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DEVELOPMENT OF FRUIT MATURITY COLOR CHART OF BARI Aam-3

[1*]M. J. Uddin, [2]M. Robbani, [3]M. F. Hasan and [4] H. Rahman

[1]PhD Fellow in Horticulture, Patuakhali Science and Technology University, Bangladesh

[2,3]Professor, Dept. of Horticulture, Patuakhali Science and Technology University, Bangladesh

[4]Professor, Dept. of Plant Pathology, Patuakhali Science and Technology University, Bangladesh

*Corresponding Author

ABSTRACT

The objective of this study was to evaluate the physico-chemical characteristics at different color stages and develop a standard maturity color chart of BARI Aam-3 mango variety. The earliest physiological maturity (stage 1) was marked as the stage when the flesh was mostly cream and turning yellow at the seed and the subsequent maturity stages determined at 2-days intervals as stages 2, 3, 4, 5 and 6. For each of the maturity stages, physical (pulp-peel ratio, peel-flesh firmness, peel-flesh color and glossiness) and biochemical (titratable acidity, pH, total soluble solids, vitamin-C, reducing sugar, non reducing sugar, total sugar, anthocyanine and carotenoid) maturity indices were determined. At early stage green (G) color is prominent and gradually decreasing with maturity. At stage-1, RGB% was 86.40, 108.01 and 5.40 respectively. The highest red (R) color contain at stage-5 (RGB% 204.40, 157.81, 2.60). The anthocyanin content was more in ripe mango peel and it highest was 0.2922 µmol ml^{-1} at stage-4 and lowest was 0.01880 µmol ml^{-1} at stage-2. The Carotenoid content was more in ripe mango pulp and it highest was 1.796 µmol ml^{-1} at stage-6 and lowest was 0.1646 µmol ml^{-1} at stage-4. The highest titratable acidity (1.50%) was recorded at stage-1 and the lowest (0.4420%) was recorded at stage-6. At stage-1, the lowest pH (3.262) was recorded and the highest (5.320) was recorded at stage-6. At stage-1, the lowest TSS (7.224%) was recorded and the highest (23.85%) was recorded at stage-6. At stage-1, the highest ascorbic acid (13.78 mg) was recorded and the lowest (5.70 mg) was recorded at stage-6. At stage-1, the lowest reducing sugar (2.470 %) was recorded and the highest (5.926 %) was recorded at stage-4. At stage-1, the highest non reducing sugar (2.428%) was recorded and the lowest (0.2960%) was recorded at stage-5. At stage-5, the lowest total sugar (3.788%) was recorded and the highest (6.312%) was recorded at stage-4. The results

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revealed that, there is a significant relationship between nutritional value and maturity indices of mango fruits.

Keywords: BARI Aam-3, mango, maturity stage, color.

1. INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae, is an important and popular fruit of Bangladesh. It has a unique position in respect of nutritional quality, taste, consumer's preference etc., among the fifty kinds of fruits grown in Bangladesh (Ahmad, 1985). The fruit is believed to have originated in the Eastern India, Asam, Burma or in the Malayan region (Mukherjee, 1997). Mango is now recognized as one of the choicest fruits in the world market for its excellent flavour, attractive color and delicious taste.

It has medium calorific and high nutritional values. Carbohydrate content in ripe mango pulp is 16.9% (Salunkhe and Desai, 1984). Besides, mango contains appreciable quantity of provitamin A, vitamin C and soluble sugar (Samad *et al.*, 1975). The unripe fruits contain nearly 50% more vitamin C than the ripe ones and in mineral content, mango holds an average position among fruits and in containing iron, unripe mango is the first and ripe fruit, about the 16th position among all major fruits (Hossain, 1989). The fruit has really of immense value in respect of money and prosperity. In Bangladesh it is called as "King of the fruit". According to BBS (2004), Bangladesh produces 190 thousand metric-tons of mangoes per annum from 50.61 thousand hectares of land. The average yield of mango in Bangladesh is only 3.72 t/ha (BBS, 2004). This yield is much lower compared to that of our neighboring countries like India (8.95 t/ha) (Gosh, 1998) and the Philippines (9.41 t/ha) (Espino and Javier, 1989). Mango is a very important fruit, widely cultivated and consumed fruits in several tropical and subtropical regions, and its distribution in world trade is expanding. Global production of mangoes was about 30 million tons (MT) in 2010 (FAO, 2010) and it is the second largest tropical fruit crop in the word, after banana. For mangoes in particular, successful postharvest handling involves managing the ripening process and avoiding quality loss due to physical damage and decay. As mango fruit mature on the tree and begin to ripen, eating quality improves but potential marketable life decreases due to the difficulty of controlling the ripening changes once they have been initiated, and increased bruising susceptibility and decay (Yahia, 2005; Yahia *et al.*, 2006a).

