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A Comparative Study on Changes in Carbohydrate and Sugar Content at different Developmental Periods of Ten Local Varieties of Mango (*Mangifera indica* L.) of Murshidabad District of West Bengal

Epsita Halder[1] and Dr. Sudipta Kumar Sil[2]

[1,2]Department of Botany Gour Banga University Malda, West Bengal, 732103
E-mail: [1]haldar.epsita@gmail.com, [2]sudiptakrsil@gmail.com

Abstract—*A detailed study were carried out with the changes in the carbohydrate and sugar content of mango during growth and development of ten local varieties of Murshidabad district. Fruits were harvested at three stages i.e., 3,7and 10th week after efflorescence. As mango is a climacteric fruit carbohydrates are the main component of it, during ripening process the complex carbohydrates such as starch get hydrolyzed into simple sugars and disaccharides. During initial development starch accumulation increased later decreased during maturity. Total sugars (sucrose, fructose and glucose), are one of the biochemical components of fruit quality, which is related to fruit development and its excellence. Increase in total sugar content during maturity is depend on sucrose accumulation. Those varieties shows distinct carbohydrates accumulation and hydrolysation upon maturity and development. The results indicate that those fully ripe mango varieties at 10th week shows a high carbohydrate content with increasing nonreducing sugar and total sugar. The starch accumulation is decreasing during the ripening periods. The variety Champa shows a high content of sugar, Rani shows a highest amount of carbohydrate accumulation.*

1. INTRODUCTION

Mango (*Mangifera indicia L.*) belongs to the family Anacardiaceae, is important commercially grown tropical fruit of India. It is known as King of fruit in India for its delicious taste, colour, flavour and aroma [1]. India is one of the biggest producer and promising exporter of mango with an annual production of 18.78 million tons in 83947 hg/ha area and share a world's first rank among the tropical fruit grown in the world [2]. In north east India the district Murshidabad of West Bengal gained fame and prominence mango orchards under the patronage of Bengal Nawabs. The culture of raising mango orchards in the area was synchronous with the crowning of MurshidQuli Jafar Khan as the first Nawab of Bengal who transferred the capital to Murshidabad from Dacca in 1704. Those exotic fruit is unrivalled in color, flavor and taste. Lack of proper documentation and maintenance some of the so called 'Royal' or 'Elite' varieties are on the verge of extinction. A serious effort is needed to restore the germplasm. Mango is a climacteric fruit mainly composed of carbohydrates and water and with some amount of protein, fat, dietary fiber, vitamins C, A, phenols, minerals etc. [3]. The composition of fruit varies with the variety. The ripening stage and the mango variety play an important role in the amount of carbohydrates present in the fruit [4]. During the developmental periods the carbohydrates content of those varieties showed a diversified range. The selected varieties are said to be with high carbohydrate ranges between. The predominant carbohydrate in the unripe state of mango is starch, which is later replaced to sucrose, fructose and glucose like simple sugars [5]. During ripening of mango starch get hydrolyzed. A minimum level of carbohydrate accumulation is associated with fruit maturation. All the biochemical parameters are depending on variety and growing condition [6]. Total sugar, reducing and non-reducing sugar content are associated mainly with the fruit sugar [7]. The fructose are high in ripe mangoes than sucrose. Along with other bio chemical components in mango, fruit sugar is considered as an effective quality parameter for taste and flavour [8].

2. MATERIALS AND METHODS

2.1 Experimental materials

The ten mango varieties of Murshidabad namely, Kohitoor, Beera, Sarenga, Rani, Champa, Bhabani, Dhubani, Molayemjam, Kishenbhog, Panja were selected as experimental materials. The mango varieties undertaken for investigation were collected from the orchards of the district Murshidabad, the locations were- Lat. 24.175334 Long. 88.293136, Lat. 24.171213 Long. 88.265185, Lat. 24.153541 Long. 88.2775116. Fresh fruits were harvested from the orchards at 3rd, 7th and 10th weeks after efflorescence. The fully mature fruits were carefully selected during harvest. The more or less similar size, shape, colour, unblemished fruits were harvested manually from each plant of the ten varieties. Samples were selected at the same maturity level.

2.2 Biochemical Methods

2.2.1 Determination of Carbohydrate Content of Mango pulp. Total Carbohydrate Content of mango pulp was determined colorimetrically by anthrone method [9] [11].

