IOSR Journal of Biotechnology and Biochemistry (IOSR-JBB)
ISSN: 2455-264X, Volume 6, Issue 1 (Jan. –Feb. 2020), PP 47-50
www.iosrjournals.org

Biochemical Variation in the Sugar Concentration of the Two Cultivars of *Carica Papaya* Fruit after Cutting

Sneha Pednekar[1] and Kiran Mangaonkar[2]
[1]*Department of Biochemistry, RamnarainRuia Autonomous College, Matunga, Mumbai 400019*
[2]*Guide, Department of Chemistry, G. N. Khalsa College (Autonomous), Matunga, Mumbai 400019*

Abstract: *In nature papaya without seeds is a peculiar product of unfertilized flower of a female papaya plant. Since the seedless variety of papaya instinctively grows from the same plant as those with seeds, there is significantly no difference between the seedless and seeded variety of papaya. However, there is still much to be learned about the biochemistry of the seeded and seedless cultivars of papaya fruits. In addition, it is generally observed that when a papaya is cut and left at room temperature, the sweetness of the papaya increases with time. Thus the present research attempts to assess the variation in the sugar concentration of both the seeded and seedless variety of papaya fruit after cutting. It is observed that the Carica papaya fruit pulp with seeds contain 9.86% more total carbohydrates compared to the seedless fruit. The reducing sugars present in seeded fruit pulp are almost 4 times more when compared with the seedless papaya cultivar. It is clear that the change in the total carbohydrates content over time in the fruit pulp and its peel of both the seedless and seeded cultivars is negligible whereas the change in the reducing sugars content over time is considerable.The statistical analysis of the data obtained from the current study reveals that there exists a strong positive correlation between the total carbohydrates and reducing sugars content in the fruit pulp (r = 0.83) and peel (r = 0.75) of seeded cultivar. This variation is more pronounced in the seeded cultivar of papaya compared to the seedless cultivar.*

Key words: *Carica papaya, variation in sugar concentration, seedless and seeded cultivar*

Date of Submission: 30-01-2020 Date of Acceptance: 17-02-2020

I. Introduction:

Papaya is a climacteric fruit (**Akamine, 1966; Selvaraj et al., 1982**) which undergoes a number of changes during fruit ripening. Fruit softening, sweetening, decreased bitterness and colour change are the major changes witnessed during the ripening process. The edible portion of papaya is composed mostly of water (86.8%) and carbohydrates (12.2%) (**Wenkam, 1990**).The cell wall polysaccharides and soluble sugars are the predominant carbohydrates in papaya fruits. During ripening, the cell wall polysaccharides including pectin are degraded by enzymes resulting in the loss of firm structure of the fruit. The enzymatic breakdown and hydrolysis of storage polysaccharides produces water soluble molecules such as fructose, glucose and sucrose. During fruit ripening, gluconeogenesis also occurs. Additionally, very low starch content (about 0.1%) is detected in the late fruit development stage and is mainly associated with the skin (**Chan et al., 1979; Selvaraj et al., 1982**).

Sugars play an important role in the flavour characteristics of the papaya and are also a commercial measure of fresh fruit quality. Fruit that lack stored carbohydrate reserves such as muskmelon and papaya, must remain attached to the plant to allow accumulation of soluble sugars (**Chan et al., 1979; Hubbard et al., 1990; Tucker and Grierson, 1987; Hubbard et al., 1991**). At the early stage of fruit development in *Carica papaya*, glucose is the main sugar but the sucrose content increases during ripening and can reach up to 80% of the total sugars (**Paull, 1993**). Developing papaya fruit accumulates soluble sugars during the last stage of fruit growth (**Chan et al., 1979; Zhou et al., 2001**). Development studies of papaya fruit have shown that total sugar, especially sucrose, increases rapidly, ≈20 to 30 d before fruit ripening (**Chan et al., 1979; Selvaraj et al., 1982; Zhou et al., 2000**). Thus, the unripe papaya which has a crunchy, cucumber like mild flavour when ripens, it gets transformed into the reddish–orange colour sweet delight.