Consumers are experiencing inconsistent fruit maturity and ripening variability, sometimes even in a single consignment.

Mango fruits have a short production season and storage life, and therefore fruit prices after seasonal peak can be very high and therefore may not be affordable by many consumers. The storage life of mangoes is limited to 2–3 weeks in air at 10 °C−15 °C (Yahia, 1998a). Variability

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in mango fruit quality is detected in the supply chain with respect to taste, flavour, color, aroma, weight, size and shape, influenced by the production management practices. According to Kader (2002), quality performance of mangoes depends largely on external and internal quality parameters. Consumer acceptance is higher for mangoes free from external damages including bruises, latex or sap injury, decay, uniform weight, color and shape which are external quality attributes. Internal quality attributes include uniform and intense flesh color, freedom from damage, and adequate acidity (or pH) and SSC (brix°), depending on cultivar and type of consumer preferences (consumers in different regions have different preferences). Mango flavour quality depends on the type of cultivar, stage of maturity at harvest; postharvest handling methods including the type of treatments, and incidence of mechanical damages or chilling injury, which can also affect fruit flavour (Kader, 2008a, 2008b).

Optimum skin color is an important fruit quality parameter that affects consumer acceptance and preference. The obvious noticeable change during ripening is skin color change from dark green to olive green or reddish or orangish yellow or yellow that forms a base color. Some cultivars show reddish bluish skin color mainly due to the presence of anthocyanins (Tharanathan et al., 2006). These skin color changes are due to the disappearance of chlorophyll and the appearance of other pigments (carotenoids and/or anthocyanins) as mentioned before. Carotenoids are the predominant pigments in yellow cultivars. Presence of the anthocyanin phenondin-3-galacytosa has been reported in the skin of some types of cultivars (e.g. Tommy Atkins) (Proctor & Creasy, 1969).

The color in a mango is the most important visible characteristic used to assess ripeness, and it is a major factor in the consumer's purchase decision. The degree of ripeness is usually estimated visually by human graders who compare the mango color to a classification chart. Human identification of color is complex because sensations such as brightness, intensity, and lightness are important. As color is an indication of mango ripeness, a green to yellow gradient can also be used to assess the stage at which a mango should be harvested and consumed. The mango fruit is a climacteric fruit, and therefore, it continues maturing after it has been harvested. However, very little information on the maturity color stage of fruits at growers, arathdars, pikars, beparies, retailers and consumers level. With this views in mind, the present study was conducted to know the perfect maturity color stage of BARI Aam-3 for harvesting, selling and consumption which will help for developing appropriate postharvest practices to reduce its losses. Therefore the present investigation was undertaken to evaluate the physico-chemical characteristics at different color stages and develop a standard maturity color chart of BARI Aam-3 mango variety.

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2. MATERIALS AND METHODS

Experimental Site

The experiment was carried out at the Postharvest laboratory, Department of Horticulture, Patuakhali Science and Technology University (PSTU), during January to July 2016.

Atmospheric Conditions of Storage Room

The temperature and relative humidity of the storage room were recorded daily during the study period with a digital thermo hygrometer (THERMO, TFA, Germany). The minimum and maximum temperatures during the study period of the storage room were 24.0 $^{\circ}$C and 33.0 $^{\circ}$C, respectively. The minimum and maximum relative humidity were 82% and 90% respectively.

