Plant Archives Vol. 14 No. 2, 2014 pp. 751-756 *ISSN 0972-5210*

CHEMICAL COMPOSITION, RIPENING BEHAVIOR AND ORAGANOLEPTIC QUALITY OF MANGO cv. ALPHONSO AS INFLUENCED BY THE PERIOD OF MATURITY

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Abstract

Field experiments were conducted in 2011 and 2012 at Dr. B.S.K.K.V., Dapoli at Post Graduate Institute of Post Harvest Management, Killa-Roha, Maharashtra, India to evaluate the chemical composition, ripening behavior and oraganoleptic quality of mango cv. Alphonso as influenced by the period of maturity of four stages of mango maturity (90, 105, 120 and 135 days after fruit set) with five replications. The mango fruits harvested from trees were selected for the study and on each tree, 100 fruits were labelled at fruit set of above mentioned days. The results indicated that increasing trend in TSS, reducing sugar, total sugars and pH while decreasing trend in moisture and titratable acidity was noticed at harvest as well as at ripe stage with increase in the period of maturity of mango cv. Alphonso. Among the four mango stages under study, $\mathbf{T}_4$ stage maturity (135 days) mango fruit recorded fastest rate of ripening followed by all other treatments. The physiological loss in weight varied significantly due to the period of maturity of mango fruits. Based on the PLW, the mango fruits from the treatments $\mathbf{T}_1$ and $\mathbf{T}_2$ had shelf life of 12 days, whereas it was 14 to 16 days in the treatments $\mathbf{T}_3$ and $\mathbf{T}_4$. The organoleptic score for colour, flavour, texture and overall acceptability increased with increase in the period of maturity. The mango fruits from 120 ($\mathbf{T}_3$) and 135 ($\mathbf{T}_4$) days maturity stage were significantly superior to other stages of maturity with respect to organoleptic qualities of mango cv. Alphonso.

Key words : Maturity, chemical composition, ripening, PLW, organoleptic quality.

Introduction

Mango (*Mangifera indica* L.) is grown in Konkan region of Maharashtra, especially in the district of Ratnagiri, Sindhudurg, Raigad and Thane. Mango, the 'King of Fruits', is an evergreen fruit crop of tropical and sub-tropical regions. It has great economic potentialities as it fulfills the requirements for nutritional, medicinal, commercial, industrial, religious, needs. Its young unripe fruits earn high prices in the market for their culinary preparation, pickles, chutney, amchur, whereas ripe fruits are eaten as a fresh table fruit or are preserved in different forms like canning, juices, squash, jam, jelles and mango leather. The fruit contains protein, fat, carbohydrate, minerals, calcium, phosphorus, iron, vitamin A and C, riboflavin and nicotinic acid (Cheema *et al*., 1954 and Singh and Singh, 1960).

In India, Uttar Pradesh is leading state with 3.62 mMt with production of mango, which is followed by Andhra Pradesh (3.36), Karnataka (1.77), Bihar (1.33), Gujarat (0.91), Tamil Nadu (0.82), Orissa (0.64), West Bengal (0.62), Jharkhand (0.42), Kerala (0.38) and Maharashtra (0.33) (Anonymous, 2011). Konkan region located on the West coast of Maharashtra comprises four mango growing districts *viz.*, Thane (43492 ha), Raigad (45758 ha), Ratnagiri (50190 ha) and Sindhudurg (25494 ha) which is emerging as one of the largest mango growing belts in the Maharashtra, occupying 1.65 lakh ha of area under mango, (Shrinivasan, 2005), which accounts for about 10 per cent of the total area under mango in the whole of the country, of which over 80 per cent is under a single largest growing variety 'Alphonso' locally called as 'Hapus' with a major export share to the tune of over 35 per cent (Anonymous, 2005).