Generally, the vast majority of plants self-abort if the flowers fail to fertilize. In nature papaya without seeds is a peculiar product of unfertilized flower of a female papaya plant. Since the seedless variety of papaya instinctively grows from the same plant as those with seeds, there is significantly no difference between the seedless and seeded variety of papaya with respect to the physical characteristics: mildly sweet fruits, with pink or orange flesh, and spherical and pear-like shapes. The seedless papayas are highly valued on the commercial market for tropical fruits because they taste as good as papaya with seeds. However, there is still much to be learned about the biochemistry of the seeded and seedless cultivars of papaya fruits.

In addition, it is generally observed that when a papaya is cut and left at room temperature, the sweetness of the papaya increases with time. However, no studies have been carried out to assess this claim. A criterion for the genetic improvement of papaya could be an empathetic knowledge of the biochemistry and fundamental enzymes involved in sugar build-up in the fruit during its development. Thus the present research attempts to assess the change in the sugar concentration of both the seeded and seedless variety of papaya fruit after cutting.

II. Materials and Methods

Chemicals

All chemicals and reagents used were of analytical grade andobtained from LobaChemie, Merck and Sigma Chemical Company.They were used without furtherpurification.

Plant Material

The two cultivars of papaya fruit namely seedless papaya (cultivar 1) and seeded papaya (cultivar 2),both of which were in the fully ripen state, were obtained from a local nursery. They were washed thoroughly with distilled water to remove dirt particles. The fruit pulp and peel were used for the analysis at regular time intervals of 0, 1, 2, 3, 4 and 24 hours. The time was considered from the moment the fruit was cut. The cut fruit was stored at room temperature throughout the analysis till 4 hours. However, after sampling at the end of 4^{th} hour, the fruit was refrigerated till the 24^{th} hour.

Total Carbohydrate Content

The anthrone method to estimate the total carbohydrate content of the fruit pulp and peel was used as described by (**Hedge and Hofreiter, 1962**) with slight modifications. For this, 200 mg of sample was digested for 1 h with 10 ml of 2.5N HCl. After neutralizing the solution with sodium carbonate, the digested sample was filtered through cotton and the volume was made to 100 ml with distilled water. This treated sample was used for the estimation of total carbohydrates in which 4 ml ice-cold Anthrone reagent was added to 1 ml of the treated sample. It was vortexed and then heated in boiling water bath for 1 min. The absorbance of the cooled solution was read at 630 nm immediately and the amount of carbohydrate was calculated using a standard curve of D-glucose prepared in the same manner.

Reducing Sugar Content

The reducing sugar content of the fruit pulp and peel was estimated as described by (**Miller, 1972**) with slight modifications. 100 mg of the sample wasused to extractthe sugars with hot 80% ethanol twice (5 ml each time). The supernatant was collected and evaporatedusing a water bath at 80°C. The sugars thus, obtained were dissolved in 10 ml distilled water and this solution was used for the estimation.

III. Results and Discussion

Carica papaya		**Total Carbohydrates**	**Reducing Sugars**
Cultivar 1	**Fruit**	44.1	495.2
	Peel	32.25	831.8
Cultivar 2	**Fruit**	48.45	1920.7
	Peel	24.75	356.6

Table 1: *Total carbohydrates and reducing sugars (mg/g) of the two cultivars of C. papaya (Cultivar 1 : Seedless fruit and Cultivar 2 : Seeded fruit)*

The content of total carbohydrates and reducing sugars determined for the two cultivars of papaya fruit is depicted in Table 1. It is observed that the *Carica papaya* fruit pulp with seeds contain 9.86% more total carbohydrates compared to the seedless fruit. The peel of the seeded fruit contains as much as half the amount of total carbohydrates as that estimated in its pulp. The reducing sugars present in seeded fruit pulp are almost 4 times more when compared with the seedless papaya cultivarwhereas the peel of the seeded fruit contains minimum amount of reducing sugars compared to others.

