

Physicochemical Changes During Ripening Of Monthan Banana

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ABSTRACT: The changes occur during normal ripening of banana variety (Monthan) was studied for nine days of storage. Percent moisture content of whole fruit was increased initially and decreased after the middle of ripening period, but moisture content of pulp increased gradually. The gradual increase in TSS was observed till the end of storage period. Steep depletion in firmness was positively correlated with the reduction in peel thickness. Pulp to peel ratio and specific gravity was increased steadily with decreasing fruit weight. The percent finger drop was 33.37 at the eight days of storage. The prominent maturity indices in monthan variety are weight, TSS, and firmness.

Keywords: normal ripening, variety, compositional changes.

1 INTRODUCTION

The banana (*Musa paradisiaca*) is one of the important fruit grown in tropical countries and consumed as raw, ripe or processed into pulp-liquid fruit, canned slice, deep fried chips, toffees, fruit bars, brandy etc.[1]. The raw banana is used for processing whereas ripe bananas preferred for consumption. In the meantime of ripening, banana undergoes various noticeable physicochemical changes simultaneously. These changes are complex as it covered three different physiological stages, namely the pre-climacteric (green life) stage, climacteric (ripening) stage and senescence (dying) stage where the fruits are over-ripe. The physiological stage and compositional changes of harvested banana varies for each individual variety and may depend on the factors such as climate, cultivation practices, post-harvest handling, storage condition etc. Moreover, the stage of ripeness of fruit after harvest is an important aspect in determining its suitability for processing and development of better products. Many authors documented the trail of banana ripening. Physical and mechanical characteristics of two varieties of green-mature banana fruits are well documented [1]. Investigation is done to understand the textural changes of banana and plantain pulp during ripening [2]. Physicochemical properties of some local banana cultivars also studied [3]. The effect of storage temperature on properties of banana fruit is investigated [4]. Investigation on effect of storage humidity, temperature and fruit length on characteristics of banana fruit were done [5]. The changes in color and texture of banana during storage at 10°C and 20°C also reported in literature [6]. However, significant variation is observed among every investigation, and it is unusual as the experiment conditions are varied. In addition, the characteristics of each ripening stage of banana is function of fruit maturity, humidity, ventilation, mechanical damage, transit temperature, fungal infection and many other factors [7]. Therefore, every single banana variety needs to be investigating with respect to location and ripening stages. Monthan (ABB) is a widely cultivated variety across the world for processing. The new prolific 'Monthan' type clones of economic value namely 'Kanchi Vazhai' and 'Chakkia' are recently becoming popular in India. Apart from its culinary use of fruits, pseudostem core is a highly relished vegetable with many medicinal properties. Monthan variety is also cultivated for production of leaves in southern part of India. However, literature scan reveals that, none of the researcher investigated the physicochemical changes during ripening of monthan banana. Therefore, the

intention of this work is to investigate the physicochemical changes in normal ripening of trendy banana variety namely Monthan (ABB) in order to determine best maturity indices and suitable stage for the consumption and production of quality banana products.

2 MATERIAL AND METHODS

2.1 Sample Selection

Fully mature, unripe (green) fruit of banana that had 80% ripening indices with angular cross sections procured from the local orchard. The fruits placed in a corrugated cardboard box and transported by refrigerated truck (25°C) to the laboratory within 3 hours of harvest. The hands were cleaned by chlorine solution and stored in ambient temperature (24 ± 2°C) and humidity (70 ± 5%).

2.2 Chemical Analysis

The pulp and peel analyzed for moisture content from the green stage through to the fully ripe stage using oven-drying method. The banana slices of 3-4 mm thick with and without peel placed in a stainless steel dishes in drying oven. Drying was done in tray dryer (Ms. Everflow, Chennai), for 24 hours at 100°C [8]. Total soluble solids content was determined by using lab level refractometer (ATAGO, RX7000α, Japan), ideally both the instrument and fruit pulp were maintained at the same temperature (20°C). A scoop of banana pulp from the apical, middle and basal part of fruit placed on a muslin cloth separately, and a drop of it squeezed out onto the refractometer. In case of unripe banana, juice was extracted by squeezing pulp in muslin cloth, three-four drops of squeezing banana set on the sensing screen of refractometer.

