Indian J. Hort. 64(1), March 2007: 12-16

Influence of maturity on shelf-life and quality changes in banana during storage under ambient conditions

C.K. Narayana* and M.M. Mustaffa

National Research Centre for Banana, Thayanur Post, Tiruchirapalli 620 102

ABSTRACT

Various pre-harvest factors including maturity affect the quality and shelf-life of banana. The information pertaining to chemical composition of banana at different levels of maturity, ripening and its effect on quality is very limited. Poovan (Mysore, AAB) and Karpuravalli (Pisang Awak, ABB) banana bunches were harvested at 75, 90 and 100% maturity based on days from shooting to harvest. All the fruits were stored at ambient condition (26-32°C, 65-75% relative humidity) and changes in its physico-chemical and organoleptic quality were monitored. The results showed that fruits harvested at lower maturity grade had longer green life. The weight loss during storage and ripening was less in fruits of 100% maturity while the level of total soluble solids, titratable acidity and reducing and total sugars were high. It is concluded that the extended green life observed in 75% mature banana fruits may be due to the shift in the climacteric peak and reduction in chemical changes associated with ripening process. However, after ripening there is no difference in organoleptic quality among the different maturity fruits irrespective of their chemical composition.

Key words: Banana, maturity, ripening, quality characteristics, shelf-life.

INTRODUCTION

Banana contributes 31% of total fruit production in India and it is the largest producer of banana in the world with a production of 16.82 million tonnes from an area of 4.90 lakh hectares. Though Cavendish group of cultivars are largely grown, Poovan (Mysore, AAB) and Karpuravalli (Pisang Awak, ABB) are the most common cultivars in southern and north-eastern states of India and also popular in south-east Asian countries like Philippines. Maturity of banana is very important from marketing point of view as the harvest maturity depends on the destination market. The most common method of measuring the maturity in advanced countries is based on the number of weeks or days after anthesis (Stover and Simmonds, 12; Thompson and Burden, 14). The maturity of fruit is influenced by climate, soil, water, light availability and genomic status of the cultivar. Measuring the diameter, shape and angularity of individual fingers are the other methods to estimate the maturity, which are destructive and practically difficult to use in the field. Information on the quality of banana fruits of different maturity grades during ripening, particularly Indian cultivars, are meager. The objective of the present investigation was to study the influence of different maturity of fruit on the shelf-life, quality and physico-chemical changes in two commercial cultivars, *viz.* Poovan (Mysore, AAB) and Karpuravalli (Pisang Awak, ABB).

* Corresponding author's E-mail: cknarayana2001@yahoo.com

MATERIALS AND METHODS

In the present investigation, the stage of maturity was determined based on the number of days after anthesis to harvest. In addition, angularity of fingers, fall of floral remnants, fullness of fingers and change in peel colour were also taken into consideration. Based on the above criteria, 100 days from shooting (flowering) to harvest was determined as time required for full maturity in Poovan and 125 days for Karpuravalli. Accordingly, 90 and 75 days after shooting for Poovan, and 113 and 94 days for Karpuravalli were fixed for 90 and 75% maturity respectively for harvesting of fruits. After harvest, the fruit were dehanded by making a sharp cut along the crown cushion and washed in clean water. Later, they were dipped in 500 ppm carbendazim solution for 5 min. to prevent crown rot during the storage and ripening. The fruits were placed in plastic crates in single layer and stored under ambient conditions (26-32°C; 65-75% RH). The sampling of fruits for physico-chemical analysis was done once in every two days till the end of shelf-life. The stage of maturity was taken as main treatment and sampling dates as sub-treatments. The physico-chemical parameters recorded were physiological loss in weight (PLW), total soluble solids (TSS), titratable acidity, reducing sugar, total sugars and organoleptic quality of ripe fruits. The PLW was calculated based on initial weight and weight at subsequent intervals of time and the weight loss was expressed as percentage. The total soluble solids (TSS) was measured using hand refractometer (Erma, Japan) and values were