Selection of the Fruits

A total 100 healthy fruits with uniform size shape and color were selected from tree of BARI Aam-3 belonging to the Regional Horticulture Research Station, BARI, Lebukhali, Patuakhali.

Fruit Harvest

Fruits were harvested when it attained in light green color with uniform size and shape. The fruits having no defect were cut off with a sharp knife keeping intact about 2 cm stalk with them and loaded immediately with care and transferred to the Horticulture Laboratory.

Determination of Physical Characteristics at Different Stages of the Fruit

External Peel Color

The peel color of fruits was determined using a Android Application Software namely “On Color Measure” (developed by PotatotreeSoft, Version 3.0) that was equipped with an aim pointer. On Color Measure is an amazing way to recognize color by using the camera of mobile device. It provides an easiest way to store the information’s of each color detection. Color measurements were made at the stem end, equatorial region and blossom end of each face of the fruit and a mean value obtained.

Glossiness of Fruit

Glossiness of mango was determined by gloss meter **(Model: ETB-0686).** Gloss is measured by directing a constant intensity light beam, at a fixed angle, on to the test surface and then monitoring the amount of reflected light from the same angle. This specular reflectance is

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measured using a glossmeter. A glossmeter provides quantifiable gloss measurements, expressed as gloss units (GU).

Firmness, Pulp to Peel Ratio

Firmness of mango was determined by firmness testing machine (Model: GY 4). This method was mentioned by Hassan (2006).

The pulp to peel ratio was measured with the following formula-

$$\text{Pulp to peel ratio} = \frac{\text{Weight of fruit pulp}}{\text{Weight of peel}}$$

Determination of Chemical Characteristics at Different Stages of the Fruits

Anthocyanine and Carotinoid

The Total Anthocyanine Content of peel and the carotinoid content of pulp were determined by the method of Sims and Gamon (2002). Content of chlorophyll-a and chlorophyll-b as well as anthocyanine content and carotinoid content were calculated by using the following formula:

$$\text{Chlorophylla-a } (\mu g/ml) = 12.21\ A_{665} - 6.88\ A_{649}$$

$$\text{Chlorophylla-b } (\mu g/ml) = 20.13\ A_{646} - 5.03\ A_{663}$$

$$\text{Carotinoids } (\mu g/ml - \mu g/g) = \frac{1000\ A\ 470 - 3.27\ Ca - 104\ Cb}{229}$$

$$\text{Anthocyanine } (\mu mol/ml) = A_{529} - 0.288\ A_{650}$$

$$\text{Anthocyanine } (\mu mol/g \times 207.247 = \mu g/g) = A_{529} - 0.288\ A_{650}$$

Where, Ax is the absorbance of the extract solution in a 1-cm path length cuvette at wave length x.

Titratable Acidity, pH, Total Soluble Solids Concentration, Ascorbic Acid, Total Sugar, Reducing Sugar, Non-reducing Sugar

Titratable acidity (TA) was determined according to the method by Ranganna (1977). The remaining of the filtrated juice from TA determination was used to measure the pH of the fruit pulp. The pH was determined by using a glass electrode pH meter (PHS-25 Precision pH/mV meter, LIDA Instrument). The soluble solids concentration of fruits pulp was determined by using a digital refractometer (BOE 32195, BOECO Germany). Ascorbic acid was determined according to the dye method by Ranganna (1977). Sugar content of fruit was estimated by the

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following procedures described by the Lane and Eynon (1923). Percent reducing sugar was calculated according to the following formula:

$$\text{Reducing sugar (\%)} = \frac{F \times D \times 100}{T \times W \times 1000}$$

Where,

F= Fehling's solution
D= Dilution
T= Titre, and
W= Weight of sample

The percentage of total invert sugar was calculated by using the formula used in incase of reducing sugar. Non-reducing sugar was estimated by using the following formula:

Non-reducing sugar (%) = Total invert sugar (%) - Reducing sugar (%)

Statistical Analysis

The data on different parameters of the experiment were collected two days interval from first maturity stage up to six maturity stage and tabulated, analyzed CRD with five replications (Gomez and Gomez, 1984) adopting a statistical programme MSTAT-C. All the treatment means were calculated and the analysis of variances (ANOVA) of different characteristics considered was done by 'F' variance test. The means were separated by Least Significant Difference (LSD) test at 1% and 5% levels of significance.