Reagents:

1. 2.5 N HCL
2. Anthrone reagent - The reagent was prepared by dissolving 200mg anthrone in 100ml 95% H_2SO_4
3. Standard glucose solution: A standard glucose solution was prepared by dissolving 10mg of glucose in 100ml distilled water.

Procedure

100 mg of mango pulp cut into small pieces and homogenized with 5 mL of 2.5N HCL and kept for hydrolyses in a boiling water bath for three hours. Sodium carbonate was used to neutralize the homogenized sample. After that centrifuged was done to get the supernatant. Aliquot of 1 mL of supernatant were pipetted out for analysis. A standard curve of glucose was prepared by taking 0.0, 0.1, 0.2, 0.4, 0.6, 0.8, and 1.0 mL of standard glucose solution in different test tubes containing 0.0, 10, 20, 40, 60, 80, and 100 µg of glucose, respectively and the volume was made up to 1mLwith distilled water. Then 4 mL of anthrone reagent was added to each test tube and mixed well. The tubes were placed in a boiling water bath for 10 min and cooled. A blank reagent was prepared by using 1 mL of water and 4 mL of anthrone reagent in a test tube and treated similarly. The absorbance of the dark green dark green solution was measured at 680 nm in a UV spectrometer (labtech8100c). The amount of carbohydrate present in mango pulp was calculated from the standard curve of different concentrations of glucose and expressed as g/100g of fresh fruits.

2.2.2 Determination of starch content of mango pulp. Total starch content of mango pulp was determined colorimetrically by anthrone method [10] [11].

Reagents:

1. Anthrone reagent - The reagent was prepared by dissolving 200mg anthrone in 100ml 95% H_2SO_4
2. 80% Ethanol
3. Standard glucose solution - A standard glucose solution was prepared by dissolving 10mg of glucose in 100ml distilled water.

Procedure

0.5g mango pulp is cut in small pieces and homogenized well with hot 80% ethanol to remove the sugar. It was then centrifuged and the residue were retained. The residue was then filtered through double layered of fine clothes and heated to dryness. Then it was dissolve in 6.5mL of fresh 52% Perchloric acid and 5mL of water. Extraction of the residue were done by centrifuged it in 0^0C for 20min and the supernatant was kept aside. This extraction procedure was repeated and the volume make up to 100mL. 0.2mL of supernatant was pipetted out and volume was make up with 1 mL of water. A standard curve of glucose was prepared by taking 0.0, 0.1, 0.2, 0.4, 0.6, 0.8, and 1.0 mL of standard glucose solution in different test tubes containing 0.0, 10, 20, 40, 60, 80, and 100 µg of glucose, respectively and the volume was made up to 1mLwith distilled water. Then 4 mL of anthrone reagent was added to each test tube and mixed well. The tubes were placed in a boiling water bath for 10 min and cooled. A blank reagent was prepared by using 1 mL of water and 4 mL of anthrone reagent in a test tube and treated similarly. The absorbance of the dark green dark green solution was measured at 680 nm in a UV spectrometer (labtech8100c). The amount starch present in mango pulp was calculated from the standard curve of different concentrations of glucose and multiply by a factor of 0.9 and express as g/ 100g fresh fruit pulp.

2.2.3 Determination of Total Sugar (TS) of mango pulp. Total Soluble Sugar of mango pulp was determined by Phenol and H_2SO_4 using a spectrophotometer [12].

Reagents:

1. 96% H_2SO_4
2. 5% Phenol solution.
3. Standard glucose solution - A standard glucose solution was prepared by dissolving 10mg of glucose in 100ml distilled water.

Procedure:

1gm of mango pulp pieces was plunged into 80% ethanol. The homogenized samples were kept into boiling water bath for refluxed for one hour. Aliquot of 2.0 mL of extract was pipetted out into test tubes and the volume make up to 3mL. To these test tubes 1 per cent 1 mL phenol was added. Then 5% concentrated H_2SO_4 were added to those test tubes and kept for 30 minute at room temperature for development of colour. A standard curve of glucose was prepared by taking 0.5 mL to 2.5 mL glucose and the volume was made up to 3 mL with distilled water. 1 mL 1% phenol and 5 mL 96% H_2SO_4 was added to it. The absorbance of the solution was measured at 490 nm in a UV spectrophotometer using a blank reagent. The amount of total soluble sugar present in the mango pulp extract was calculated from the standard curve of glucose. The percentage of the total soluble sugar was determined by using the following formula:

$$\%\ total\ Sugar\left(\frac{g}{100g\ of\ Mango}\right) = \frac{(G.F\ \times O.D.\times Total\ Voulme)}{Aliquiot\ taken\ \times Wt.of\ Sample\ \times 10000}$$

2.2.4 Determination of Reducing Sugar of Mango Pulp. Reducing sugar of fresh mango pulp is determined by Dinitrosalicylic acid (DNS) method [13].

