarat (Dahod, Anand, Surat, Vadodara, Bharuch, Kheda, Mahesana). The collected seeds were sown and the plants were grown as per standard agronomic practices. Selfing was carried out to maintain the genetic purity of each genotype. This process was repeated over successive generations and the fourth generation was used for biochemical characterization.

Standard cultural practices were followed uniformly for the successful cultivation of papaya plants. The experimental field was thoroughly prepared by deep ploughing and making raised beds, followed by the application of well-decomposed FYM at the rate of 20-25 kg/pit before transplanting. Seedlings were transplanted at a spacing of 2 m × 2 m, and proper irrigation was provided by drip method. Staking also required in earlier stage of plant to reduce chances of damage due to wind. Regular weeding and hoeing were carried out to maintain field. A balance dose of fertilizers 200:200:250 g NPK/plant was applied in split doses.

Results and Discussion

The fruit quality of different genotypes was analyzed in term of total soluble solids (TSS), total sugars, reducing sugars, non-reducing sugars, ascorbic acid, titratable acidity, pH, Vitamin A and TSS/TTA ratio (Table 1). The maximum TSS (15.53 °B) was found in GPG-39 while minimum (6.37 °B) in GPG-14. Furthermore, twelve genotypes had higher TSS (> 13 °B). The fruits with higher TSS values are generally preferred in table purpose due to better sweetness and eating quality. Genotypes with high TSS also tend to have higher consumer acceptability and market value. The present findings are in agreement with the findings by Jana *et al.* (2006) [5] who found that the variation in TSS in papaya at Ranchi.

Good variation was observed with respect to total sugars content among all genotypes. The higher total sugars (12.39%) were recorded in GPG-35 whereas the minimum (7.28%) in GPG-14. Total sugars include all the soluble sugars present in the fruit, mainly glucose, fructose and sucrose. It is directly related to TSS but gives a more specific biochemical estimate of the sugar composition. Zaman *et al.* (2006) [12] also noted the variation in total sugar at Bangladesh.

The higher reducing sugars (8.42%) were noticed in GPG-35 while minimum (3.96%) in GPG-19. Reducing sugars primarily include glucose and fructose. Reducing sugars are quick source of energy and their presence is a key indicator of fruit maturity and sweetness. Higher reducing sugar have enhanced flavor and favored for direct consumption. Zaman *et al.* (2006) [12] also reported variation in reducing sugar in different papaya genotypes.

Good variation was also observed in the content of non-reducing sugars among the genotypes, the maximum non-reducing sugars (4.29%) were recorded in genotype GPG-13 while minimum (0.55%) in genotype GPG-15. Non-reducing sugars are primarily composed of sucrose. High non-reducing sugars are ideal for fresh market and dessert use, as they tend to have a more palatable and pleasant sweetness. These genotypes also show greater storage potential, since non-reducing sugars are less reactive during storage and processing compared to reducing sugars. The similar results for non-reducing sugars were reported by Zaman *et al.* (2006) [12] at Bangladesh.

The maximum ascorbic acid (61.40 mg/100 g) recorded in GPG-18 while minimum (58.44 mg/100 g) in GPG-14. Ascorbic acid is a vital nutritional quality trait, acting as a powerful antioxidant that contributes to human health. High ascorbic acid containing genotypes are essential for enhancing the nutraceutical value of papaya. The results are in agreement with Schweiggert *et al.* (2012) [11] who recorded high variation in ascorbic acid content in different papaya genotypes.

Great variation was observed among the acidity present in papaya genotypes. The lower acidity (0.05%) was observed in genotype GPG-12 and GPG-49; while the higher acidity (0.19%) was observed in genotype GPG-18 followed GPG-32 (0.16%). Genotypes with moderate acidity are often preferred for fresh consumption, as they offer a pleasant flavor balance, while higher acidity may be desirable in processing, where flavor sharpness is important. Range for variability is in agreement with the earlier reports of by Schweiggert *et al.* (2012) [11] in papaya hybrids and lines at Germany.