3. RESULTS AND DISCUSSION

The results on the different parameters are presented in figure and table for ease of discussion under the following sub-headings and possible interpretations have been given whenever necessary.

Studies on the Physical Characteristics at Different Stages of the Fruits
Peel Color

Color is one of the most important criteria of quality of most fruits. The changes in color of mango peel green to yellow are the most obvious changes which occur during, storage of fruits.

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Stage-1
(Dull green)

Stage-2
(Olive green)

Stage-3
(Yellowish green)

Stage-4
(Light yellow)

Stage-5
(Saddle brown)

Stage-6
(Dark golden**)**

Plate 1. Different maturity stages of BARI Aam-3

Change of peel color during ripening and senescence of fruits involves chlorophyll degradation or qualitative and quantitative alternation of the green pigment into other pigments. During color change the pulp becomes softer and sweeter as the ratio of the sugar to starch increased and the characteristics aroma is produced. Significant variation was observed in respect of color at different maturity stages of the fruits (Figure 1).

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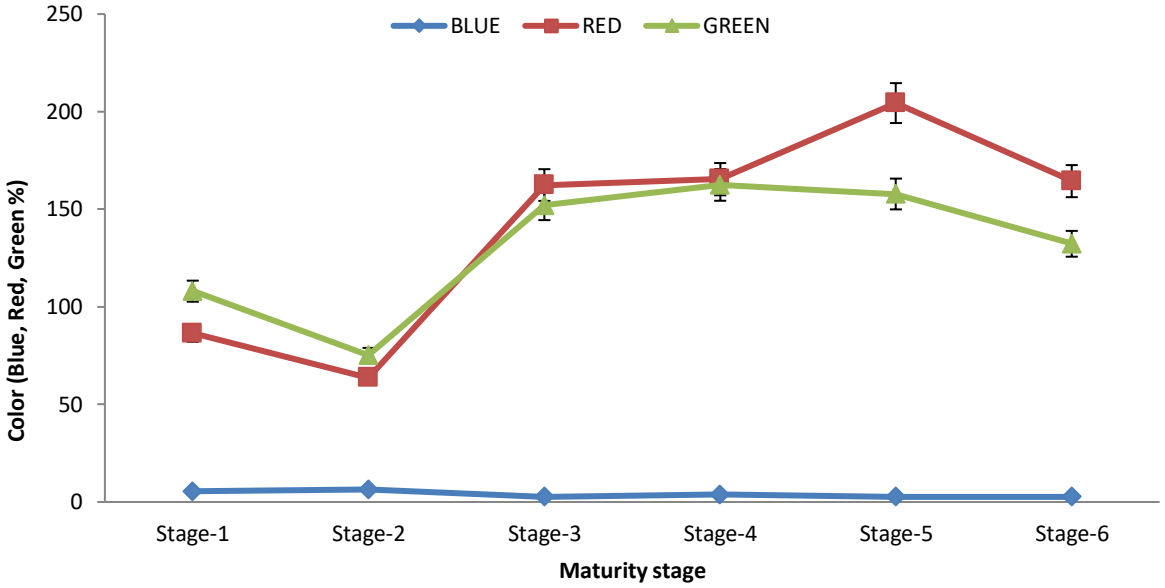

Figure 1. Color content (red, green, blue %) of BARI Aam-3 at different maturity stages. Vertical bar represent LSD at 1% level.

At early stage green (G) color is prominent and gradually decreasing with maturity. At stage-1, RGB% was 86.40, 108.01 and 5.40 respectively. The height red (R) color contain at stage-5 (RGB% 204.40, 157.81, 2.60). Then value of RGB% decreasing due to deterioration of color pigment.

Firmness

Firmness is important criteria of fruits quality. The firmness of mango pulp from hard to eating ripe are obvious changed which occur during storage. During firmness change the pulp become softer and sweeter as the ratio of the sugar to starch increases and characteristic aroma is produced. Highly significant variation was observed in respect of firmness of mango pulp at different stages (Table 1). The firmness of mango changes due to conversion of starch and pectin into sugars.