Maturity has been determined that the stage of maturity at the time of picking influence the storage life and quality of fruit, when picked at immature stage mango develops white patches or air pockets during ripening and lacking in normal brix acid ratio or sugar acid ratio, taste and flavour on the other hand, if the fruits are

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harvested over mature or full ripe they are easy susceptible to microbial and physiological spoilage and their storage life is considerably reduce. Such fruits persist numerous problems during handling, storage and transportation. Therefore, it is necessary or essential to pick up the fruits at correct stage of maturity to facilitate proper ripening, distant transportation and maximum storage life.

The ripening process at ambient temperature depends on the cultivar and stage of fruit maturity at harvest. The subjectivity aspect of external criteria for determination of harvest maturity has led to the search for additional parameters that are able to reflect a more reliable criterion on the basis of which the harvested mango fruit should develop optimal organoleptic traits after ripening. Therefore, colour of the pulp, sugar levels, titratable acidity and external appearance of mango fruit need to be assessed in relation to the maturity stage. Hence, our attention in this study was chemical composition, ripening behavior and oraganoleptic quality of mango cv. Alphonso as influenced by the period of maturity.

Materials and Methods

The experiment were conducted during 2011-12 at Dr.B.S.K.K.V., Dapoli -The Post Graduate Institute of Post Harvest Management, Killa-Roha (Maharashtra), India. The emphasis was given on changes in chemical composition, ripening pattern and organoletptic evaluation of Alphonso mango fruits harvested at different stages (after fruit set). The experimental material, *i.e.* Alphonso mango fruits were obtained from the university orchard. The experiment was laid out in randomized block design (RBD) with five replication and four treatments. Uniform mango tree of Alphonso were selected and tagged at 70 per cent fruit set stage. The tagged fruits of uniform size were harvested for conducting the experiment during the year 2011-12. They were harvested at four stages (90, 105, 120 and 135 days). The investigation was carried out in four treatments which consisted of mango fruit harvested at 90 days after fruit set- $\mathbf{T}_1$ at 105 days after fruit set- $\mathbf{T}_2$ at 120 days after fruit set-$\mathbf{T}_3$ and at 135 days after fruit set- $\mathbf{T}_4$. All the chemicals used in this investigation were procured from Thomas Baker Chemicals Ltd., Mumbai, Hi Media Laboratories, Mumbai and Loba Chemicals Co., Mumbai. As far as possible, the chemicals of analytical reagent or guaranteed reagent grades were used. The various chemical constituents of raw and ripe mango fruits harvested at each of the four stages from each tree were determined. For this study ten fruits were randomly selected and observations were recorded on the chemical composition *viz.* moisture, total soluble solids, titratable acidity, sugars content in fruits and pH. The storage behaviour of mango fruits harvested at each of the four stages from each tree was studied at ambient temperature storage condition. For ripening pattern were observed for stages like green, turning, half ripe, ripe spoilage and shriveled at four days interval. The PLW was determined by weighing ten fruits at after four day on sensitive electric balance (Model Contech Instruments Limited) and the progressive loss in weight was recorded and calculated as per cent loss in weight as follows.

$$\text{PLW } (\%) = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

The ripe fruits were evaluated organoleptically for colour, flavour and texture by a panel of 5 judges who scored on a 9 point hedonic scale (Amerine *et al*., 1965). The overall rating was obtained by averaging the score of evaluation. The fruits with score 5.5 and above were rated as acceptable. The data were recorded and analysed by the method suggested by Panse and Sukhatme (1967).