Reagents:

1. Dinitrosalicylic acid solution (DNS).
2. Rochelle salt.

Procedure:

Aliquot of 3 mL of extract was pipetted out into test tubes and 3 mL of DNS reagent was added to each solution a mix well. The test tubes were heated is a water bath for 5 min. After developing the colour 1 mL of 10% Rochelle salt was added to the tubes. The test tubes were then cooled under running tap water. The absorbance of the orange-red solution was measured at 575nm in spectrophotometer against a blank reagent. The amount of the reducing sugar present in test tubes was calculated from the standard curve of glucose and expressed as g/100 g of mango pulp.

2.2.5 Determination of Nonreducing Sugar of Mango Pulp. Nonreducing content of the mango pulp was calculated using the following formula [16]

$$Nonreducing\ Sugar(\%) - Total\ Sugar(\%) - Reducing\ Sugar(\%)$$

3. RESULTS AND DISCUSSION

Carbohydrate content - Carbohydrate is the major component of mango fruit which is modified during the process of ripening from starch to single sugars such as monosaccharides (glucose, fructose) and disaccharides (sucrose) [6].

Rani among those randomly selected varieties shows a highest carbohydrate content 22.23%. The carbohydrate content in Rani was found to increase from 4.63% at 3 weeks to 13.63% at 10 weeks whereas Champa shows 6.08% increased carbohydrate content at 3 weeks at the end of the maturity that means at 10 weeks it slightly decreased to 12.02%. The variety Beera and Dhubani were found with low carbohydrate content (See Figure 1).

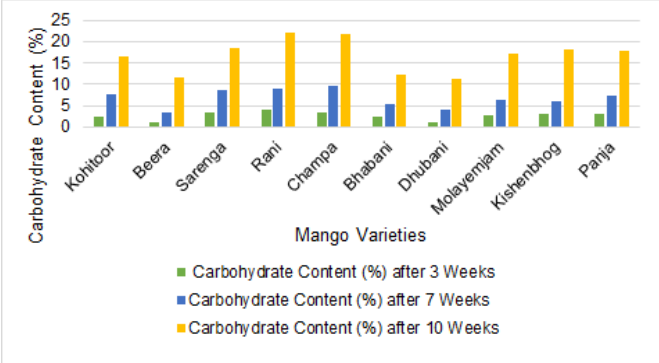

Figure 1: Carbohydrate content of different mango varieties over time.

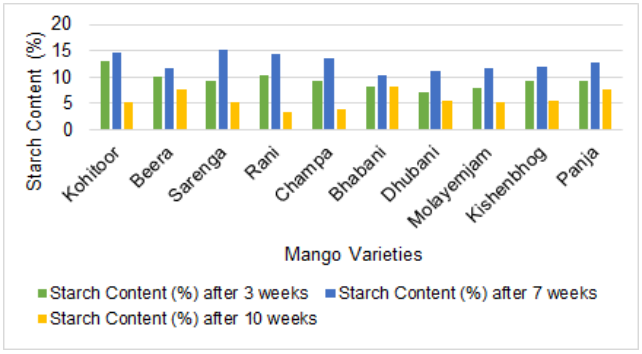

Figure 2: Starch content of different mango varieties over time.

Starch content - The starch is the main carbohydrate present in the unripe stage during ripening it get hydrolyzed by the enzyme amylase [14]. The starch content of mango pulp were found to be decrease at maturity. The depletion of starch were found in the variety at 7 week to 10 weeks from 15.22% to 5.12% and 14.32% to 3.26% in Sarenga and Rani respectively. Bhabani shows a very low degradation rate of starch about 2.18% (see Figure 2).