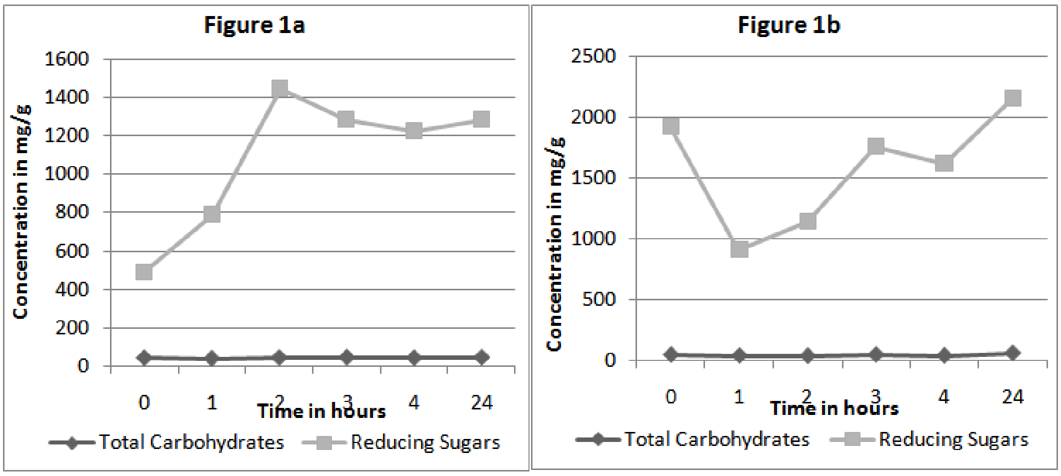

Figure 1:*Variation in the sugar concentration (mg/g) of the fruit after cutting.*
(a) cultivar 1 and (b) cultivar 2

The variation in the amount of the total carbohydrates and reducing sugars in the fruit pulp and its peelfor the two cultivars of the *Carica papaya* are depicted in Figure 1 and 2. It is clear that the change in the total carbohydrates content over time in the fruit pulp and its peel of both the seedless and seeded cultivars is negligible whereas the change in the reducing sugars content over time is considerable.

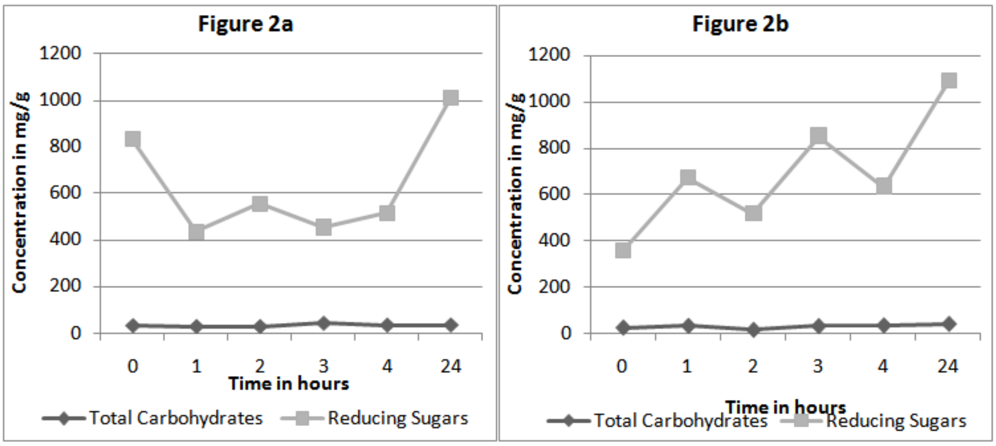

Figure 2: *Changes in the sugar concentration (mg/g) of the peel after cutting*
(a) cultivar 1 and (b) cultivar 2

The relationship between two variables is generally considered strong when their r value is larger than 0.7 (**Moore et al., 2013**). The statistical analysis (Table 2) of the data obtained from the current study reveals that there exists a strong positive correlation between the total carbohydrates and reducing sugars content in the fruit pulp (r = 0.83) and peel (r = 0.75) of cultivar 2 and a moderate positive correlation between the total carbohydrates and reducing sugars content in the fruit pulp (r = 0.61) of cultivar 1. While no correlation exists between the total carbohydrates and reducing sugars content in the peel (r = 0) of cultivar 1.