Results and Discussion

The data on changes in moisture content of mango fruit of different maturities are presented in table 1. It is clear from the data that the moisture content showed changes throughout the growth and development of fruit. The $\mathbf{T}_1$ stage mango fruit recorded significantly maximum moisture content at harvest stage but at par with $\mathbf{T}_2$ stage of maturity. The $\mathbf{T}_4$ stage mango fruits recorded minimum fruit moisture at harvest stage, which was followed by the $\mathbf{T}_3$ stage maturity fruits. Thus, the moisture content declined with the delay in harvesting of mango fruits. Decline in moisture content of the fruits from harvest stage of mango fruit under study could be attributed to the loss of moisture due to respiration and transpiration of the fruits during growth and development of fruits (Satyavati *et al*., 1972 and Ghosh *et al*., 1985). The T.S.S. of mango fruit at harvest showed significant differences due to the maturity stage of mango fruit under study. The maximum T.S.S. was recorded by $\mathbf{T}_4$ stage fruit which was significantly superior to rest of the treatments, followed by the $\mathbf{T}_3$ stage fruit with T.S.S., the mango fruits from $\mathbf{T}_1$ and $\mathbf{T}_2$ stage of maturity did not show significant variation with respect to the T.S.S. content of the fruits, but recorded significantly lowest T.S.S. at harvest. It is clear from the data that the T.S.S. content of fruit increased significantly with increase in the period of maturity. The changes in T.S.S. content was more pronounced after 105 days till 135 days of fruit growth. This could be due to conversion of starches into sugars with the advancement of period of maturity (Naik, 1985). An increase in titratable acidity of mango fruit with

increase in the period of maturity at harvest. The T_2 stage mango fruits showed significantly maximum fruit acidity at harvest stage, followed by T_1 and T_3. The T_4 stage mango fruits recorded minimum acidity at harvest stage. T_1 stage mango fruits were found to be at par with the T_3 stage of maturity with respect to titratable acidity of mango fruits (Rangawala, 1975 and Khurdiya *et al*., 1988). It could be noticed from the data that there was significant increase in the reducing sugar content of mango fruit at harvest stage with the advancement of period of maturity of mango fruits under present study. Reducing sugar content at harvest was significantly highest in T_4 stage of fruit, followed by the T_3 stage, while the lowest was observed in T_2 stage maturity; however, it was at par with T_1 stage of mango fruits. Significant increase in reducing sugar content could be attributed to the conversion of starch into sugars (Ghosh, 1985). It could be revealed from the results that there was significantly increase in the total sugars content with increase in period of maturity of mango fruits at harvest. The T_4 stage mango fruits recorded significantly maximum fruit total sugar, followed by T_3 and T_2, but they were at par with each other. However, T_1 stage mango fruits were characterised by the significantly minimum total sugar. The increase in the total sugar content can be attributed to the conversion of starch to sugars and the sugar may accumulate in the fruit due to the high rate of enzyme activity as compared with the rate of utilization in respiration. The pH was significantly maximum in T_4 stage fruits, followed by T_3 stage of maturity. The minimum pH was observed in T_2 stage fruits; however, it was at par with the fruits from T_1 stage of maturity. Differences in pH values among the stage of mango fruit under study noticed to be statistically significant at harvest stage. This increase in pH during storage could be due to corresponding decrease in the acidity caused by degradation of organic acids during different stages of maturity and senescence (Garg *et al*., 1975).