2.3 Physical Analysis

Weight loss was determined by weighing the ten fruits of banana and plantain every day. The Specific gravity was determined by using platform scale method. The weight of individual fruits taken in air and water by using lab level weight balance (PHOENIX, India), having 0.001 precision. Precaution was to ensure that fruit was fully immersed in water without touching beaker. The specific gravity was calculated using (1) [9].

$$\text{Specific Gravity} = \frac{\text{Sample weight in air} \times \text{Density of water}}{\text{Weight of displaced water}} \quad (1)$$

Pulp to peel ratio were determined by dividing the weight of pulp to peel. The sharp edge knife was used to peel the unripe bananas. The peel thickness was determined by cutting the fruits at four places across the length, and thickness measured by using vernier calliper whose least count is 0.01mm. The finger drop calculated by raising banana 15 cm above the table for thirty seconds and subjecting to gentle manual shaking. Percent finger drops is calculated using (2) [10].

$$\text{Finger Drop (\%)} = \frac{\text{Number of fruits dilodge}}{\text{Number of fruits per hand}} \times 100 \quad (2)$$

2.4 Textural Analysis

Firmness was determined by using a texture analyzer (TA-HD plus TPA), the working conditions during the measurements were; mode-measure force in compression, pre-test speed-1.5 mm/s, test speed 1.0 mm/s, post-test speed 10mm/s trigger type-auto 5 kg, the data acquisition rate and accessory was 2 mm cylinder probe (P/2) and heavy duty platform (HDP/90). During experiment fruit kept at its most stable position on a heavy-duty platform of texture analyzers, readings taken at apical, middle and basal part of fruit and recorded in Newton unit. The mean of the three readings calculated as a measure of firmness for each fruit. The samples were selected randomly from the same bunch. With concern to banana, there is no significant difference between the hands of the single bunch to consider the separate sampling within the bunch [11]. Three samples from same bunch were selected randomly every day. The data is expressed as means±standard deviation.

3 RESULT AND DISCUSSION

3.1 Moisture Content

The moisture content of fruit was found increased till the fourth day of storage and decline afterwards (Fig. 1a). Surprisingly, pulp moisture content was continued to increase till last day of storage. It reveals that within fruit moisture have been migrated from peel to pulp. However, the acceleration in pulp moisture content was more after fourth day of storage. The event had consequences with decline in whole fruit moisture content. [12] Reported that the increased in moisture content of pulp was occurred due to increase in sugar content in the pulp as a result of starch hydrolysis to sugar. The correlation between Moisture content and TSS is 0.98. Therefore, it can be inferred that amount of moisture content can influence the TSS content.

3.2 Total Soluble Solids

In most ripen fruits including banana incidence of post harvest causes sugar formation as a result of starch hydrolysis. In this study the increase in TSS was 3 to 22.24 during nine days of storage (Fig. 1b). The magnitude of increase of total soluble solids in banana is dependent on cultivar or hybrid [13]. Similar trend of TSS during banana ripening is reported in literature [6].

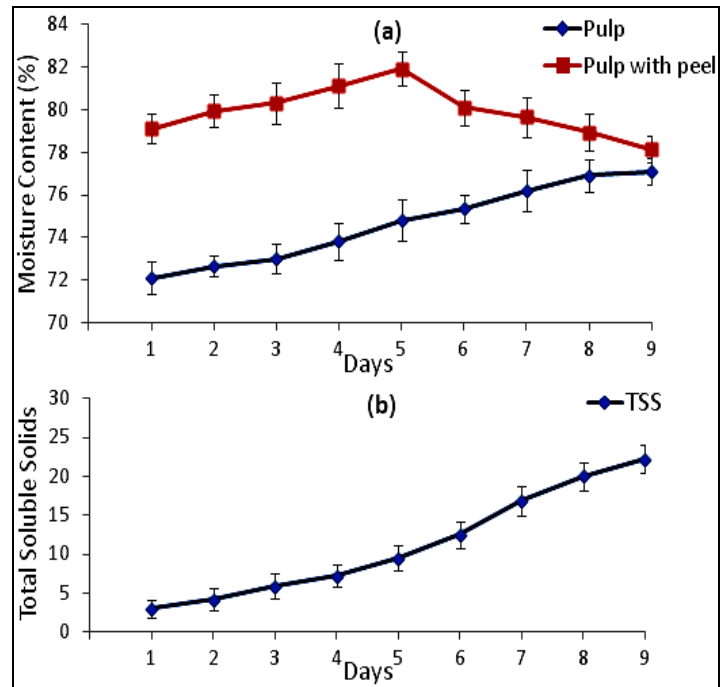


Fig 1 Changes in moisture content (a), and total soluble solids (b) of monthan banana. Vertical bar shows standard deviations.