expressed in degree Brix. Titratable acidity was estimated by titrating a known amount of aliquot of pulp against N/10 sodium hydroxide solution using phenolphthalein as indicator (Ranganna, 9). The reducing and total sugars were determined by Lane and Eynon method (AOAC, 3). The organoleptic acceptability was evaluated at ripe stage by a panel of 7 trained judges on a 9-point hedonic scale (Amerine *et al.,* 2). The data were statistically analyzed for testing the variance adopting a factorial randomized block design (Panse and Sukhatme, 8).

RESULTS AND DISCUSSION

Fruits harvested at 75% maturity recorded the maximum green life in both the cultivars. Poovan fruits at 75% maturity had a green life of 10 days whereas in Karpuravalli it was 8 days. Fully matured (100% maturity) Poovan fruit had 6 days of green life while Karpuravalli had 5 days (Figs. 1 & 2). The fruits of 100% maturity exhibited colour change (chlorophyll breakdown) faster than fruits of lower maturity. Similar observations were also recorded by Chang *et al.* (4) in banana which was attributed to high tannin content in fruits of lower maturity grade. The physiological loss in weight was maximum (11.81%) in 75% maturity while it was least (9.35%) in 100% mature Poovan fruits (Tables 1 & 2). Generally, the banana fruits harvested at 75% maturity recorded more weight loss during ripening as the immature fruits took longer period to ripen than fully mature fruits. Similar observations were also reported by other investigators (Ahmad *et al.,* 1; Thompson *et al.,* 13). However, in Karpuravalli which belongs to a different genomic group the results were reverse which needs to be investigated further.

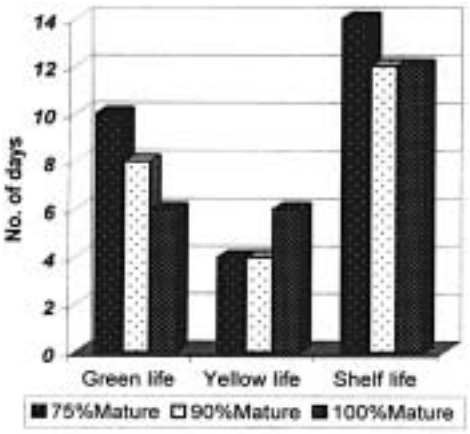

Fig. 1. Effect of maturity levels on green, yellow and shelf-life of Poovan banana.

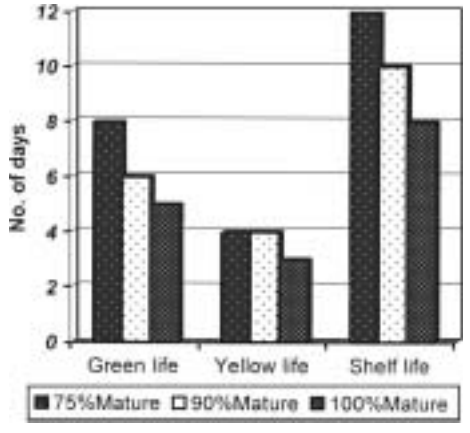

Fig. 2. Effect of maturity levels on green life, yellow life and shelf-life of Karpuravalli banana.

Table 1. Effect of maturity levels on physiological loss in weight (%) of Poovan banana.

Maturity level (%)	Storage period (days)					
	2	4	6	8	10	12
75	3.08	5.73	8.39	16.43	18.27	18.95
90	2.15	4.66	7.17	12.44	16.53	18.89
100	2.13	4.60	6.62	10.67	15.23	16.90
Mean	2.45	4.99	7.39	13.18	16.68	18.25

CD (P<0.05) Maturity level = 1.02; Storage period = 1.55; Interaction = NS.

Table 2. Effect of maturity levels on physiological loss in weight (%) of Karpuravalli banana.