It is evident from the data presented in table 1 that the moisture content of mango fruit at ripe stage was significantly maximum in T_1 maturity mango fruit at ripe stage, while minimum moisture content was observed in T_2 stage mango fruits at ripe, but it was at par with treatments T_3 and T_4 and no significant variation in moisture content was noticed with increase in the period of maturity *i.e.* from 105 to 135 days maturity period. The mango fruits from T_2 to T_4 stage of maturity ripened at faster rate resulted into more moisture loss than the fruits from T_1 stage of maturity. There was an increase in T.S.S. content of Alphonso mango fruits at ripe stage with increase in days of maturity and significant difference was recorded between the different stages of maturity. The T.S.S. content was significantly highest in T_4 stage fruits, but at par with T_3 stage maturity fruit. The minimum T.S.S. was observed in T_1 stage fruit maturity at ripe stage. An increase in the T.S.S. during ripening process of the mango fruits could be attributed to the hydrolysis of starch to sugars. The fruits harvested at 90 days maturity (T_1) were immature and did not ripen properly with low conversion of starches into the sugar as compared to the mango fruit from T_2, T_3 and T_4 stage of maturity. Hence, the treatment T_1 exhibited poor TSS content than all other treatments. Titratable acidity in mango fruit at ripe stage was significantly maximum in T_1 stage fruits, followed by T_2 and T_3 stage. The minimum titratable acidity was noticed in T_4 stage of maturity; however, it was at par with T_3 stage mango fruits. The titratable acidity of mango cv. Alphonso fruits at ripe stage with decreased with increase in the period of maturity. As the mango fruits from T_1 stage did not ripen properly, they obtained higher titratable acidity than all other treatments. Reducing sugars exhibited similar trend as that of T.S.S. of mango fruits after ripening. There was significant difference with respect to reducing sugar content among the different stages of maturity. At ripe stage, the maximum reducing sugar content was noticed in fruit from T_4 stage maturity, followed by T_3 stage fruits. The mango fruits from T_1 stage recorded minimum reducing sugar, but it was at par with T_2 stage fruits. The increase in reducing sugar content with the advancement of mango fruit maturity could be attributed to better conversion of starch into sugars during ripening of mango fruits. Total sugar content at ripe stage was significantly highest in T_4 stage fruits, followed by T_3 stage of maturity. The T_1 stage mango fruits were characterized by the lowest total sugars which were followed by T_2 stage fruit with 7.10 per cent total sugars. The differences in total sugars of mango were found to be statistically significant which could be attributed to the period required to ripening of fruits and hydrolysis of starch into sugar during this period. More the period of maturity, the better was ripening process with higher synthesis of total sugars in the fruit at ripe stages. Therefore, the mango fruits from T_4 stage maturity (135 days) exhibited the maximum total sugar content than those from other treatments. pH of mango fruits at ripe stage increased significantly with increase in the period of maturity. The maximum pH was noticed in T_4 stage fruits and minimum pH in T_1 of stage maturity. The increase in pH value with increase in period of maturity could be attributed to corresponding decrease in acidity at ripe stage of fruit. The results are in conformity with those of Patil (1996) in Alphonso.

Table 1 : Chemical composition of Alphonso mango fruits influenced by period of maturity

Treatments	Chemical parameters											
	At harvest						At ripe					
	Moisture	Total soluble solids	Titratable acidity	Reducing sugar	Total sugar	pH	Moisture	Total soluble solids	Titratable acidity	Reducing sugar	Total sugar	pH
T_1	84.59a	6.3c	2.39b	1.76c	2.67c	2.74c	82.21a	11.8c	0.54a	3.11c	5.18d	3.40d
T_2	84.28a	6.5c	3.33a	1.64c	3.16b	2.73c	81.34b	15.3b	0.40b	3.52c	7.10c	4.13c
T_3	83.68b	7.2b	2.51b	2.22b	3.17b	2.92b	81.44b	21.4a	0.12c	5.25b	14.06b	4.53b
T_4	83.24c	8.2a	1.73c	2.77a	4.60a	3.27a	81.43b	22.2a	0.10c	8.08a	21.32a	5.18a
S.Em ±	0.115	0.219	0.088	0.091	0.122	0.036	0.105	0.442	0.017	0.164	0.319	0.070
CD at 5%	0.335	0.636	0.256	0.265	0.355	0.104	0.305	1.285	0.047	0.479	0.926	0.206

Table 2 : Physiological loss in weight (days) influenced by different maturity stages of mango as during ripening at ambient condition. (22-31^{0}C, 85 per cent R.H.)

Treatments		Physiological loss in weight (%)				
	4	8	12	16	20	Mean
T_1	8.79	12.63	17.62	26.37	33.21	19.72a
T_2	5.53	11.83	18.13	28.42	34.12	19.60a
T_3	6.40	10.07	15.51	22.39	31.46	17.16b
T_4	7.10	10.52	14.68	18.86	24.34	15.10c
Mean	6.95e	11.26d	16.48c	24.01b	30.78a	17.89
		C.D. at 5%				
Treatment (A)		0.580				
Days (B)		0.649				
Treatment A x B		1.297				

Table 3 : Effect of period of maturity on organoleptic qualities of ripe mango cv. Alphonso fruit.

