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Fruit physico-chemical and quality parameters of mango cultivars as influenced by seasons

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Abstract
A study on physiochemical and quality characters of different mango (*Mangifera indica* L.) cvs. grown under Kanyakumari and Tenkasi conditions was carried out at Horticultural College and Research Institute Periyakulam in the year 2010-2012. tencultivars were studied for pysico-chemical and quality aspects. Among the ten cultivars each cultivars randomly collected ten fruit and analyzedphysico-chemical and quality characters from main as well as off-season at Kanyakumari and Tenkasi location of both main as well as off-season. In the present study also, physico-chemical parameters *viz*., fruit weight, fruit girth, pulp weight and stone weight. The highest fruit weight was recorded in cv. Bangalora (14.75 and 14.00) followed by cv. Banganapalli (13.20 and 12.50), in case of fruit girth was observed in cv. Bangalora (13.22 and 12.35) followed by cv. Banganapalli (12.60 and 12.15) whereas pulp weight was recorded in cv. Bangalora (235.50 and 213.45) followed by cv. Banganapalli (198.60 and 186.60) and stone weight was recorded in cv.Bangalora (97.10 and 86.12) followed by cv. Banganapalli (87.25 and 83.82) both main as well as off-season. quality improvement of fruits with respect to total soluble solids, reducing sugars, non - reducing sugars, total sugars, total carotenoid content, ascorbic acid content and lower acidity response to location, season and varieties. The highest total soluble solids (20.30^0Brix), reducing sugar (7.50%), non-reducing sugar (13.50%) total sugar (21.00%), carotenoids (7.70 mg 100 g^{-1}), ascorbic acid content (29.50 mg 100 g^{-1}) and lowest acidity content (0.20%) was registered by cv. Kale pad during Main season, whereas the highest carotenoid content was observed by cv. Neelum during Main season. The highest ascorbic acid content was recorded in cv. Alphonso during main season.

Keywords: Physico-chemical parameters, main season, off-season quality, TSS, sugars, mango cultivars

Introduction
Mango (*Mangifera indica* L.) is one of the most preferred, widely distributed and broadly grown tropical fruit in the world. Mangoes are increasingly of commercial importance all over the world and assume a leading position in among fruits. Their flavor, attractive fragrance and high nutritional value has placed them in a popular position as a source of income to armers, traders and countries at large, through their local and international markets (Rodriguez. *et al*.,2012) [15]. They balanced human diet by providing 64-86 calories of energy per 100g. When consumed regularly; mangoes are a rich source of phyto chemical compounds and other nutritional compounds. Vitamin C ranges from 32 to 200mg/100g (Rathore *et al*., 2007) [14]; it falls within the daily intake for both children and adult which ranges from 40-90mg of ages between 0 to 90 years (Food and Drug Association).The areas where mango is produced have increased over the last decade by about 42.5% as well as their consumption as both fresh fruits and processed products (Malik and Singh, 2006) [9]. The world production is estimated to be about 25.1% tones per year and continues to increase yearly (Rodriguez *et al*., 2012) [15]. Asia produces 76.9% of the total production, America 13.38%, Africa 9%, Europe, and oceanic countries less than 1% (Rathore *et al*., 2007) [14]. Mango varieties differ in flavor, nutritional characteristics, and storage behavior. High market losses, inadequate information on postharvest physiology and biochemistry of cultivars are the main factors limiting international mango trade in developing countries (IsahtMiaq *et al.*, 2010) [7]. The quality parameters such as, total soluble solids (TSS), acidity, ascorbic acid, reducing sugar, non- sugar, total sugar and physic-chemical characters *viz*., fruit weight, fruit girth, pulp weight and stone weight are important for the table purpose and value addition of mango fruit (Jha *et al.*, 2008) [8]. Moreover, some of the key components that contribute for the production and acceptance of high quality fresh mangoes by the consumer are flavor, volatiles, texture and chemical constituents (Mamiro *et al*., 2007; Gaaliche *et al*., 2012) [10, 3]. Sensory profile of the mangoes especially color has a great impact on consumers' decision to buy a particular type of

fruit or its fruit products (Gössinger *et al.*, 2008) [4]. Thus, fruit color serves as a good index of the quality of the product and consumer perception. Acceptance for color, taste and flavor of fruits is considerably important all over the world that enhances the import potential. The competitiveness for its sale is also primarily based on these factors in the international markets.