Maturity level (%)	Storage period (days)			
	2	4	6	8
75	1.76	3.88	5.28	6.10
90	2.36	6.71	8.84	10.24
100	2.97	6.71	15.20	19.97
Mean	2.36	6.75	9.77	12.10

CD (P<0.05) Maturity level = 0.72; Storage period = 0.93; Interaction = 1.60.

The total soluble solids were significantly higher in fully mature fruits of both the cultivars as compared to 75 or 90% mature fruits (Tables 3 & 4). Higher total soluble solids content in fruit of 100% maturity grade was attributed to increase in dry matter accumulation particularly starch, which in turn broke down to simple sugars during maturation and ripening. Dhua *et al.* (5) and Ahmad *et al.* (1) also reported an increase in the level of total soluble solids proportionate to the maturity level. An early climacteric peak in 100% mature fruit explains an early on set of ripening than 90 and 75% mature fruits. The titrable acidity was more (0.364%) in 100% mature fruits than that in lower maturity fruits (Tables 5 & 6). Among the cultivars, Poovan recorded higher acidity (0.364%) than Karpuravalli (0.225%). Palmer (7) and Marriot (6) also observed an increase

Table 3. Effect of maturity levels on total soluble solids content (°Brix) of Poovan banana.

Maturity	Storage period (days)						
level (%)	0	2	4	6	8	10	12
75	2.83	4.00	4.63	12.89	16.65	19.86	21.73
90	6.27	8.31	9.66	13.33	17.98	20.40	24.47
100	7.71	8.62	11.19	17.50	22.00	24.23	24.65
Mean	5.60	6.97	8.49	14.57	18.87	21.49	23.61

CD (P<0.05) Maturity = 0.79; Storage period = 1.30; Interaction = 2.25.

Table 4. Effect of maturity levels on total soluble solids content (°Brix) of Karpuravalli banana.

Maturity	Storage period (days)				
level (%)	0	2	4	6	8
75	3.00	4.02	6.93	9.56	16.65
90	3.05	5.47	9.85	14.32	19.71
100	3.27	6.31	16.30	27.17	30.92
Mean	3.11	5.27	11.03	17.02	22.43

CD (P<0.05) Maturity =1.14; Storage period = 2.64; Interaction = 4.57.

Table 5. Effect of maturity levels on titratable acidity (%) of Poovan banana.

Maturity	Storage period (days)						
level (%)	0	2	4	6	8	10	12
75	0.116	0.168	0.191	0.214	0.328	0.363	0.440
90	0.128	0.177	0.238	0.238	0.389	0.409	0.429
100	0.175	0.197	0.333	0.469	0.532	0.443	0.396
Mean	0.139	0.180	0.254	0.307	0.416	0.405	0.422

CD (P<0.05) Maturity = 0.008; Storage period = 0.014; Interaction = 0.025.

Table 6. Effect of maturity levels on titratable acidity (%) of Karpuravalli banana.

Maturity	Storage period (days)				
level (%)	0	2	4	6	8
75	0.052	0.074	0.080	0.107	0.174
90	0.072	0.081	0.111	0.152	0.184
100	0.098	0.111	0.288	0.306	0.324
Mean	0.074	0.089	0.160	0.188	0.227

CD (P<0.05) Maturity = 0.019; Storage period = 0.026; Interaction = 0.047.

in acidity during ripening and the main organic acids observed were malic, citric and oxalic acids. The increase in acidity might be due to excess bio-synthesis of oxalic acid in green bananas and with advance of maturity, oxalic acid content decreased while malic acid bio-synthesis predominated (Wyman and Palmer, 15).