Maturity stage	Organoleptic score for			
	Colour	Flavour	Texture	Overall acceptability
T_1	5.9b	6.0b	5.3c	5.04c
T_2	6.6b	6.4b	6.4b	6.46b
T_3	8.0a	8.2a	7.9a	8.03a
T_4	8.5a	8.3a	8.3a	8.36a
SE	0.316	0.313	0.180	0.172
CD at 5%	0.977	0.964	0.556	0.531

The overall observations on storage behaviour of the fruits influenced by period of maturity of mango fruit are presented in fig. 1. It is clear from the data that the mango fruits from (T_4) stage of maturity recorded the fastest rate of ripening, followed by T_2, T_3 and T_1. It is evident from the data that the mango fruit from T_1 stage maturity (90 days) did not ripen properly, but shriveled (40%) from 8 days of storage and 100 per cent shriveling of mango fruits was noticed after 16 days of storage. The ripening pattern was more or less similar in the mango fruits from T_2 and T_3 stage of maturity. In both the stages, the ripening was initiated from 8 days of storage at ambient conditions. However, maximum (73.33%) fruits were ripened after 12 days of storage in T_3 stage, whereas only 53.33 per cent fruits attained optimum ripe stage after 16 days of storage in the T_2 stage of maturity. It is also clear from the data that the ripening process was initiated on 4 days of storage and maximum (66.66%) number of fruits was ripened on 8 day of storage in T_4 stage of maturity (135 days) under present study and all the fruits were ripened properly after 12 days of storage at ambient condition. The mango fruits of 90 days maturity did not ripen properly due to lack of optimum maturity. The spoilage due to disease incidence was observed from 20 days of storage in T_3 and T_4 stage of maturity. The fruits from 90 days maturity stage (T_1) started shrivelling from 8 days of storage onward due to the immature harvesting stage of mango fruit, whereas in mango fruits from 105, 120 and 135 days maturity, the shriveling was started from 16, 16 and 12 days onwards, respectively during storage at ambient condition. The percentage of shrivelled fruits went on increasing upto the end of storage period in all the stages of mango fruits under study. The

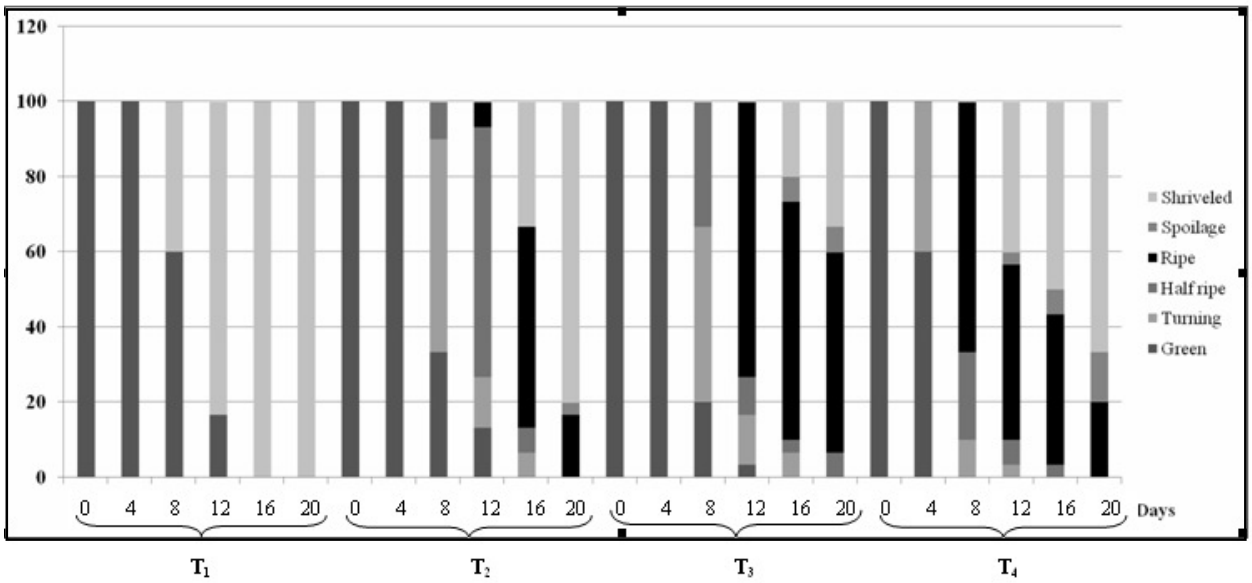

Fig. 1 : Ripening pattern of mango fruits at ambient temperature conditions. (22-31^{0}C, 85 per cent R.H.).