3.3 Pulp to Peel Ratio

Pulp to peel ratio was elevated with consequent increase in storage period and it was 5.97 at the end of storage period (Fig. 2a). Increasing pulp to peel ratio of banana is related to accumulation of moisture in the pulp derived from carbohydrate breakdown and osmotic transfer from peel to pulp [14]. Correlation between pulp to peel ratio and pulp moisture content was 0.98. Increasing the sugar content in the pulp could allow the water to move from the peel to the pulp, hence pulp to peel ratio was increasing with increase in TSS and moisture content. Rise in pulp to peel ratio during fruit ripening suggested due to changes in sugar concentration in the two tissues. A rapid increase in sugar contents in the pulp than those in the peel leads to changes in osmotic pressure because of which water is withdrawn from the peel and hence pulp to peel ratio increases accordingly. The correlation between Pulp to peel ratio and TSS is 0.95. Similar results observed by [15].

3.4 Peel Thickness

Banana fruit naturally wrapped up in thick skin, the peel not only protects fruit, but it plays a crucial role in compositional changes during ripening. In present study, significant decrease in peel thickness from 3.88±0.34 to 2.67±0.045 was observed with prolongation of ripening time (Fig. 2b). The modification of cell wall of peel may affect firmness loss and ultimately vanishing of void spaced and hence reduction in peel thickness. [16] Observed that, peel thickness and the cell layer number decreased continuously when banana ripening was initiated. Results of moisture content of pulp suggest that the moisture is getting migrated from peel to pulp and causes diminution of peel thickness. A little variation in peel thickness in early storage period occurred due to negligible swelling in the peel. In addition, in the destructive taste the samples are selected randomly on a daily basis and therefore variation in results are

expected. [17] Also found the same results of peel thickness during banana ripening.

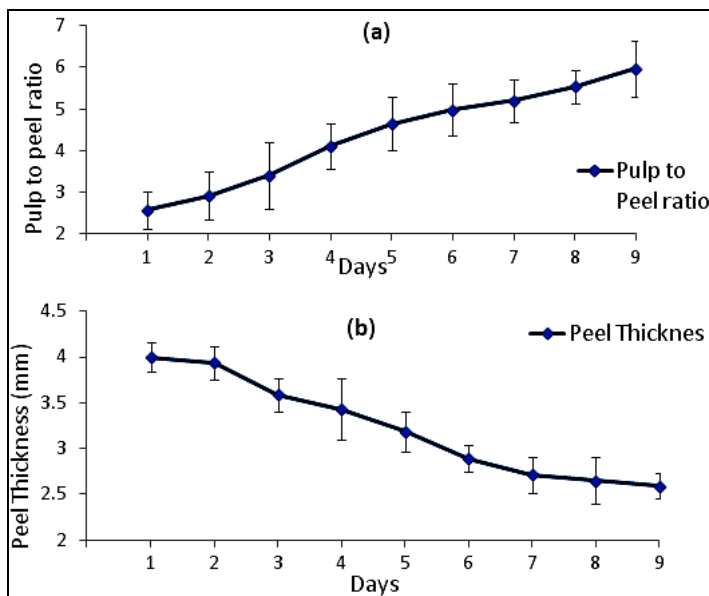


Fig 2 Changes in pulp to peel ratio (a), and peel thickness (b) of Monthan banana. Vertical bar shows standard deviation.

3.5 Specific Gravity

The specific gravity is found increased with increasing storage period. However, increase in specific gravity during ripening of banana fruits observed as 0.94 to 0.97 (Fig. 3a). It means that, the depletion of fruit weight is more than the corresponding decrease in its volume. Decrease in fruit moisture content is witness of this happening. In addition, accelerated biochemical activities and respiration may have contributed to vanished the fruit voids and hence increase in specific gravity. The high correlation between pulp to peel ratio and specific gravity ($r=0.99$) reveals that migration of biochemical compound from peel to pulp may cause of increase in specific gravity. Similar observations have been reported in Karonda [18], and Sapota fruits [19].

3.6 Firmness

The rapid loss in firmness of banana observed after third day of storage (Fig. 3b). In the beginning the fruit shown good resistant over penetration of texture analyzer probe, which was reduce with storage period. Rapid changes in biochemical and other properties such as peel thickness, TSS and moisture content are the main cause of alteration in mechanical properties of peel in banana. The correlation between peel thickness and firmness found to be 0.98. Current findings agreed with results of [20]. Degradation of nutrients and increased in moisture content of pulp can cause the strength reduction of peel fiber and may result in the flushness of pulp, which ultimately reduces the firmness quality of fruit [21].