The reducing and total sugars were more in 100% maturity fruits in both the cultivars (Tables 7-10). In many climacteric fruits, starch being the primary energy reserve, is synthesized in amyloplast during development. In unripe banana fruits, 20-25% of starch on fresh weight basis is recorded which is rapidly degraded into sugars during ripening (Reneta *et al.,* 10; Seymour, 11). Higher activity of amylase and phosphorylase enzymes coupled with higher levels of starch (substrate) would have been the reason for increased levels of reducing and total sugars during storage and ripening (Chang *et al.,* 4). However, at the end of the shelf-life, there was no difference in the total sugar content among different maturity fruits which indicated that the edible quality of fruits are not affected

Table 7. Effect of maturity levels on reducing sugars (%) of Poovan banana.

Maturity	Storage period (days)						
level (%)	0	2	4	6	8	10	12
75	0.351	0.434	1.218	1.440	6.093	10.879	17.576
90	0.446	0.640	1.192	1.192	7.317	12.576	17.152
100	0.497	0.996	2.164	3.895	13.580	15.416	20.824
Mean	0.431	0.690	1.524	2.175	8.996	12.957	18.520

CD (P<0.05) Maturity = 1.251; Storage period = 2.043; Interaction = 3.540.

Table 8. Effect of maturity levels on reducing sugars (%) of Karpuravalli banana.

Maturity	Storage period (days)				
level (%)	0	2	4	6	8
75	0.37	0.72	0.76	4.24	8.72
90	0.46	0.90	3.21	6.03	17.40
100	0.68	1.55	8.69	14.40	20.11
Mean	0.50	1.06	4.22	8.22	15.41

CD (P<0.05) Maturity = 1.35; Storage period = 1.92; Interaction = 3.32.

Table 9. Effect of maturity levels on total sugars (%) of Poovan banana.

Maturity	Storage period (days)						
level (%)	0	2	4	6	8	10	12
75	0.491	0.637	1.626	2.142	8.922	13.813	21.733
90	0.540	0.718	1.205	1.205	14.097	14.913	17.753
100	0.680	1.110	3.777	6.917	20.823	21.300	22.283
Mean	0.570	0.821	2.203	3.421	14.614	16.675	20.589

CD (P<0.05) Maturity = 1.959; Storage period = 3.199; Interaction = 5.542.

Table 10. Effect of maturity levels on total sugars (%) of Karpuravalli banana.

Maturity level (%)	Storage period (days)				
	0	2	4	6	8
75	0.41	1.06	2.70	5.28	13.75
90	0.83	1.09	3.77	7.64	18.84
100	1.15	1.92	9.00	16.08	25.27
Mean	0.79	1.36	5.16	9.67	19.29

CD (P<0.05) Maturity = 1.50; Storage period = 2.12; Interaction = 3.68.

by the level of maturity. Non-significant variations in total sugars in 75 and 100% mature fruits after ripening suggested that though the duration required for completion of ripening and senescence of 75% mature fruits was longer, the breakdown of polysaccharides to monosaccharides and other metabolic intermediary compounds were complete. This is further supported by the organoleptic quality score (Figs. 3 & 4), which showed a non-significant difference among the different maturity fruits.

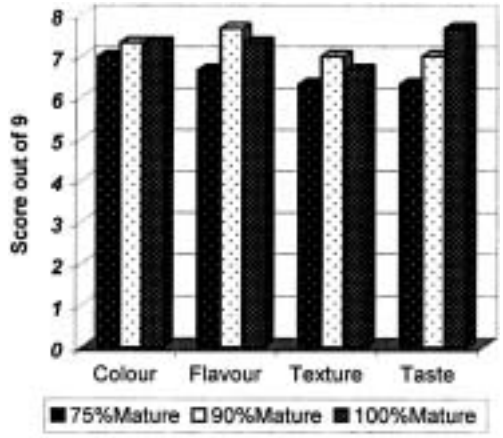

Fig. 3. Effect of Maturity levels on organoleptic score of Poovan banana.