Table 1: Fruit physico-chemical charactersof mango cultivars

Varieties	Fruit length (cm)		Fruit girth (cm)		Pulp weight (g)		Stone weight (g)	
Seasons	**Main season**	**Off season**	**Main season**	**Off season**	**Main season**	**Off season**	**Main season**	**Off season**
Alphonso	8.12	8.40	7.60	7.10	140.25	135.40	44.90	42.25
Bangalora	14.75	14.00	13.22	12.35	235.50	213.45	97.10	86.12
Kalepad	7.85	8.17	7.40	7.20	132.30	117.27	47.00	42.10
Himayuddin	12.40	11.85	11.65	10.35	185.40	174.05	74.57	72.40
Sendura	8.32	9.17	7.85	7.45	122.77	114.00	44.37	41.05
Mulgoa	10.17	10.07	9.62	8.40	181.30	177.90	79.10	76.00
Neelum	8.45	8.65	7.60	7.15	173.37	156.92	51.75	48.75
Rumani	7.97	7.10	7.32	6.35	162.70	135.40	53.40	50.10
Banganapalli	13.20	12.50	12.60	12.15	198.60	186.60	87.25	83.82
Swarnarekha	11.30	10.92	9.62	9.62	177.77	158.02	66.92	63.30
SEd	0.04697		0.04502		0.66341		0.36502	
CD (0.5%)	0.09500		0.09106		1.34188		0.73832	

Materials and Methods

An experiment was conducted at State Horticultural Farm, Kanyakumari District was undertaken by the Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam during the year 2010-2012. The experiment was laid out in a Factorial Randomized Block Design (FRBD), with two seasons and ten varieties and replicated twice. Ten year old trees of mango cultivars were selected for this study. Ten mango cultivars selected for this study *viz.* Alphonso, Bangalora, Kalepad, Himayuddin, Sendura, Mulgoa, Neelum, Rumani, Banganapalli and Swarnarekha and seasons are main and off-season.

Statistical Analysis

The study was conducted in a factorial randomized block design (FRBD) and consisted of ten mango cultivars with combination of two replications. Data were collected and analyzed using AGRESS Software and the means compared by the Duncan's multiple range tests (DMRT) at the ≤ 0.05% level of probability suggested by Hoshmand (2006) [6].

Total Soluble Solid content: This was determined using an Atago hand refractometer (Model RX 5000, Atago, Tokyo, Japan). A drop of the homogenized mango pulp was placed at the prism of a hand refractometer, which had been calibrated, the lid closed and TSS read directly from the digital scale at 20 °C±1 and results expressed in ºBrix.

Total Titratable Acidity content: This was determined by titrating the sample with 0.1N sodium hydroxide in the presence of phenolphthalein indicator. T.T.A results were expressed as % citric, which is the main organic acid in mango fruit (Ueda *et al*., 2000) [19].

Ascorbic acid content: This was determined using the AOAC.967.21 (1996) method. Five grams of the pulped mango was diluted with 10% trichloroacetic acid (TCA) to 100.0ml mark of 100ml volumetric flask. 2, 6- dichloph enolindophenol was titrated to 10.0ml of the pulp filtrate. Ascorbic acid was calculated as: Ascorbic acid, (mg/100g) = (A-B) X C X 100/s X (100/10).

Total carotenoids: The total carotenoid content of fruits was determined as per the method described by Ranganna 1977) [13] and expressed as mg 100 g-1.

Total sugars: The total sugar content of the fruits was determined as per the method suggested by Somogyi (1952) [17] and the mean was expressed as percentage.

Reducing sugars: The reducing sugar content of the fruits was determined as per the method suggested by Somogyi (1952) [17] and the value was expressed as percentage.

Non - reducing sugars: The non- reducing sugar content was computed by subtracting reducing sugars from total sugars and value was expressed in percentage.

Table 2: Quality parameters in mango cultivars

Varieties	TSS (^{0}Brix)		Reducing sugar (%) (%)		Non-reducing sugar (%)		Total sugar (%)	
Seasons	**Main season**	**Off season**	**Main season**	**Off season**	**Main season**	**Off season**	**Main season**	**Off season**
Alphonso	18.50	17.35	5.53	4.85	11.54	10.75	17.08	15.60
Bangalora	16.80	15.95	4.85	4.30	9.36	8.77	14.21	13.07
Kalepad	19.90	19.30	7.35	6.65	13.25	12.60	20.60	19.25
Himayuddin	16.85	15.85	4.35	4.05	8.95	8.35	13.30	12.40
Sendura	17.87	16.35	4.45	4.05	10.00	9.02	14.45	13.07
Mulgoa	17.15	16.35	4.18	3.60	8.80	8.22	12.98	11.82
Neelum	19.10	18.10	6.42	5.85	12.10	11.62	18.52	17.47
Rumani	15.35	14.05	3.58	3.07	8.37	7.82	11.96	10.90
Banganapalli	18.10	17.10	5.26	4.65	10.10	8.80	15.36	13.45
Swarnarekha	15.35	14.15	3.75	3.25	8.20	7.72	11.95	10.97
SEd	0.03370		0.02329		0.03390		0.05623	
CD (0.5%)	0.06817		0.04710		0.06856		0.11374	