Statistical Analysis		**Correlation between Total Carbohydrates and Reducing Sugars**	**Regression of Total Carbohydrates over Time**			**Regression of Reducing Sugars over Time**		
		Correlation (r)	**r^2 value**	***p*-value**	**F value**	**r^2 value**	***p*-value**	**F value**
Fruit	**Cultivar 1**	0.61	0.26	0.30	1.42	0.14	0.46	0.68
	Cultivar 2	0.83	0.74	0.03	11.20	0.36	0.21	2.20
Peel	**Cultivar 1**	0.00	0.05	0.66	0.22	0.52	0.10	4.37
	Cultivar 2	0.75	0.42	0.16	2.88	0.67	0.05	8.23

Table 2: *Statistical analysis of the two cultivars of C. papaya*
(Cultivar 1 : Seedless fruit and Cultivar 2 : Seeded fruit)

The values of the r^2 calculated reveals that the variation in total carbohydrates content over time is 26% in the fruit pulp and 5% in the peel of cultivar 1 whereas cultivar 2 has 74% variation in the fruit pulp and 42%

variation in its peel. However, the reducing sugars and time share a variation of 14% in the fruit pulp and 52% in the peel of cultivar 1 while cultivar 2 shares a variation of 36% in thefruit pulp and 67% in its peel.

A *p*-value ≤ 0.05is statistically significant and indicates strong evidence against the null hypothesis. In such situations the null hypothesis is rejected and the alternative hypothesis is accepted. For the present study, the null hypotheses of no relationship between the variations in the total carbohydrates content over time and no relationship between the variations in the reducing sugars content over time are considered. It is evident from table 2 that the hypothesis test is statistically significant in case of the fruit pulp of cultivar 2 ($p = 0.03$) for the variations in the total carbohydrates content over time and in case of the peel of cultivar 2 ($p = 0.05$) for the variations in the reducing sugars content over time. Further, the F value of 11.20 in case of fruit pulp of cultivar 2 indicates a relationship between the variations in the total carbohydrates and timewhilethe F value of8.23 in case of peel of cultivar 2 indicates a relationship between the variations in the reducing sugars and time.

IV. Conclusion

The process of fruit ripening brings about a number of physical and chemical changes in the fruit.Sometimes this ripening process continues even after the fruit is harvested and such fruits are calledclimacteric fruits. The present study reveals that there occurs variation in the total carbohydrates and reducing sugars after cutting the *Carica papaya*fruit which is considered a climacteric fruit.This variation is more pronounced in the seeded cultivar of papaya compared to the seedless cultivar which contradicts the literature citing – there is significantly no difference between the seedless and seeded cultivar of papaya becauseboth the papaya cultivarsinstinctively grows from the same plant. The reasons for these observed variations could behigh rate of fruit respiration, increased enzymatic activities responsible for the breakdown of stored polysaccharides to release simple sugars, gluconeogenesis and various others.

Acknowledgement

We would like toexpress our sincere thanks to Dr.JyotiDipakVora for her insight that helped us in the research. We would also like to show our gratitude to the faculty and the non-teaching staff of both the colleges for their support and co-operation.

References

[1]. Akamine, E.K. (1966) Respiration of fruits of papaya (*Carica papaya* L.var. Solo) with reference to effect of quarantine disinfestation treatments. *Proceedings of American Society of Horticultural Science*, **89**, 231–236

[2]. Bruce Ratner.The Correlation Coefficient: Definition, viewed 26 Dec, 2019, http://www.dmstat1.com/res/TheCorrelationCoefficientDefined.html.