tender nature of fruits had high moisture content leading to faster loss of moisture as compared the fruits with higher stage of maturity. Hence, it is suggested to harvest the mango cv. Alphonso fruits after attaining either 120 or 135 days maturity for early and optimum ripening of mango fruits (Agnihotri *et al.*, 1963; Kalra and Tandon, 1984 and Sethi, l987) reported the observations in accordance with these findings in different mango varieties.

The data on physiological loss in weight (PLW) of mango fruits cv. Alphonso influenced by the different periods of maturity are presented in table 2. It is observed from the data that the mean PLW of mango cv. Alphonso fruits decreased with increase in the period of maturity. The mango fruits from $\mathbf{T}_4$ stage of maturity (135 days) recorded the lowest mean PLW, followed by the treatment $\mathbf{T}_3$ *i.e.* 120 days maturity stage with 17.16 per cent PLW. The mean PLW was noticed highest in $\mathbf{T}_1$ stage maturity fruit, which was at par with the treatment $\mathbf{T}_2$. However, these treatments $\mathbf{T}_1$ and $\mathbf{T}_2$ recorded significantly higher PLW than the treatments $\mathbf{T}_3$ and $\mathbf{T}_4$. Thus, the moisture loss was found to be higher in immature fruits than those with optimum fruit maturity. A linear increase in PLW of mango fruits was observed during storage upto 20 days irrespective of treatments. The physiological loss in weight was increased significantly from 6.95 per cent at 4 days of storage to 30.78 per cent after 20 days of storage at ambient conditions (Rangavalli *et al*., 1993). The interaction effect between treatments and storage was also found to be statistically significant. The PLW was significantly lowest in $\mathbf{T}_2$ and $\mathbf{T}_3$ stage fruits after 4 days of storage, whereas it was significantly highest in the treatments $\mathbf{T}_1$ and $\mathbf{T}_2$ after 20 days of storage. It is also evident from the data that the PLW was 17.62 and 18.13 per cent in $\mathbf{T}_1$ and $\mathbf{T}_2$ treatments respectively, but was at par with each other after 12 days of storage, which was significantly higher than that of in $\mathbf{T}_3$ and $\mathbf{T}_4$ treatments. Thus, based on the PLW, the mango fruits from the treatments $\mathbf{T}_1$ and $\mathbf{T}_2$ had shelf life of 12 days, whereas it was 14 to 16 days in the treatments $\mathbf{T}_3$ and $\mathbf{T}_4$ (Kapse *et al.*, 1979).

The organoleptic score for colour, flavour, texture and overall acceptability of mango cv. Alphonso fruits are presented in table 3. It is seen from the data that the oraganoleptic score from colour of mango cv. Alphonso fruit increased significantly with increase in the period of maturity of mango. The mango fruit from $\mathbf{T}_4$ stage recorded highest oraganoleptic score for colour but at par with $\mathbf{T}_3$ stage fruits, followed by $\mathbf{T}_2$ stage fruit with 6.6 score for the colour. The lowest score for colour was noticed in $\mathbf{T}_1$ stage of maturity since the fruits from this treatment were physiologically immature. Similar trend with respect to sensory score for flavour, texture and overall acceptability was noticed. The mango fruits of 120 or 135 days maturity stage had better overall palatability than those from 90 or 120 days maturity stage after ripening. Thus, the quality of fruit at ripe stage with respect to chemical composition as well as sensory parameters is dependant on the maturity of the fruit.

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