Glossiness

Gloss is an important aspect of our visual perception of objects. The perception of gloss can relate to a product's finish, texture and how a sample is illuminated and viewed. Surfaces with high reflectance are perceived as glossy, shiny or lustrous, whilst less reflective surfaces are perceived as semi-gloss or matt. Gloss can be measured by several different techniques. One of them is by using an optical instrument called a gloss meter. A glossmeter provides quantifiable

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gloss measurements, expressed as gloss units (GU). Gloss is measured by directing a constant intensity light beam, at a fixed angle, on to the test surface and then monitoring the amount of reflected light from the same angle. This specular reflectance is measured using a gloss meter. Statistically highly significant variation was observed in respect of glossiness of mango peel at different stages (Table 1).

Table 1. Analysis of data of physical characteristics at different maturity stages of BARI Aam-3

Physical characteristic stages	Pulp firmness	Glossiness of fruit	Pulp to peel ratio
Stage-1	72.36	1.350	6.162
Stage-2	50.02	1.540	6.556
Stage-3	27.48	2.420	6.634
Stage-4	26.58	3.360	6.414
Stage-5	21.54	3.580	6.608
Stage-6	17.00	4.560	6.682
LSD(0.05)	2.713	0.4086	0.8872
LSD(0.01)	3.638	0.5538	1.202
Sx	0.9198	0.1400	0.3040
Level of Significance	**	**	NS
CV%	5.05	3.99	6.19

**= Significant at 1% level of probability. NS= Non Significant.

Pulp to Peel Ratio

The effects of different postharvest treatments were non-significant during the entire period of storage. The maximum value of pulp to peel ratio (6.682) was observed at the maturity stage-6 where minimum value of pulp to peel ratio (6.162) was observed at the stage-1(Table 1). Aina (1990) reported that the some physical and chemical measurements were applied to mature green African mango fruits (*Irvingia gabonensis* Baill.) during a 7 days storage ripening period at tropical ambient conditions (27-30° C and 68-70% relative humidity). Changes in fruit weight, texture and color reflected the most significant chemical changes in the fruit such as starch degradation, formation of sugars and increase in total carotenoids etc.

Bio-chemical Characteristics at Different Stages of the Fruits

Total Anthocyanin Content

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Anthocyanins are a group of phenolic compounds in the plant kingdom and they exhibit good antioxidant properties. Anthocyanins below pH 2 exist primarily in the form of flavyllium cation (Takeoka & Dao, 2002) and at this low pH, they absorb light around 510 nm, while degraded anthocyanins in the polymeric form absorb light below 2 pH and pH 4.5. As can be seen from figure, the anthocyanin (Table 3) content was more in ripe mango peel and it highest was 0.2922 µmol ml^{-1} at stage-4 and lowest was 0.01880 µmol ml^{-1} at stage-2.

Total Carotenoid Content

Carotenoids are one of the most widespread groups of pigments in nature and more than 600 of these have been identified. Beside provitamin A activity, carotenoids are important as antioxidants and protective agents against various diseases. As can be seen from table, the Carotenoid (Table 3) content was more in ripe mango pulp and it highest was 1.796 µmol ml^{-1} at stage-6 and lowest was 0.1646 µmol ml^{-1} at stage-4.

Titratable Acidity

The titratable acidity content of fruits varied significantly (Table 2) at different stages during storage. The titratable acidity content of fruit at different stages under the study varied from 0.442-1.50% depending on maturity stages. The highest titratable acidity (1.50%) was recorded at stage-1 followed by stage- 2 (1.410%) and stage-3 (1.312%). Then the titratable acidity was decreased up to fully ripen. The lowest titratable acidity (0.4420%) was recorded at stage-6.