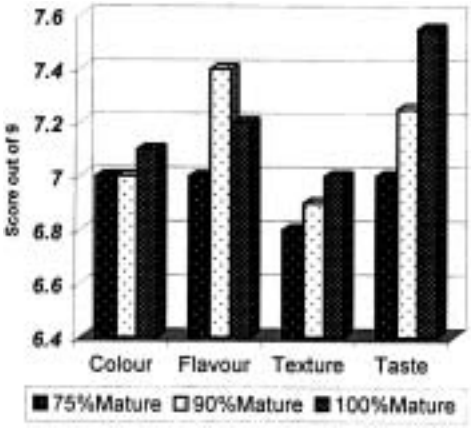

Fig. 4. Effect of maturity levels on organoleptic score of Karpuravalli banana.

The present study revealed that banana harvested at 75% maturity had extended green life due to a shift in climacteric peak and exhibited slow changes in chemical parameters like total soluble solids, organic acids, reducing and total sugars during ripening. The edible quality of fruits are not significantly affected by the level of maturity in Poovan and Karpuravalli bananas.

REFERENCES

1. Ahmad, S., Clarke, B., Thompson, A.K. 2001. Banana harvest maturity and fruit position on the quality of ripe fruit. *Ann. Appl. Biol.* **139**: 329-35.
2. Amerine, M.A., Pangborn, R.M. and Roessler, E.B. 1965. *Principles of Sensory Evaluation of Foods.* Academic Press, pp. 349-52.
3. A.O.A.C. 1995. *Official Methods of Analysis.* Association of Analytical Chemists. Benjamin Franklin Station, Washington, D.C., pp. 8.
4. Chang, W.H., Hwang, Y.J. and Wei, T.C. 1990. Chemical composition and enzyme activity of Taiwan Northern banana fruit of different maturity and harvested in different seasons. *Acta Hort.* **274**: 621-30.
5. Dhua, R.S., Sen, S.K. and Bose, T.K. 1988. Physico-chemical development in banana cv. Giant Governor during fruit growth and maturity. *Prog. Hort.* **19**: 128-32.
6. Marroit, J. 1980. Banana–Physiology and biochemistry of storage and ripening for optimum quality. *CRC Critical Rev. of Food Sci. Nutrition,* **13**: 41-88.
7. Palmer. J.K. 1971. The Banana, **In:** *The Biochemistry of Fruits and their Products*, Vol. 2. (Ed., A.C. Humes). Academic Press, London, pp. 65-105.
8. Panse V.G. and Sukhatme, P.V. 1978. *Statistical Methods for Agricultural Workers*. Indian Council of Agricultural Research, New Delhi. 180 p.
9. Ranganna. S. 1986. *Handbook of Analysis and Quality Control for Fruit and Vegetable Products.* Tata McGraw Hill Publishing Co., New Delhi, pp. 9-15.
10. Reneta V.da., Beatriz R. Cordunusi, Joao, R.O. do Nascimento., Eduardo Purgatto., Maraia R.M. Rosseto and Franco M. Lajolo. 2002. Activity and expression of banana starch phosphorylases during fruit development and ripening. *Planta,* **256**: 325-33.

11. Seymour, G.B. 1996. Banana. **In:** *Biochemistry of Fruit Ripening* (Eds., G.B. Seymour, Taylor J.E. and Tucker, G.A.). Chapman and Hall, London, pp. 89-90.

12. Stover, R.H. and Simmonds, N.W. 1987. *Bananas,* Longman, London, pp. 468-70.

13. Thompson, A.K., Been, B.O. and Perkins, C.V. 1972. Handling, storage and marketing of plantains. *J. Amer. Soc. Hort. Sci.* **16**: 205-12.

14. Thompson A.K. and Burden, O.J. 1995. Harvesting and fruit care. **In:** *Bananas and Plantains* (Ed., S. Gowen), Chapman and Hall, London. pp. 403-27.

15. Wyman, H. and Palmer, J.K. 1963. The organic acids of the ripening banana fruits. *Plant Physiol.* **38**: 19-22.

(Received: June 2006; Revised: December, 2006; Accepted: January, 2007)