The maximum pH (5.44) recorded in GPG-18 and minimum (4.25) in GPG-16. pH is a useful indicator of fruit maturity and storability, low pH values help in delaying microbial spoilage. The balance between pH and titratable acidity is essential for determining overall flavor. The results are in agreement with Zaman *et al.* (2006) [12], Schweiggert *et al.* (2012) [11] and Brewer *et al.* (2021) [3] who recorded high variation in pH in different papaya genotypes.

The lower Vitamin A (0.64 mg/100 g) was observed in genotype GPG-37 followed by genotypes GPG-01 (0.84 mg/100 g); while the higher Vitamin A (4.86 mg/100 g) was observed in genotype GPG-22 followed GPG-48 (4.48 mg/100 g). Yellow-fleshed genotypes generally having lower content and reddish-orange genotypes having significantly higher levels. High beta-carotene genotypes can contribute to nutritional security and add functional value of papaya-based products. Similar result was obtained for Vitamin A by Deshmukh (2013) [4].

The higher TSS to acid ratio (270.00) was noticed in GPG-12 and minimum (55.17) in GPG-18. TSS to acid ratio is a reliable indicator of sensory quality in papaya and can be effectively used in genotype selection. Schweiggert *et al.* (2012) [11] and Deshmukh (2013) [4] also reported variation in TSS to acid ratio in different papaya genotypes.

From above given biochemical characters of papaya fruit, Vitamin A showed higher variability (39.04%) followed by TSS/TTA ratio (38.65%), reducing sugars (27.92%), titratable acidity (27.89%), TSS (21.44%), non-reducing sugar (18.69%), total sugars (17.08%), pH (4.41%) and ascorbic acid (1.23%).