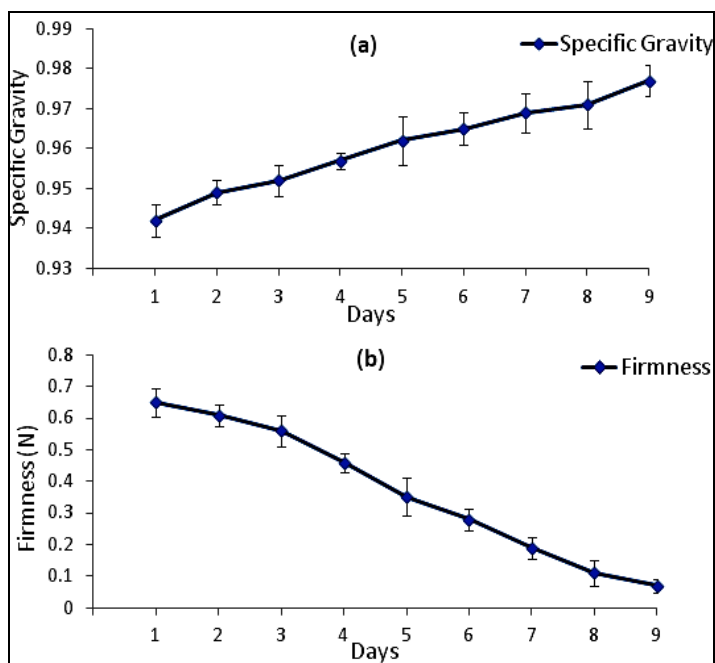


Fig 3 Changes in specific gravity (a), and firmness (b) of Monthan banana. Vertical bar shows standard deviation, if no bar shown standard deviation is smaller than symbol.

3.7 Weight

Difference in vapor pressure causes osmotic withdrawal of fruit moisture and hence weight reduction after harvesting. Water loss after harvesting causes fruit mass reduction and may also induce senescence. The loss in percent moisture content was found 15.56% (data not shown). Several factors responsible for this phenomena including peel morphology, post harvest treatment, atmospheric condition etc. As decrease in peel thickness with passage of ripening period accelerates the weight loss of fruit. The correlation between peel thickness and moisture content was found 0.97.

3.8 Finger Drop

The falling of the fingers can be occurred due to rupture of the peel at the pedicel. In consumer point of view, finger drop of banana fruit plays crucial role to judge the quality of food. In present investigation, the maximum finger drop begins from fifth day of storage. However, highest value recorded as 33.37% at the eight day of storage (data not shown). Accelerated ripening process causes the rupture at the junction of fruit pulp and pedicel. The banana rupture area does not contain an abscission zone, which means that the rapture must be due to a weakening of the peel at the pedicel [10]. One of the reasons for such weakening might be pectin degradation. [21] Reported that resistance to finger drop among several banana cultivars did not correlate well with finger length or finger diameter. It means individual variety had different reasons to cause finger drop. The possible factors, which may account for the finger drop are peel thickness, peel fiber content, water content, cell wall structure, degradation of cell wall macromolecules, circumference of pedicel, relative humidity and percent water content. Results agreed with findings of [10].

4 CONCLUSION

The extracted data shows significant differences in physical and chemical properties on a daily basis with passage of stor-

age time. The most useful and reliable maturity indices for banana fruits of monthan variety are fruit weight, pulp texture, and TSS content. These tests found objective, consistent, fast, cheap and reliable. The investigation can be helpful to process industry since the selection of fruit with optimum value of respective physicochemical property can yield the product with good quality. The physicochemical characteristics evaluated in this study can be important postharvest quality criteria for the processing, screening and breeding.

