Research Article

Dynamics of Physico-Chemical Properties in Kew Pineapple across Maturity Grown Under Subtropical Mid Hill Condition

Thejangulie Angami[1]*, Homeswar Kalita[1], Takar Ronya[1], Sikimoni Baruah[2], Banu Bam[1], Amit Sen[1], Arifa Khatoon[1], Kshitiz Kumar Shukla[1]

[1]ICAR (RC) for NEH Region, AP Centre, Basar, Arunachal Pradesh
[2]Regional Rainfed Lowland Rice Research Station (NRRI), Gerua, Kamrup, Assam

Abstract

The study was undertaken to evaluate the physico-biochemical changes of Kew pineapple across maturity so as to standardize the optimum stage of harvesting grown under subtropical mid hill condition of Arunachal Pradesh. The results showed that properties of fruits were significantly changed corresponding to different maturity levels. The fruit length and breadth increased gradually from initial green mature stage to turning stage thereafter remained almost constant at full ripe stage (161-165 DAF). Moisture content of fruit pulp decreased with the advancement of maturity whereas the juice pH increased gradually from green mature stage to full ripe stage. TSS and sugar content increased with the advancement of fruit maturity. Ascorbic acid content was found to decrease from 34.14 mg per 100 g to 32.84 mg per 100 g at green mature stage to full ripe stage however it exhibited an increased value of 43.38 mg per 100 g at 151-155 DAF (50 % colour development stage). Experimental findings revealed that fruits harvested at 156-160 DAF (75 % colour development stage) can be considered as the right stage for distant market which can be reached within a day or two and fruits harvested during 161-165 DAF (full ripe stage) can be considered as the optimum stage for local market as well as for fresh consumptions.

Keywords: Pineapple, Maturity, Physico-chemical, TSS, Sub-tropical, Mid-hill

***Correspondence**
Author: Thejangulie Angami
Email: thejaangami@yahoo.com

Introduction

The pineapple (*Ananas comosus* L. Mer), member of Bromeliaceae family is one of the popular fruits of the tropical and sub tropical region of the world. In India, it is being cultivated in high rainfall and humid coastal regions of peninsular India and hilly areas of North-eastern region. The fruit are grown for fresh consumption or for its juice which are widely used in preparation of beverages and other value added products or are often added to other fruit juices to enhance aroma due to its unique and delicate flavor. Fruits are utilized only after maturity, as immature fruits are acidic and contain less juice as well as flavour. Pineapple is one of the major fruit in the North-eastern region of India, where Kew variety is the most popular and preferred cultivar amongst the growers due to its excellent quality. The region produces about 49 per cent of the total pineapple of the country and almost 90-95 per cent is organic [1].

It is known fact that the quality of fruits depend on various physico-biochemical changes, which occur during fruit growth, development and maturity [2]. However, biochemical changes during growth and development of fruit is an important factor in fixing the appropriate maturity indices of the fruit. Maturity at harvest is an important factor affecting quality perception and the rate of change of quality during post harvest handling [3]. The information pertaining to the dynamics of physico-chemical properties of pineapple at different stages of maturity is lacking especially for pineapples grown in the mid hill zone of Arunachal Pradesh in particular, where fruits are normally harvested a month later during August to September as compared to the plain areas where harvesting commences from late May up to July. Such information is required as physico-chemical changes during maturity can be used as important criteria for determining the optimum stage of harvesting the fruit both for local and distant market. Standardization of maturity indices of 'Kew' pineapple is required to reduce the postharvest losses during handling operations as well as to maintain the quality of the harvested produce. Therefore, keeping these facts in view, the present study has been carried out to investigate various physico-chemical changes that takes place across the maturity stages of the fruit to determine the optimum stage of harvest maturity of Kew pineapple grown under sub-tropical mid hill conditions of Arunachal Pradesh.