Table 1: Performance of some papaya genotypes for fruit quality parameters

Sr. No	Genotypes	TSS (°B)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg/100 g)	Titratable acidity (%)	pH	Vitamin A (mg/100 g)	TSS/TTA ratio
1	GPG-1	11.27	10.22	6.87	3.36	58.67	0.12	5.23	0.84	93.89
2	GPG-2	10.97	9.08	5.18	3.90	60.89	0.10	4.97	2.57	115.26
3	GPG-3	9.30	8.09	4.73	3.36	59.90	0.11	4.86	1.91	87.19
4	GPG-4	13.47	9.51	5.69	3.83	59.97	0.14	5.02	2.82	98.54
5	GPG-5	7.53	6.53	2.64	3.89	60.00	0.07	5.15	2.53	102.73
6	GPG-6	9.47	8.55	4.73	3.82	59.30	0.10	5.10	2.60	94.67
7	GPG-7	8.93	8.35	4.66	3.69	59.54	0.06	4.65	2.17	141.05
8	GPG-8	7.67	7.44	4.12	3.32	59.28	0.09	4.95	1.22	85.19
9	GPG-9	13.47	10.66	6.99	3.67	59.29	0.12	5.09	1.83	115.43
10	GPG-10	14.00	10.65	6.98	3.67	59.76	0.06	4.87	2.31	247.06
11	GPG-11	13.43	11.77	7.94	3.83	60.45	0.10	4.97	2.58	138.97
12	GPG-12	13.50	11.10	7.15	3.95	61.33	0.05	5.17	2.95	270.00
13	GPG-13	12.20	11.43	7.14	4.29	60.53	0.10	5.30	2.52	122.00
14	GPG-14	6.37	6.28	3.40	2.88	58.44	0.08	4.84	2.23	79.58
15	GPG-15	11.57	8.31	7.76	0.55	59.36	0.12	5.35	1.74	93.78
16	GPG-16	11.33	8.40	4.81	3.59	58.65	0.12	4.25	1.74	94.44
17	GPG-17	9.57	9.17	7.09	3.08	58.71	0.14	5.25	2.46	66.74
18	GPG-18	10.67	10.40	6.81	3.59	61.40	0.19	5.44	0.89	55.17
19	GPG-19	10.33	7.32	3.96	3.35	59.36	0.11	5.05	1.80	93.94
20	GPG-20	10.70	8.14	5.29	2.85	60.74	0.11	4.83	2.22	94.41
21	GPG-21	8.33	8.29	5.32	2.97	59.63	0.08	4.44	2.52	100.00
22	GPG-22	13.70	8.85	6.13	2.72	60.87	0.11	4.78	4.86	124.55
23	GPG-23	8.27	7.28	3.15	4.13	59.39	0.10	4.70	2.38	80.00
24	GPG-24	7.60	6.64	2.93	3.71	58.58	0.08	5.08	1.12	99.13
25	GPG-25	6.83	5.92	2.24	3.68	60.29	0.06	5.06	1.75	113.89
26	GPG-26	8.53	7.95	4.19	3.76	59.49	0.11	4.96	1.88	75.29
27	GPG-27	11.30	7.52	4.62	2.90	59.48	0.06	4.89	1.65	178.42
28	GPG-28	8.67	8.49	5.02	3.47	60.18	0.11	5.16	1.92	78.79
29	GPG-29	12.93	11.47	8.11	3.36	60.42	0.11	4.95	2.69	123.33
30	GPG-30	13.30	10.90	7.51	3.38	58.81	0.13	4.89	2.00	99.75
31	GPG-31	10.83	10.76	7.24	3.52	60.22	0.13	4.90	2.16	81.25
32	GPG-32	11.07	9.43	6.84	2.60	61.06	0.16	5.15	1.76	69.17
33	GPG-33	10.63	10.42	7.49	2.93	60.33	0.13	4.99	2.02	81.79
34	GPG-34	12.17	10.48	7.85	2.63	60.06	0.11	5.34	2.20	110.61
35	GPG-35	8.53	8.39	4.42	3.97	60.07	0.06	5.28	0.92	150.59
36	GPG-36	9.63	8.63	5.29	3.35	60.04	0.07	5.13	2.91	137.62
37	GPG-37	8.67	8.37	5.78	2.59	60.54	0.11	5.22	0.64	78.79
38	GPG-38	10.23	9.58	6.68	2.90	59.78	0.14	5.28	2.33	73.10
39	GPG-39	15.53	9.35	6.89	2.46	59.30	0.12	5.06	1.81	129.44
40	GPG-40	8.67	7.98	5.29	2.69	59.63	0.10	5.03	1.92	83.87
41	GPG-41	8.60	7.82	4.22	3.60	59.56	0.10	4.93	1.57	86.00
42	GPG-42	12.53	9.42	6.98	2.43	60.19	0.14	5.04	1.81	89.52
43	GPG-43	13.93	8.75	5.06	3.69	59.79	0.11	5.06	2.38	126.67
44	GPG-44	11.23	10.73	7.81	2.92	60.17	0.13	4.95	1.97	86.41
45	GPG-45	9.40	8.69	5.38	3.31	60.16	0.08	4.83	3.81	112.80
46	GPG-46	12.73	10.58	7.59	2.99	60.61	0.11	5.00	4.10	115.76
47	GPG-47	14.53	8.29	4.58	3.71	60.57	0.13	4.81	0.91	109.00
48	GPG-48	15.53	12.05	8.33	3.72	59.68	0.13	4.83	4.48	119.49
49	GPG-49	12.53	12.17	8.10	4.07	58.48	0.05	5.09	3.09	235.00
50	GPG-50	13.40	8.03	4.58	3.45	59.19	0.12	4.98	2.08	108.65
Mean		10.91	9.09	5.79	3.32	59.84	0.11	5.00	2.19	110.97
Range		9.17 (6.36-15.53)	6.25 (5.92-2.17)	6.09 (2.24-8.33)	3.74 (0.55-4.29)	2.96 (58.44-61.40)	0.14 (0.05-0.19)	1.19 (4.25-5.44)	4.22 (0.64-4.86)	214.83 (55.17-270.00)
S.D.		2.34	1.55	1.62	0.62	0.74	0.03	0.22	0.86	42.89
C.V.%		21.44	17.08	27.92	18.69	1.23	27.89	4.41	39.04	38.65