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6. REFERENCES

- [1] Kachru R. P., Kotwaliwale N., and Balasubramanian D., "Physical and mechanical properties of green banana," (Muss paradisiaca) fruit. *Journal of Food Engineering* 26, 369-378, 1995.
- [2] Kajuna S.T., A. R. Bilanski W. K., and Mittal G. S., "Textural changes of banana and plantain pulp during ripening," *J. Sci. Food Agric*, 75, 244–250, 1997.
- [3] Perera O. D., A. N. Basnayake B. M., K. M. K., and Anjani, M., "Physicochemical characteristics, popularity and susceptibility to anthracnose of some local banana cultivars," *J. Natn. Sci. Foundation Sri Lanka*, 27(2), 119-130, 1999.
- [4] Ahmad S., Thompson A. K., Hafiz I. A., and ASI A. S., "Effect of temperature on the ripening behavior and quality of banana fruit," *International journal of agriculture and biology*, 3(2), 224–227, 2001.
- [5] Ahmad S., Perviez M. A., Chatha Z. A., and Thompson A. K., "Improvement of banana quality in relation to storage humidity, temperature and fruit length," *International journal of agricultural and biology*, 8(3), 377-380, 2006.
- [6] Salvador A., Sanz T., and Fiszman S. M., "Changes in color and texture and their relationship with eating quality during storage of two different dessert bananas," *Post-harvest Biology and Technology*, 43, 319–325, 2007.
- [7] Soto M., "Bananos; Cultivo y comercialization, 2da ed. Litografia e Imprenta LIL, S.A., Costa Rica, 1992.
- [8] AOAC (Association of Official Analytical Chemists), *Official methods of analysis*, Washington D.C. 37:1-53, 1996.
- [9] FAO, (2014) "Basic harvest and post-harvest handling considerations for fresh fruits and vegetables," <http://www.fao.org/docrep/005/y4358e/y4358e05.html>
- [10] Wachiraya Imsabai, Saichol Ketsa, and Wouter G. van Doorn, "Physiological and biochemical changes during banana ripening and finger drop," *Postharvest Biology and Technology* 39:211-216, 2006.
- [11] Douglas H. Marin, Sylvia M. Blankenship, Turner B. Sutton, and William H. Swallow, "Physiological and chemical changes during ripening of costa rican bananas harvested in different seasons," *Jour of Americ. Soc. of Hort Sci.* 121(6):1157-1161, 1996.
- [12] Mohapatra D., Sabayasachi M., and Namrata S., "Banana and it's by products utilisation: an overview," *Journal of Scientific and industrial research* 69: 323-329, 2010.
- [13] Hibler M. and Hardy D., "Breeding a better banana," *IDRC Report* 22(1):16-18, 1994.
- [14] Palmer J. K. and The banana. In: HULME, A.C. (Ed.), "Biochemistry of Fruits and Their Products," Vol. 2. London: Academic Press, pp. 65-105, 1971.
- [15] Ngoh Newilah G., K. Tomekpe, and C. Dhuique-Mayer, "Physicochemical changes during early fruit development and ripening of three musa cultivars in Cameroon," *Proc. IC on Banana and Plantain in Africa* Eds.: T. Dubois et al. *Acta Hort.* 879:401-406, 2010, ISHS.
- [16] Parker. R. and B. K. Maalekuu, "The effect of harvesting stage on fruit quality and shelf-life of four tomato cultivars," (*Lycopersicon esculentum* Mill). *Agriculture and Biology Journal of North America* 4(3):252-259, 2013.
- [17] Ratule M.T., Osman A., Saari N. and Ahmad S.H., "Micro-structure of peel cell wall and selected physicochemical characteristics of 'Berangan' banana (*Musa cv. Berangan* [AAA]) ripened at high temperature," *Asia Pacific Journal of Molecular Biology and Biotechnology* 15: 8-13, 2007.
- [18] Pawar C.D., A. A. Patil, and G. D. Joshi, "Physicochemical parameters of sapota fruits at different maturity stages," *Karnataka journal of Agricultural Science* 24(3):420-421, 2011.
- [19] Joshi G. D., Prabhudesai V. G., and Salvi M. J., "Physicochemical characteristics of Karonda (*Carissa carandas* L.) fruits," *Maharashtra J. Hort.* 3(1):39-44, 1986.
- [20] Ali Z.M., Chin L., Marimuthu M., and Lazan H., "Low temperature storage and modified atmosphere packaging on carambola fruit and their effects on ripening related texture changes, wall modification and chilling injury symptoms," *Postharvest Biology and Technology* 33:181-192, 2004.
- [21] Harker. R., Redgwell. R.J., Hallett I.C., Murray S.H., and Carter G., "Texture of fresh fruit," In: *Horticultural Reviews*, New York: John Wiley and Sons, Inc. Volume 20, ed. J. Janik, pp 121-224, 1997.
- [22] Nunes de Jesus O., de Oliveria e Silva S., Di Credico, and M. Sauza Rocha H. (2002) "Resistance to finger drop of diploid genotypes," *Infomusa* 11:22-24, 2002.