Materials and method

A study was conducted at ICAR Research Farm, Gori, Basar, Arunachal Pradesh, situated in the mid hill zone at the latitude of 27°59.537' N and longitude of 94°41.269' E with an altitude of 650 m above mean sea level during 2015 and 2016. The location is under sub-tropical hill zone characterized by high rainfall with humid subtropical wet summer [4]. The average annual minimum temperature of the study area is 15.6ºC with average annual maximum temperature of 24.2ºC (Agromet Observatory, ICAR (Research Complex) for NEH Region, Arunachal Pradesh Centre, Basar). Fruits were harvested at five different maturity stages during August – September based on visible colour change and analyzed for different physico-chemical parameters (**Table 1**). The experiment was laid out in completely randomized design considering five maturity levels as treatments with five replications involving three fruits per replication. Average fruit length and breadth were measured from selected fruits with the help of digital Vernier calipers (Mitutoyo, Japan). Moisture content was determined on fresh weight basis by taking 10 g samples [5]. The fruit juice was extracted from the pulp by squeezing and straining through muslin cloth and the juice was obtained. The pH of fruit juice was determined by using the pH meter. As far as biochemical analyses were concerned, total soluble solids (TSS) was determined by one drop of the juice calibrated in digital Erma hand refractometer (0-32°Brix). Titratable acidity was estimated by titrating against 0.1N sodium hydroxide using phenolphthalein as indicator [6]. Ascorbic acid content was determined by titrating sample filtrate in 4% oxalic acid using 2, 6 - dichlorophenol indophenol dye to a pink point and expressed as mg/100 g [7]. Total sugar was determined in pulp extracts according to the Anthrone method and expressed in percentage. Here anthrone reagent was used in colour development resulting in blue green solution. The intensity of blue green colour was measured in UV-VIS spectrophotometer at 630 nm against a reagent blank. Reducing sugar was estimated according to Nelson-Somogyi method. In this, sugar was extracted by macerating 100 mg of the sample with 5 ml of hot 80% ethanol. After centrifuging the sample at 3000 rpm for 5 minutes, the supernatant was allowed to evaporate on water bath followed by dissolving the sugars with water. An aliquot of 0.2 ml was taken and diluted to 2 ml with distilled water. Further, 1 ml of alkaline copper tartarate reagent was added followed by heating in boiling water for 10 minutes. After cooling down, again 1 ml of arsenomolybolic acid reagent was added and final volume was made up to 10 ml with distilled water. The sample was read against the blank solution in a UV visible spectrophotometer at 620 nm after 10 minutes. Both the sugar content was estimated from a standard curve prepared with known concentration of glucose [8]. Total phenol was determined using the Folin-Ciocalteau reagent [9].

Table 1 Different maturity levels of pineapple var. Kew

Days from flowering to harvesting	Growth stage
130 – 135 Days	Mature green stage
145 – 150 Days	25 % colour development stage
151 – 155 Days	50 % colour development stage
156 – 160 Days	75 % colour development stage
161 – 165 Days	Fully ripe stage

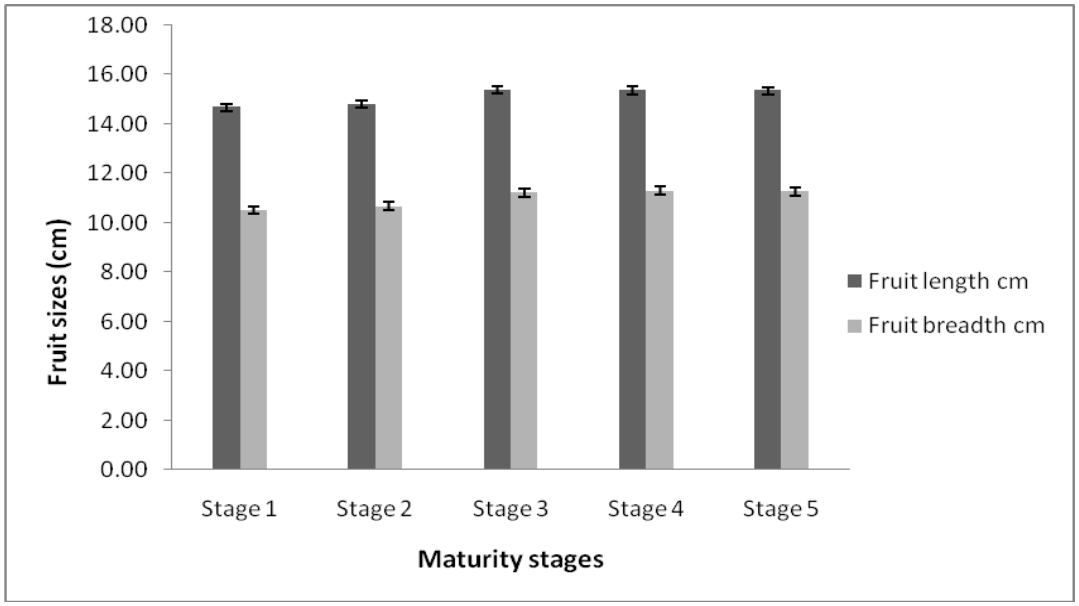

Figure 1 Changes in fruit length and fruit breadth of pineapple var. Kew at different stages of maturity

Table 2 Changes in chemical constituents of pineapple var. Kew at different stages of maturity

