Evaluation Of Growth And Development In Mango Fruits Cvs. Julie And Peter To Determine Maturity

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Abstract

Two mango cultivars viz., Julie and Peter, were studied for growth and development of fruits in 2001 and 2002 starting from 47 days after fruit set (DAFS) till ripening. The objective was to determine the optimum stage of fruit maturity and consequently the proper time to harvest the fruits in order to minimize post-harvest losses. The mango fruits were assessed through various physico-chemical parameters at 9 – 10 day intervals at initial stages (47 – 93 DAFS) and at 7-day intervals at later stages (103-117 DAFS) of growth. Seven dates of harvesting after fruit set in Julie and nine harvesting dates in Peter mango constituted the treatments. For each date of harvest, 12 mango fruits were manually and randomly plucked from the trees and handled intact. The fruits were then divided into 4 equal groups with 3 fruits in a group as a replication. Data on maturity indices recorded for two years were pooled and subjected to analysis of variance procedures for randomized complete block design. Results showed that fruit development took longer duration in Peter mango (117 DAFS) compared to Julie mango (100DAFS) and Peter was classed a late mango cultivar. Development of an integument at the proximal end of the mango fruit was completed at 88 DAFS in Julie and at 100 DAFS in Peter, which indicated physiological maturity stage of the mango fruits. Specific gravity value greater than 1.0 was noted at 93 DAFS in Julie and 103 DAFS in Peter mango. At the same time, the endocarp completed its development. Although physiological maturity occurred earlier, the completion of endocarp development indicated that mango fruits have reached harvest maturity later at 93 DAFS in Julie and 103 DAFS in Peter. There was leap increase in TSS/acid ratio, upsurge in β-carotene content and change in pulp colour from whitish yellow to deep yellow which started from 93 DAFS in Julie and 103 DAFS in Peter. These observations suggested that mango fruits have attained harvest maturity. Therefore, mango fruits can be harvested at maturity between 93-100 DAFS in Julie and 103-117 DAFS in Peter. Post-harvest shelf life of mango fruits was more in Peter (8-10 days) than in Julie (4-7 days).

Keywords: Growth, Development, Harvest maturity, Mango fruits, Physicochemical parameters.

Introduction

Mango, the fruit of *Mangifera indica* L., belonging to the family Anacardiaceae, occupies a prominent place among the dietary fruits of the world (Kanchan *et al.*, 1987). In Nigeria, mango growers harvest the fruits usually by plucking with hand and also assess fruit maturity prior to harvesting for immediate consumption or for commerce, on the basis of size, shape and external fruit colours or after a few ripe fruits have dropped from the tree. Consequently, up to 40-50% post-harvest losses in mango fruits in Nigeria have been reported (Soyele and Bolaji, 1995). The losses were attributed to inadequate storage facilities and processing techniques or nely harvesting of the fruits done mostly pre-turely and sometimes overripe harvested fruits e predisposed to spoilage. The losses, so far, remain unabated and have not received sufficient research attention till date. Harvesting mango when the fruits have reached the optimum stage of maturity is of considerable importance to the farmers because at this stage, the fruits develop good flavour, aroma, and attain uniform ripening and desirable marketability indices and fetch high prices (Cruess, 1969).

In order to determine the correct stage of growth to harvest mango fruits, it is necessary to know the physical and chemical changes that occur during development and maturation of the fruits. Rhodes (1984) reported changes in total soluble solids (TSS), vitamin C, β-carotene and other parameters during the development of mango fruits. Reports by Singh *et al.*, (1986) noted that vitamin C content declined with the growth of mango fruits while Mukerjee and Tewari (1989) observed an increase in vitamin C at the maturity stage of mango fruits. The assessment of maturity in mangoes was mainly determined on the basis of shoulder growth, specific gravity, TSS and titrable acidity (Lakshiminarayana, 1990).