Results and Discussion

In any production system, the primary goal is to achieve maximum fruit yield per unit area without affecting the fruit physic-chemical characters and fruit quality.

Fruit physico-chemical characters

The interaction effect on seasons and varieties, in the present study, revealed that there was significant increase in the fruits length, fruit girth, pulp weight, stone weight. The highest fruit length, fruit girth, pulp weight and stone weight was recorded by Bangalora during Main season (Table.1). The variations among cultivars for fruit weight, fruit girth, fruit length, pulp weight and stone weight might be to their different genetic makeup. The results on fruit length and perimeter are partially in agreement with the findings obtained by Bibi *et al.,* (2006) [2] who reported that Bangalora produced the highest fruit weight and fruit girth followed by Banganapalli and Himayuddin. The fruit growth was correlated with several growth regulating substances. Enlargement is sigmoidal reaching a constant size of the fruit. This was in accordance with the earlier findings of Prakash and Ram, (1984) [11]. The highest rate of fruit growth has been associated with peak levels of putative endogenous auxins found in seeds (Singh and Singh, 1974) [16]. The mango cv. Mallika was found be superior to other cultivars in respect of fruit size, while the cv. Langra and Sunderja also produced fruits of reasonable good size. The variation noticed might be due to the different types of environmental conditions enjoyed by the tree. This result was accordance with the findings of Rajput and Pandey (1997) [12].

Quality parameters in mango cultivars

In mango, the quality is mainly judged by total soluble solids (TSS), total sugars, ascorbic acid and total carotenoids content in fruits. The primary objective aimed in any research was to achieve higher production and productivity without compromising nutritive as well as the most favour edible quality of the harvested produce. In the present study also, quality improvement of fruits with respect to total soluble solids, reducing sugars, non - reducing sugars, total sugars, total carotenoid content, ascorbic acid content and lower acidity response to location, season and varieties. The highest total soluble solids, reducing sugar, non-reducing sugar and lowest acidity content was registered by Kalepad during Main season, whereas the highest carotenoid content was observed by Neelum during Main season. The highest ascorbic acid content was recorded in Alphonso during Main season (Table 2). This might be attributed due climatic factors influenced the higher photo synthetic efficiency. (Hoda *et al.* 2001) [5]. The above positive and desirable results might be due to rapid hydrolysis of polysaccharides into soluble solids and also due to fast mobilization of carbohydrates from source to sink under the influence of congenial environmental factors. Carotenoid, the precursor of vitamin A which adds colour to fruit pulp, is another important quality parameter, particularly for yellow-pulped fruits like mango. The nutritional value of the fruit is also decided by the content of carotenoids. The decline in acidity of the fruits might have been due to faster conversion in to sugars and their derivatives or consumption in the process of respiration or both. Maximum reduction of acidity in the fruit was caused due to climatic factors and easy conversion of starch into sugars. The production of off-season bearing in mango fruits which coincides with November-December months should be carefully considered for quality aspects as the fruits developing during rainy/cool season months will be generally inferior in quality because of prevalence of lower quantum of required heat units at Kanyakumari (Ananthanarayan and Pillai, 1968) [1]. In mango, the quality is mainly judged by the content of total soluble solids (TSS), total sugars, titrable acidity and total carotenoid content in fruits. Srinivasan and Shanmugavelu (1971) [18] also observed the seasonal influence affecting the quality of mango during the off season. It is concluded that a combination of physico-chemical and quality fruit

Parameters is employed to specify the export of mango fruits. The results of the present experiment indicate that most of the mango cultivars studied in this tropical marginal area (Kanyakumari and Tenkasi) met the standard parameters for considering the fruit to be of high quality, especially Bangalora, Banganapalli and Himayuddin. Therefore, mango cultivation in tropical region of south India production off-season would be of great significance in increasing the productivity of mango and also in offering high returns to the farmers as it is market driven.

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