(Days from flowering to harvesting)	Moisture (%)	Juice pH	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)	Total sugar (%)	Reducing sugar (%)	Total Phenols (mg/100 g)
130 – 135 DAF	86.89^{a} ± 0.51	4.22^{b} ± 0.08	8.04^{d} ± 0.16	0.23^{c} ± 0.05	34.14^{bc} ± 1.40	7.50^{c} ± 0.14	3.57^{d} ± 0.05	9.71 ± 0.68
145 – 150 DAF	85.53^{ab} ± 0.48	4.24^{b} ± 0.03	9.85^{c} ± 0.35	0.28^{bc} ± 0.02	35.16^{bc} ± 1.30	7.83^{c} ± 0.17	3.83^{c} ± 0.11	8.96 ± 0.44
151 – 155 DAF	84.27^{bc}± 0.61	4.39^{a} ± 0.03	12.25^{b} ± 0.40	0.44^{a} ± 0.03	43.38^{a} ± 2.53	8.73^{b} ± 0.14	4.08^{b} ± 0.11	7.99 ± 0.49
156 – 160 DAF	84.05^{bc} ± 0.50	4.40^{a} ± 0.02	13.71^{a} ± 0.58	0.38^{ab} ± 0.06	38.46^{ab} ± 1.86	9.22^{a} ± 0.12	4.33^{b} ± 0.04	8.03 ± 0.21
161 – 165 DAF	83.10^{c} ± 0.90	4.45^{a} ± 0.03	13.88^{a} ± 0.20	0.31^{bc} ± 0.03	32.84^{c} ± 1.53	9.53^{a} ± 0.18	4.59^{a} ± 0.09	8.04 ± 0.40
$LSD_{(0.05)}$	1.840	0.126	1.106	0.117	5.292	0.453	0.255	-

Values within the columns with similar superscripts are statistically identical and values with dissimilar superscripts differ significantly at $p<0.05$ level of significance

Statistical analysis

The experiment was carried out in completely randomized design. The data recorded were tabulated and subjected to statistical analysis using Statistical Analysis System 9.3 computer software (SAS Institute Inc., 13). DMRT procedure was used at P = 0.05 level to determine if there were significant differences among the means.

Results and Discussions

The fruits attained maximum length (15.37 cm) at 151-155 DAF and breadth (11.28 cm) at 156-160 DAF after which, they remained almost constant up to 161-165 DAF. The increase in fruit length (14.66-15.37 cm) and breadth (10.50-11.28 cm) up to certain stage might be due to an increase in cell size because of cell division and cell elongation, which enabled the accumulation of food materials. The present result is in conformity with the findings in mango [10] and in passion fruit [11].

Moisture content of pulp of pineapple fruit decreased linearly with the advancement of maturity whereas the pH of the juice increased gradually from green mature stage to full ripe stage. Similar results were also obtained in pineapple (FLHORAN41 cv.) [12]. A gradual increase in TSS contents (8.04-13.88 °B) of the fruit was observed with the advancement of maturity. The increase in TSS content is the result of degradation of starch to sugars during later stage of harvest maturity. Similar trend were reported in persimmon [13] and in passion fruit [14]. Acidity of the fruit increased gradually and was at its maximum (0.44 %) on 151-155 DAF followed by a decreasing trend as the fruit approached maturity and ripening stage. The increase in acidity might be attributed to an increased biosynthesis of organic acid during the growth period. The decrease at later stages was due to conversion of organic acid into sugar. Similar results were also observed by [15]. Ascorbic acid content was found to decrease from 34.14 mg per 100 g to 32.84 mg per 100 g at mature green stage to full ripe stage. The decline in ascorbic acid content might be attributed to an oxidation of ascorbic acid [16]. Similar results were also reported in plum [17] and in Khasi Mandarin [18]. Both total (7.50-9.53 %) and reducing sugars (3.57-4.59 %) were found to increase linearly up to 161-165 DAF. The increase in sugar was due to an increase in TSS and accumulation of glucose, fructose and sucrose. Similar trend was also reported in grapes [19]. The decrease in total phenol has been attributed to the oxidation of polyphenols by polyphenoloxidase during fruit maturity while the decrease in total phenols with advancing fruit maturity had been reported for different pomegranate cultivars [20].

Conclusions

Pineapple fruit is regarded as a non-climacteric fruit and it must be harvested at right maturity stage in order to meet the customer requirement. The main changes in fruit composition such as physicochemical properties are usually associated with ripening process. The result of this work shows that the fruit size, moisture content, juice pH, total soluble solids, acidity, vitamin C, sugar content changes significantly during ripening process and can be considered as a suggested indices for taking harvest decision. Henceforth, fruits harvested at 156-160 DAF (75 % colour development stage) can be considered as the right stage for distant market (which can be reached within a day or two)

and fruits harvested during 161-165 DAF (full ripe stage) can be considered as the optimum stage for local market as well as for fresh home consumptions. In these stages the fruits exhibited a better quality attributes.