[3]. Chan, H.T., Hibbard, K.L., Goo, T. and Akamine, E.K. (1979) Sugar composition of papayas during fruit development. *Hort Science*, **14**, 140–141

[4]. Hubbard, N. L , Pharr, D. M., and Huber, S. C. 1990a. Role of sucrose phosphate synthase in sucrose biosynthesis in ripening bananas and its relationship to the respiratory climacteric. Plant Physiol. 94:201.

[5]. Hubbard, N. L., Pharr, D. M., and Huber, S. C. 1990b. Sucrose metabolism in ripening muskmelon fruit as affected by leaf area. J. Amer. Soc. Hort. Sci. 115: 798-802.

[6]. Hubbard, N. L., Pharr, D. M., and Huber, S. C. 1991. Sucrose phosphate synthase and other sucrose metabolizing enzymes in fruits of various species. Physiol. Plant. 82: 191-196.

[7]. Hedge, J E and Hofreiter, B T (1962) In: Carbohydrate Chemistry **17** (Eds Whistler R L and Be Miller, J N) Academic Press New York.

[8]. McDonald, J.H. 2014. Handbook of Biological Statistics (3rd ed.). Sparky House Publishing, Baltimore, Maryland.

[9]. Miller, G.L. (1972) Use of Dinitrosalicylic Acid Reagent for Determination of Reducing Sugars. Analytical Chemistry, 31, 426-428.

[10]. Moore, D. S., Notz, W. I, & Flinger, M. A. (2013). The basic practice of statistics (6th ed.). New York, NY: W. H. Freeman and Company.

[11]. Paull, 1993Paull, R.E. and Chen, N.J. (1983) Postharvest variation in cell wall-degrading enzymes of papaya (*Carica papaya* L.) during fruit ripening. *Plant Physiology*, **72**, 382–385

[12]. P. K. Ray. Breeding Tropical and Subtropical Fruits. Springer Science & Business Media, 2002.

[13]. Sadasivam, S. and A. Manikam (1992). Biochemical Methods for Agricultural Sciences, Wiley Eastern Limited, New Delhi: 10-12.

[14]. Selvaraj et al., 1982Selvaraj, Y., Pal, D.K., Subramanyam, M.D. and Iyer, C.P.A. (1982a) Fruit set and the developmental pattern of fruits of five papaya varieties. *Indian Journal of Horticulture*, **39**, 50–56

[15]. Selvaraj, Y., Pal, D.K., Subramanyam, M.D. and Iyer, C.P.A. (1982b) Changes in the chemical composition of four cultivars of papaya (*Carica papaya* L.) during growth and development. *Journal of Horticultural Science*, **57**, 135–143

[16]. Tucker, G. A. and Grierson, D. 1987. "Fruit ripening". In *The Biochemistry of Plants*, Edited by: Davies, D. Vol. 12, 265–319. New York: Academic Press Inc.

[17]. Umedi L. Yadava, 1996. 'Exotic Horticultural Plants with Commercial Potential in the United States Market: Introduction to the Workshop'. *Hortscience, Vol. 31(5), September 1996*.

[18]. Wenkam, N. S. 1990. Foods of Hawaii and Pacific Basin Fruits and Fruits Products, Raw, processed, and prepared. Vol. 4. Composition. Research Extension Series 110, College of Tropical Agriculture and Human Resources, Honolulu, 96pp.

[19]. Zhou, L.L., D.A Christopher, and R.E. Paull, 2000. Defoliation and fruit removal effects on papaya fruit production, sugar accumulation, and sucrose metabolism. J. Amer. SocHort Sci. 125:644–652.

[20]. Zhou Liliand PaullRobert E. (2001). Sucrose Metabolism During Papaya (Carica papaya) Fruit Growth and Ripening. J. AMER. SOC. HORT. SCI. 126(3):351–357. 2001.