The titratable acidity content of the fruit at different maturity stages under the study varied up to 1.45% depending on variety. A gradual decrease in titratable acidity with the advancement of maturity due to various enzymatic activities. Uddin *et al*. (2006) conducted an investigation on some bio-chemical characteristics of twenty two germplasm of mango. Mixed special had the highest titratable acidity (1.53%) and BARI Aam-3 had the lowest content of titratable acidity (0.24%).

pH of Fruit Juice

The pH of the fruit pulp at different stages varied significantly (Table 2) at different stages during storage. The pH of the fruit pulp at different stages under the study varied from 3.262-5.320 depending on maturity stages. At stage-1, the lowest pH (3.262) was recorded followed by stage- 2 (3.840) and stage-3 (4.392). Then pH was increased up to stage-6 significantly. The highest pH (5.320) was recorded at stage-6. Statistically highly significant variation of pulp pH was observed at different stages due to conversion of pectin into sugars.

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Table 2. Analysis of data of biochemical characteristics at different maturity stages of BARI Aam-3

Maturity stage	Titratable acidity (TA)	Total soluble solids (TSS)	pH	Vitamin-C	Reducing sugar (RS)
Stage-1	1.500	7.224	3.262	13.78	2.470
Stage-2	1.410	12.15	3.840	12.38	2.796
Stage-3	1.312	15.48	4.392	11.23	3.424
Stage-4	1.272	20.68	4.854	11.20	5.926
Stage-5	0.7980	22.51	4.942	6.234	3.478
Stage-6	0.4420	23.85	5.320	5.700	3.916
LSD(0.05)	0.09230	0.2407	0.2545	0.8338	0.1168
LSD(0.01)	0.1251	0.3262	0.1582	1.130	0.1582
Sx	0.03162	0.08246	0.0400	0.2857	0.0400
Level of Significance	**	**	**	**	**
CV%	6.07	2.08	4.96	5.34	3.49

**= Significant at 1% level of probability

TSS of Fruit Juice

The TSS content of fruits varied significantly (Table 2) at different stages during storage. The TSS content of fruit at different stages under the study varied from 7.224-23.85% depending on maturity stages. At stage-1, the lowest TSS (7.224%) was recorded followed by stage- 2 (12.15%) and stage-3 (15.48%).Then the TSS was increased up to fully ripen. The highest TSS (23.85%) was recorded at stage-6.

The TSS content of fruit at different stages under the study varied from 7-25.34% depending on maturity stages. Total soluble solids content of a solution is determined by the index of refraction. This tests the solids concentration of a sucrose containing solution. It is widely used during fruit processing to determine the concentration of sugar in the products. During the development of the flesh of a fruit, in many species, nutrients are deposited as starch, which during the ripening process is transformed into sugars. The progression of the ripening process leads to increasing sugar levels. Bhuyan and Guha (1995), found 16.22 to 24.14% TSS in mango fruits under the climatic conditions of Rajshahi.

Ascorbic Acid

The ascorbic acid content of fruits varied significantly (Table 2) at different stages during storage. The ascorbic acid content of fruit at different stages under the study varied from 5.70-13.78 mg/100g depending on maturity stages. At stage-1, the highest ascorbic acid (13.78 mg)

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was recorded followed by stage- 2 (12.38 mg) and stage-3 (11.23 mg). Then the ascorbic acid was decreased up to fully ripen. The lowest ascorbic acid (5.70 mg) was recorded at stage-6.

Reducing Sugar

The reducing sugar content of fruits varied significantly (Table 2) at different stages during storage. The reducing sugar content of fruit at different stages under the study varied from 2.470-5.926 % depending on maturity stages. At stage-1, the lowest reducing sugar (2.470 %) was recorded followed by stage- 2 (2.796 %) and stage-3 (3.424 %). Then the reducing sugar was increased up to fully ripen. The highest reducing sugar (5.926 %) was recorded at stage-4. A gradual increase in reducing sugar was observed with the advancement of maturity due to various enzymatic activities. Reducing sugar content of mango varied from 2.6 to 7.1% as described by Chaudhari *et al*. (1997). Sharma and Josan (1995), Muhammad *et al.* (2004), Uddin *et al.* (2006) also reported that reducing sugar content of mango varied depending upon maturity stages.