References

[1] Deka, B.C.; Saikia, J. and Sharma, S. (2005). Standardization of Maturity Indices of 'Kew' Pineapple. Proc. 5th International Postharvest Symposium. Eds. F. Mencarelli and P. Tonutti. Acta Hort. 682. ISHS.

[2] Harding, P.L. and Hatoon, T.T. (1967). Mangoes at their best. Proc. International Symposium on Sub tropical and Tropical Horticulture, Horticultural Society of India, Bangalore, pp 137-145.

[3] Lamare, R.L.; Deka, B.C.; Nath, A. and Patel, R.K. (2013). Dynamics of physico-chemical values in Sohshang (Eleaegnus latifolia L.) across maturity. Indian Journal of Hill Farming. 26(2): 49-53.

[4] Mishra, A.K.; Bundela, D.D. and Satapathy, K.K. (2004). Analysis and characterization of rice environment of Arunachal Pradesh. ENVIS Bulletin-ENVIS Centre on Himalayan Ecology. 12(1): 15-24.

[5] Ranganna, S. (1997). Handbook of Analysis and Quality control for fruits and Vegetable Products. 2nd Edition. Tata McGrow Hill Publishing Company Ltd., New Delhi.

[6] AOAC. (2000). Official Methods of Analysis. 17th Edition. Association of Official Analytical Chemists. Washington DC, USA.

[7] AOAC. (2005). Official Methods of Analysis. 18th Edition. Association of Official Analytical Chemists, Washington DC, USA.

[8] Sadasivam, S. and Manickam, A. (2005). Biochemical methods. 2nd Edition. New Age International Publication. New Delhi. pp 8-9.

[9] Singleton, V.L. and Rossi, J.A. (1965). Colorimetry of total phenolics with phosphomolybdic phosphotungstic acid reagents. American Journal of Enology and Viticulture. 16: 144-158.

[10] Gowda, I.N.D. and Huddar, A.G. (2001). Studies on ripening changes in mango (Mangifera indica L.) fruits. Journal of Food Science and Technology. 38(2): 135-137.

[11] Kishore, K.; Bharali, R.; Pathak, K.A. and Yadav, D.S. (2006). Studies on ripening changes in purple passion fruit (Passiflora edulis Sims). Journal of Food Science and Technology. 43(6): 599-602.

[12] Brat, P.; Hoang, L.N.T.; Soler, A.; Reynes, M. and Brillouet, J.M. (2004). Physicochemical Characterization of a New Pineapple Hybrid (FLHORAN41 Cv.). Journal of Agricultural and Food Chemistry. 52: 6170−6177.

[13] Candir, E.E.; Ozdemira, A.E.; Kaplankirana, M. and Tophia, C. (2009). Physico-chemical changes during growth of persimmon fruits in the east Mediterranean climate region. Scientia Horticulturae. 121(1): 42-48.

[14] Singh, A.; Patel, R.K.; Babu, K.D. and Bhuyan, M. (2006). Flowering, fruiting and ripening physiology of passion fruit. Environment and Ecology. 245: 693-697.

[15] Deka, B.C.; Sharma, S. and Borah, S.C. (2006). Post-harvest management practices of mandarin. Indian Journal of Horticulture. 63(3): 251-255.

[16] Belitz, H.D. and Grosch, W. (1992). Food Chemistry. 2nd Edition. Springer. p 145, 148, 295, 391.

[17] Bal, J.S. Chohan, G.S. and Josan, J.S. (1981). Studies on growth and development of plum. Punjab Horticulture Journal. 21: 83-88.

[18] Dubey, A.K.; Patel, R.K. and Singh, A.K. (2003). Standardization of fruit maturity indices in Khasi mandarin (Citrus reticulata Blanco.) under Meghalaya. Annals of Agricultural Research. 24(3): 559-562.

[19] Selveraj, Y.; Pal, D.K. and Shikhamany, S.D. (1996). Changes in chemical composition and enzyme activity of grape during growth and development. Indian Journal of Horticulture. 53: 81- 88.

[20] Shwartz, E.; Glazer, I.; Bar-Ya'akov, I.; Matityahu, I.; Bar-Ilan, I. and Holland, D. (2009). Changes in chemical constituents during the maturation and ripening of two commercially important pomegranate accessions. Food Chemistry.115: 965-973.

Publication History
Received 20th Mar 2019
Revised 26th Apr 2019
Accepted 10th May 2019
Online 30th May 2019