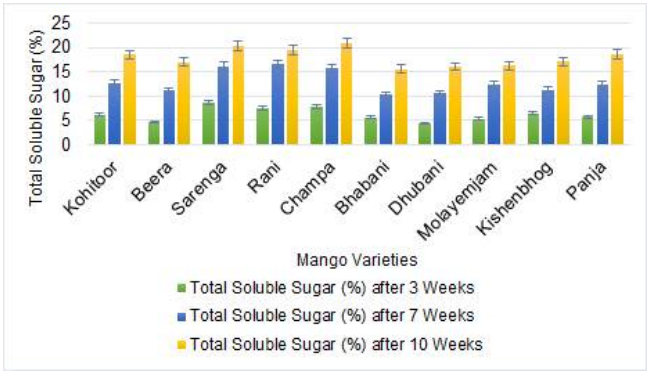

Figure 3: Total soluble sugar content of different mango varieties over time.

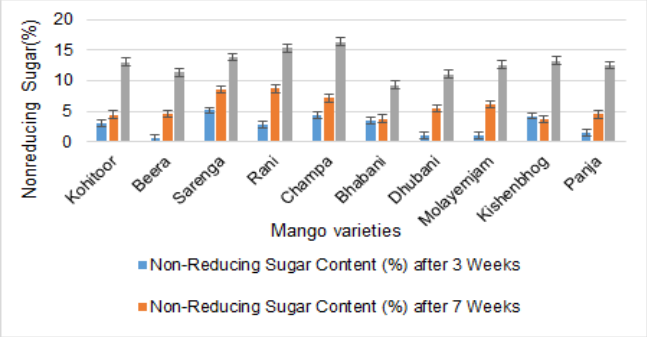

Figure 4: Reducing sugar content of mango varieties over time.

Total sugar, Reducing and Nonreducing sugar - All the mango varieties shows an increasing trend of total sugar content throughout their maturity and development. At ripening state (10weeks) Champa was found to be with high total sugar content 21% followed with the variety Sarenga 20.31%. Bhabani was found with low sugar content 15.6% (see Figure 3).

The reducing sugar is one of the major fruit sugar known as sucrose which get increased during the ripening stage but later decrease with increase temperature and storage period [15]. The varieties Champa, Kishenbhog, Kohitoor and Sarenga shows the highest amount of reducing sugar (10.32-10.22)% at ripening state. The variety Dhubani shows a lowest range 8.47% of reducing sugar content. Sucrose accumulation during maturity of those varieties are related to increase in total sugar content (see Figure 4).

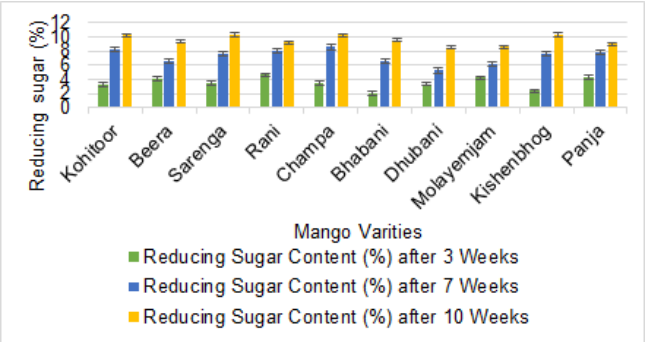

Figure 5: Nonreducing sugar content of mango varieties over time.

Nonreducing sugar is the simplest form of sugar mainly the fructose and glucose [16]. Fructose is the chief sugar content naturally present in fruit and vegetables. The variation among the varieties highly significant in respect of nonreducing sugar content at different developmental stages [17]. The result of nonreducing sugar content in the variety Champa showed an enhanceable trend with 16.35% the lower amount was recorded from Bhabani 9.42% (see Figure 5).

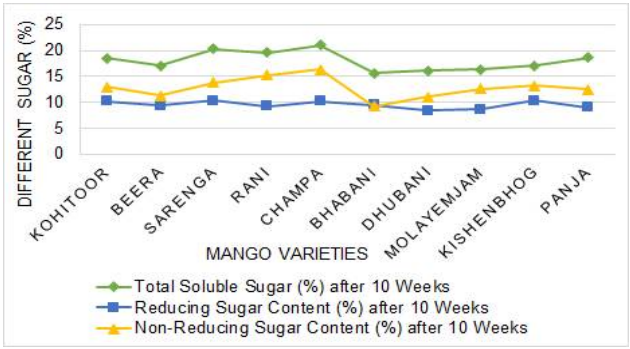

Figure 6: Different sugar content of mango varieties at ripening state.

4. CONCLUSION

A comparative study on biochemical parameters mainly focused on carbohydrates of those mango varieties suggested that those varieties are with high carbohydrates. The varieties like Champa, Rani, and Sarenga are with high sugar content (see Figure 6). Champa considered as the sweetest among those varieties.

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