Non Reducing Sugar

The non reducing sugar content of fruits varied significantly (Table 3) at different stages during storage. The non reducing sugar content of fruit at different stages under the study varied from 0.2960-2.428% depending on maturity stages. At stage-1, the highest non reducing sugar (2.428%) was recorded followed by stage- 2 (1.248%) and stage-3 (1.048%). Then the non reducing sugar was decreased up to stage-5 significantly. The lowest non reducing sugar (0.2960%) was recorded at stage-5. The non reducing sugar content of the fruit at different maturity stages under the study varied up to 13% depending on maturity stages. Uddin *et al*. (2006). conducted an investigation on some bio-chemical characteristics of twenty two germplasm of mango. The non-reducing sugar content of the fruit pulp of mangoes varied from 0.34 to 3.95%. BARI Aam-3 had the highest percentage of non-reducing sugar (5.10%). A gradual increase in non reducing sugar was observed with the advancement of maturity due to various enzymatic activities.

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Table 3. Analysis of data of biochemical characteristics at different maturity stages of BARI Aam-3

Maturity stage	Non reducing sugar (NRS)	Total sugar (TS)	Carotenoid	Anthocyanin
Stage-1	2.428	4.898	0.1760	0.08760
Stage-2	1.248	5.166	0.5228	0.01880
Stage-3	1.048	4.472	0.5846	0.02100
Stage-4	0.3860	6.312	0.1646	0.2922
Stage-5	0.2960	3.788	1.262	0.2492
Stage-6	1.352	4.148	1.796	0.04640
LSD(0.05)	0.0985	0.1488	0.09230	0.01305
LSD(0.01)	0.1938	0.2017	0.1251	0.02502
Sx	0.04899	0.05099	0.03162	0.006325
Level of Significance	**	**	**	**
CV%	6.73	2.40	5.76	4.17

**= Significant at 1% level of probability

Total Sugar

The total sugar content of fruits varied significantly (Table 3) at different stages during storage. The total sugar content of fruit at different stages under the study varied from 3.788-6.312% depending on maturity stages. At stage-5, the lowest total sugar (3.788%) was recorded followed by stage- 6 (4.148%) and stage-3 (4.472%). Then the total sugar was increased up to fully ripen. The highest total sugar (6.312%) was recorded at stage-4. Mango pulp contains amylase, invertase and high percentage of starch. Starch accumulation is the main activity of fruit which increases fruit weight. Amylase and invertase in the mango pulp play an important role during the development of mango. The hydrolysis of starch during fruit ripening by hydrolytic enzymes has been reported for mango. Changes in amylase activity in mango fruits during development and after being exposed to chilling temperatures have been reported. Fruit softening during ripening is complex process that presumably involves structural changes in the walls of fruit cells. It is thought that these changes are brought about through the action of cell wall hydrolyses, degrading various wall polymers although other mechanisms may be involved. The activities of all these enzymes increased with degree of maturity. Bhuyan and Islam (1986), Absar *et al*. (1993), Jana *et al*. (1998) also reported that total sugar varied depending upon storage duration.

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4. CONCLUSION

Data on morphological as well as physico-chemical characters were studied. The wide variations were observed among the stages in terms of qualitative and quantitative characters namely fruit peel color, pulp firmness, fruit glossiness, anthocyanine content, carotenoid content, titrable acidity, pulp pH, ascorbic acid, TSS , reducing sugar, non reducing sugar and total sugar. Total anthocyanine content was increased with maturity. It increased up to 0.2922 μmol ml^{-1} at maturity stage-4. The highest ascorbic acid content was recorded in 13.78 mg/100g at stage-1 and decrease with maturity up to 5.70 mg/100g. The highest TSS content in the fruits was recorded at stage-6 (23.824%) and lowest at stage-1 (7.220%). The percent total sugar and reducing sugar was the highest in at stage-4 (6.312%, 5.926%) respectively with best eating quality. The titratable acidity was highest at stage-1 (1.50%) and decreased up to (0.4420%).
From the findings it could be concluded that among the maturity stages of fruit, stage-6 was found to be the best considering the overall performances of all the stages. Among the maturity stages, stage-2 is best for harvesting of fruit and stage-6 is best for consumption of mango fruit. Farmers can harvest their BARI Aam-3 mango fruits compare with maturity color chart and maintain their nutritional quality as well as post harvest indices.

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