Harding and Hatton (1997) correlated the duration of stone growth and change of pulp colour in mango cv. Dashehari, to physiological maturity. Mango fruits cv. Peter, with large fruit

size and higher pulp percentage is a late cultivar (BNARDA, 2000) and information on the fruit growth and development at optimum stage of maturity is very limited. Scanty information is also available on the maturity indices of the Julie mango fruits. Julie and Peter cultivars are two popular mangoes in Benue State and substantial quantities of the two mangoes are hauled to other states in Nigeria for commerce. Detailed information on changes in different physico-chemical parameters during growth, development and maturation of these mango cultivars would be useful to determine the proper stage of fruit maturity and consequently its harvesting. Since research information on the physiology of fruit maturity in the local mangoes is completely lacking, an experiment was therefore conducted to ascertain the harvest maturity of the two important mangoes cvs. Julie and Peter, through various physico-chemical changes during fruit growth and development.

Materials and Methods

The investigation was carried out during 2001 and 2002 seasons on 10-year old mango trees grown in a farmer-managed local orchard at Aliade, Gwer Local Government Area of Benue State, Nigeria. Agronomic practices in the orchard followed standard recommendations (Udo-Ekong, 1995). Five mango trees each of cvs. Julie and Peter were randomly selected for the studies. The mango branches having approximately a uniform fruit set were tagged for recording observations starting from 47 days after fruit set (DAFS) till ripening. Harvesting dates after fruit set constituted the treatments (Table 1). At each harvesting date, samples of 12 mango fruits from each cultivar were taken randomly from the trees at 9 – 10 day intervals at the initial stages (47-93 DAFS), but at later stages (103-117 DAFS), the sampling period was reduced to 7-day intervals. The harvested experimental mango fruits were first rinsed with distilled water, air-dried and then divided into 4 equal groups, with 3 fruits in a group and each group representing a replication. Total soluble solids (TSS) of freshly extracted mango juice samples were recorded using a hand refractometer at room temperature ($26^0C - 28^0C \pm 1^0C$) at the Crop Science Laboratory, University of Nigeria, Nsukka. Moisture, vitamin C, β-carotene and percentage acidity in the pulp were determined according to AOAC (1990).

Five additional Julie mango fruits were harvested at 93 and 100 days after fruit set. They were stored at room temperature in a low-density polythene (LDPE) bags of 120-guage thickness (0.03mm) with vents of $1cm^2$ spaced 5cm, until fully ripe. The ripe mangoes were designated Ripe I for mango batch harvested earlier at 93 DAFS and Ripe II for those harvested later at 100 DAFS (Table 2). Similarly, five additional Peter mango fruits were harvested at 110 DAFS (earlier) and 117 DAFS (later). The mangoes were handled intact and stored in the manner similar to Julie mango fruits until they became fully ripe. The mean monthly rainfall received during the period of fruit development (March-July) were 194.6mm in 2001 and 189.7mm in 2002. Data collected in 2001 and 2002 were similar in trend and magnitude and were pooled and statistically analysed using analysis of variance procedures for randomized complete block design (RCBD). Test of significance of means was by Fisher's Least Significant Difference (F-LSD) at 5% probability level.

Results

Significant changes occurred in physical characteristics during development of mango fruits cvs. Julie and Peter and these are presented in Table 1. A constant increase in growth parameters viz., fruit length, fruit diameter and average weight of fruit were noticed till 93 and 103 days in Julie and Peter mangoes respectively. The maximum average weight of fruit was higher in Peter mangoes compared to Julie mango fruits. There was a constant decrease in fruit peel (exocarp) percentage but it was sharp at initial stages and slowed down thereafter. The fruit pulp (mesocarp) did not exhibit significant variations in Julie mangoes. However, there was a greater density for the fruit pulp to increase with the advancement of fruit development in Peter fruits. The endocarp increased with the advancement of fruit growth. In Julie mango, there was an abrupt increase in endocarp percentage at 65 days after fruit set and thereafter, it became almost constant till 100 days of fruit set. No such leap in endocarp percentage was noticed in Peter mangoes, rather, a slight increase was observed at 103 days after fruit set. Specific gravity of 1.0 and above was recorded at 93 days in Julie mango and at 103 days in Peter mango.