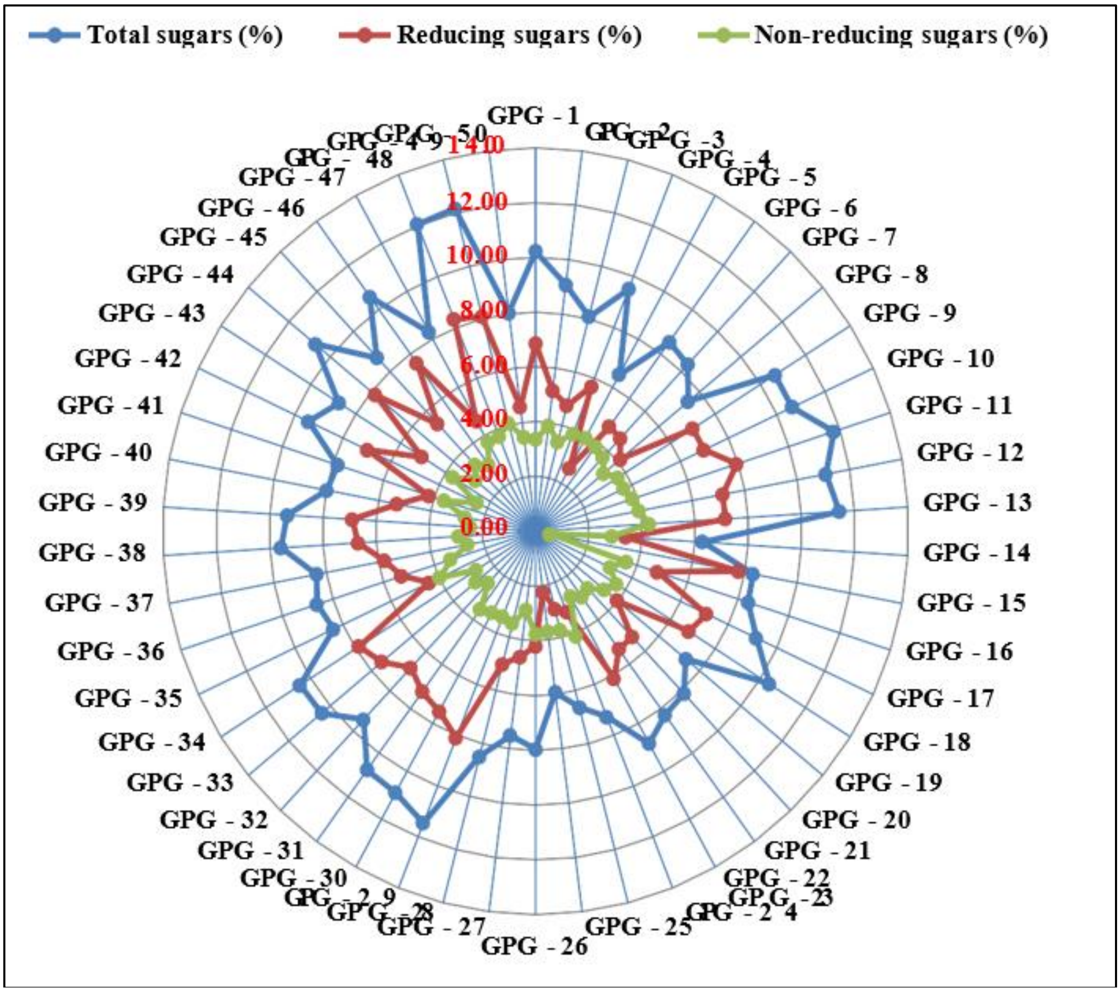

Fig 1: Variation in total sugar (%), reducing sugar (%) and non-reducing sugar (%) of papaya genotypes

Conclusion

From the present study, it can be concluded that the great variation exists within the genotypes based on fruit biochemical characters. The 20 genotypes were found to be superior than rest of the genotypes *i.e.* GPG-01, GPG-04, GPG-09, GPG-10, GPG-18, GPG-22, GPG-23, GPG-24, GPG-28, GPG-29, GPG-31, GPG-35, GPG-37, GPG-43, GPG-44, GPG-45, GPG-46, GPG-48, GPG-49 and GPG-50. Further, these genotypes can be used for advance breeding programme for development of new papaya variety for commercial cultivation.

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