Data on chemical characteristics during development of Julie and Peter mangoes are presented in Table 2. Moisture content (%) decreased throughout the growth period and was least in ripe mango fruits. Abrupt and significant increase in total soluble solids (TSS) was observed at 93 days in Julie and at 103 days in Peter mangoes. In the ripe mango fruits, TSS was higher in Peter than in Julie fruits. After an initial and significant increase in titrable acidity in Peter

mangoes, it declined and was least in ripe fruits of both Julie and Peter mangoes. The vitamin C content decreased at earlier stages of Julie mango fruits growth, then increased at 75 days and beyond but was the least in ripe fruits. In Peter mangoes, vitamin C declined throughout the growth period with the ripe fruits having the least values. Steep and significant rise in β-carotene was observed at 93 days in Julie mangoes and at 103 days in Peter mangoes. In the ripe mango fruits, β-carotene was much higher in Peter than in Julie

Table 1: Influence of harvesting after fruit set on physical characteristics during development of mango fruits cvs. Julie and Peter

Harvesting date	Days after fruit set (DAFS)	Mean fresh weight (g)	Fruit length (cm)	Fruit diameter (cm)	Exocarp (%)	Mesocarp (%)	Endocarp (%)	Specific gravity
				Julie				
May 11	47	73.9±5.3	6.90±0.43	3.99±0.24	20.0±0.7	75.7±1.2	4.3±0.6	0.968±0.011
May 20	56	133.5±4.9	8.65±0.22	5.03±0.15	16.0±0.9	75.5±0.5	4.5±1.4	0.987±0.010
May 29	65	186.4±3.3	8.87±0.22	5.24±0.18	17.2±0.2	73.7±1.7	9.1±1.8	0.987±0.002
June 8	75	215.7±1.8	9.49±0.37	5.92±0.22	14.3±0.4	76.4±0.9	9.3±0.8	0.974±0.003
June 17	84	223.6±13.4	9.83±0.31	6.27±0.14	11.6±0.7	78.8±0.9	9.6±0.5	0.986±0.006
June 26	93	273.6±11.5	10.18±0.46	6.76±0.06	12.4±0.4	78.1±0.9	9.90±0.8	1.015±0.012
July 3	100	268.5±13.3	9.79±0.04	6.28±0.13	11.1±0.1	78.9±1.1	9.9±0.9	1.011±0.015
F-LSD (0.05)		18.2	0.65	0.46	1.11	NS	NS	0.015
				Peter				
May 11	47	114.9±12.6	11.17±0.36	6.47±0.23	21.1±0.6	74.5±2.4	3.9±1.8	0.963±0.010
May 20	56	116.9±12.5	12.32±0.63	6.98±0.23	18.0±0.4	77.7±2.5	4.9±1.6	0.979±0.006
May 29	65	299.5±27.7	14.30±0.64	8.15±0.23	15.9±0.8	77.2±0.5	5.8±1.2	0.982±0.015
June 8	75	340.3±30.4	14.67±0.78	8.71±0.29	13.8±0.5	78.7±2.5	6.7±1.2	0.882±0.010
June 17	84	416.6±42.0	15.60±0.71	9.24±0.08	13.3±1.6	78.3±2.1	7.6±1.2	0.998±0.002
June 26	93	431.5±29.6	14.78±0.55	8.63±0.30	12.2±1.4	79.1±1.6	7.4±0.6	0.997±0.009
July 6	103	557.0±47.8	16.90±0.40	10.01±0.12	10.6±1.0	81.8±2.3	8.9±1.7	1.054±0.04
July 13	110	556.3±54.9	16.89±0.74	9.52±0.13	11.3±1.0	81.8±0.8	8.6±0.7	1.049±0.016
July 20	117	550.5±19.5	16.49±0.71	9.63±0.23	11.1±0.9	81.5±1.8	8.7±1.0	1.068±0.020
F-LSD (0.05)		88.4	1.15	0.59	1.75	3.01	2.5	NS

Date of fruit set: 25th March

Table 2: Influence of harvesting after fruit set on chemical characteristics during development of mango fruits cvs. Julie and Peter

Harvesting date	Days after fruit set (DAFS)	Moisture content (%)	TSS content (%)	Acidity as citric acid (%)	Vitamin-C (mg %)	β-carotene (ug %)	TSS/acid ratio
				Julie			
May 11	47	89.5±0.1	7.8±0.4	3.27±0.02	164.2±14.1	6±4.0	2.40±0.1
May 20	56	85.6±0.3	6.4±1.0	3.15±0.17	145.5±12.1	12±5.0	2.03±0.4
May 29	65	84.9±0.5	9.1±0.3	3.16±0.15	126.6±11.4	59±8.0	2.88±0.1
June 8	75	80.7±0.4	9.7±1.2	2.41±0.19	209.4±15.2	50±9.0	4.02±0.8
June 17	84	81.6±0.5	8.1±0.7	1.89±0.12	213.1±11.8	54±8.0	4.29±0.6
June 26	93	79.3±0.6	19.7±1.0	1.50±0.18	229.2±24.0	192±12.4	13.1±1.5
July 3	100	78.4±1.0	19.2±0.5	1.18±0.07	216.4±23.1	198±24.0	16.3±0.3
Ripe I		76.8±0.2	21.7±0.6	0.35±0.01	117.6±6.5	1062±32.7	62.0±2.4
Ripe II		78.9±0.3	21.5±0.4	0.31±0.03	119.9±9.4	1968±27.4	69.4±3.6
F-LSD (0.05)		1.27	1.71	0.25	37.10	35.6	3.06
				Peter			
May 11	47	89.7±0.2	6.3±1.0	3.33±0.20	238.2±16.1	11±2.0	1.89±0.2
May 20	56	87.8±0.6	5.9±0.6	3.42±0.23	201.3±13.4	6±4.0	1.73±0.1
May 29	65	86.0±0.8	9.3±0.1	3.69±0.35	113.2±16.7	56±1.0	2.52±0.2
June 8	75	82.7±1.6	8.4±1.4	3.56±0.10	149.9±8.6	48±15.0	2.36±0.4
June 17	84	81.7±0.6	6.8±0.3	3.06±0.17	118.9±6.4	44±30.0	2.22±0.2
June 26	93	79.8±1.0	9.0±0.4	2.86±0.35	95.9±8.2	81±23.0	3.15±0.4
July 6	103	79.0±0.5	14.3±0.9	1.89±0.15	83.4±4.1	224±84.0	7.57±0.4
13	110	77.6±0.5	14.1±1.0	1.67±0.13	62.9±0.9	1138±40.70	8.44±1.1
y 20	117	77.7±0.4	14.2±1.7	1.45±0.34	55.5±3.0	1202±28.50	9.79±3.6
ipe I		75.5±0.4	24.1±0.4	0.52±0.15	35.1±2.5	3009±63.90	46.3±1.55
Ripe II		75.4±0.8	24.2±0.3	0.45±0.09	36.2±4.2	3455±73.20	53.8±1.09
F-LSD (0.05)		1.58	2.03	0.36	20.2	90.7	1.85

mangoes. At the same time, the pulp colour changed from whitish yellow to deep yellow in Julie and Peter mangoes respectively. The TSS/acid ratio, after an initial lag, significantly

increased at 93 days in Julie mango fruits and at 103 days in Peter mangoes. The duration of ripening was linked with the stage of maturity. Julie mangoes harvested at 93 days after fruit set took 7 days to ripen, whereas, the mangoes harvested at 100 days after fruit set ripened only in 4 days. Similarly, Peter mangoes harvested at 110 days after fruit set took 10 days to ripen while the mangoes harvested at 117 days after fruit set ripened in 8 days. Ripening time was invariably shorter in Julie mangoes than in Peter mangoes. The implication here is that the post-harvest shelf life of Peter mango fruit is longer than that of Julie mangoes.

Discussion

Fruit growth stabilized in Julie mangoes after 93 days of fruit set whereas in Peter mango fruits, the physical growth indices were almost constant from 103 days and beyond, indicating that Peter mangoes took longer duration for fruit development and therefore was classed a late mango cultivar. Further, the weight increase of Julie fruits was uniform compared to the irregular growth of Peter mango fruits as it is evident from the standard deviation of mean fruit weight (Table 1). The irregular fruit growth habit noticed in Peter mangoes probably induced longer duration for the fruit development. This result is in accordance with those obtained by Singh (1969) who observed that most late mango varieties are associated with prolonged fruit development. Although, an average weight of 307g in Peter mangoes at maturity was reported (Emecheta, 1995), larger size and weight of about 500g were recorded in the present study (Table 1) probably due to adoption of improved agronomic practices. After 56 days of fruit set in Peter mangoes, yellowing of a small portion was observed in few mango fruits. Such fruits fell pre-maturely as the yellowing turned to light brown in colour and the fruits consequently became induced into false ripening from the discoloured portion. The cause of this physiological disorder was not identified in the present study. Therefore, further investigation in this direction is recommended. No such physiological disorder was noticed in Julie mangoes.

The pulp percentage in Peter mango fruits was higher than in Julie fruits particularly due to smaller endocarp size of Peter fruits. The formation of parchment type integument which was initiated about 75 days after fruit set in both the mango cultivars was completed about 84-88 days of fruit set in Julie fruits and about 93-100 days of fruit set in Peter mangoes. This integument was seen in the proximal end of the fruit and its completion marked the physiological maturity of the mango fruits since similar observations were used to indicate physiological maturity in Indian mango fruits cv. Dashehari (Harding and Hatton, 1997). In sorghum hybrids, physiological maturity was marked by the formation of a black layer (Singh and Polikar, 1990) which corroborates the result of the present study. Specific gravity value of 1.0 has been acclaimed as one of the important maturity indices of mango (Singh *et al.*, 1986). Data from the present study indicate that specific gravity rose to above 1.0 at 93 and 103 days after fruit set in Julie and Peter mangoes respectively and this index could be relied upon for determining maturity of the two mango cultivars: Julie and Peter. On the contrary, Harding and Hatton (1997) observed little relation between specific gravity and ripening quality in different mangoes and thereafter concluded that specific gravity could not be reliably used as maturity index for all mango varieties.

Percentage moisture decreased throughout the fruit developmental period and was at its lowest in mature and ripe mangoes. Thus, at maturity, the moisture content of seeds decreased with the steady accumulation of dry matter during seed maturation (Palanisamy *et al.*, 1984). Total soluble solids (TSS) decreased with fruit growth prior to physiological maturity and started rising till ripening. Similar trend in Indian mango cv. Dashehari was reported by Askar *et al.* (1991). Titrable acidity increased in Peter mango fruits at initial stages of growth and then it decreased till ripening. In Julie fruits, acidity declined throughout the developmental period. These results show that titrable acidity has inverse relationship with mango fruit development. In Julie fruits, vitamin C decreased initially then increased and became almost constant after 84 days of fruit set; probably indicating physiological maturity. This is an unusual change only noticed in Julie cultivar, the significance of which could be ascertained through further metabolic studies. In the case of Peter cultivar, vitamin C was high at initial stages and afterwards decreased continuously till ripening.

There was an upsurge in β-carotene in Julie and Peter mango fruits approaching maturity. Mann *et al.* (1974) also reported a sudden increase in total carotenoids and observed that this change significantly correlated to fruit maturity in Dashehari and Langra cultivars of mango. An increase in TSS/acid ratio, one of the parameters used for assessing fruit maturity (Askar *et al.*, 1991), was noted at 93 and 103 days of fruit set in Julie and Peter mangoes

respectively. This ratio could be taken decisively for ascribing fruit maturity in Julie and Peter mango cultivars. Julie mangoes harvested at 93 or 100 days of fruit set ripened in 7 days or 4 days respectively, at room temperature. This indicated that the post-harvest life could be more in fruits harvested earlier. Similar pattern of ripening or duration of post-harvest life was observed in Peter mango fruits.

Conclusion: Julie mango fruits took 93 days after fruit set to mature while Peter mango fruits matured at 103 days of fruit set. At this growth stage, mango fruits were characterized by upsurge in β-carotene content, increase in TSS/acid ratio, presence of integument in the proximal end of fruits, rise in specific gravity to above 1.0, change in pulp colour from whitish yellow to deep yellow and complete endocarp formation. This stage therefore can decisively be ascribed to harvest maturity in Julie and Peter mango cultivars. It implies that fruits of Julie can be harvested between 93-100 days after fruit set, and Peter fruits between 103-117 days after fruit set. Mango fruits took 4-7 days to ripen in Julie and 8-10 days to ripen in Peter.

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