

Comparative Study of Phytochemical Contents of Various Mango (*Mangifera indica* L.) Cultivars of Bihar

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Abstract: Mangoes are naturally very rich subtropical fruit with unique flavor, fragrance, taste and health promoting compounds like phytochemicals which consists of carotenoids, phenolic, alkaloids, nitrogen containing compounds and organo sulphur. Out of which carotenoids and phenolic are most important healthy ingredients. The different cultivars popularly available in Bihar are – Amrapali, Maldah, Jardalu and Sinduri. Amrapali and Maldah cultivars are very popular in North Bihar as well as Central Bihar while Jardalu is famous particularly in Bhagalpur (Vikramshila region). Sinduri cultivar of mango is common in South Bihar. All the four cultivars of mango were collected and investigated for carotenoids, phenolics, reducing sugar and other parameters in the peels and pulps of green mature (GM) stage and fully ripe (FR) stages of all the cultivars. Carotenoids contents and phenolic contents in all the four cultivars of mangoes were analyzed by solvent extraction method followed by spectrophotometric method. Among the different mango cultivars Amrapali contains the highest amount of carotenoids which is about 27 mg/100g followed by Maldah containing about 22.34 mg/100g. Jardalu and Sinduri cultivars contains 20.45 mg/100g and 21.67 mg/100g respectively. With respect to total phenolic again Amrapali cultivar is found to be the richest with 78mg GAE/100g in its peel. Maldah and Jardalu have almost the same content of phenolics with 40; 44 mg GAE/100 g and 300; 305.49 mg GAE/100g of their pulp and peels respectively. The Sinduri cultivar has been found to possess the lowest content of total phenolics with 30.29 mg GAE/100 g and 269.85 mg GAE/100 g of its pulp and peels respectively. For all the cultivars peels were found with greater contents of phenolics than that of pulp but for Amrapali and Maldah the carotenoids content were found less in their peels than their pulp, but for the rest two varieties the carotenoids content is slightly greater in peels than pulp.

Keywords: Carotenoids, Phenolics, Phytochemical.

1. Introduction

Phytochemicals are highly bioactive compounds in fruits, vegetables, grains and other plant. Particularly carotenoids and phenolics present in food are powerful antioxidant [1]-[3]. Liu [4] has broadly classified antioxidative phytochemicals in plants and fruits as carotenoids, phenolics, alkaloids, nitrogen containing compounds and organo sulphur compound as given in figure 1.

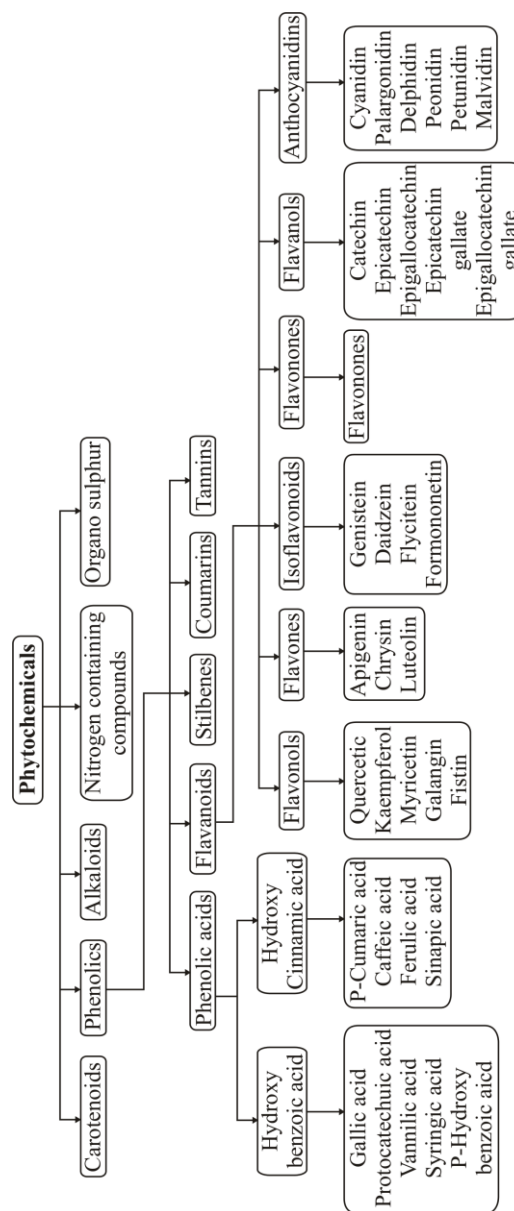


Fig. 1. Phytochemicals

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Mangoes have been reported as wonderful source of β -carotene, Vitamin C, phenolics and dietary fiber [5]. Vitamin A deficiency is a major problem in our country causing childhood blindness, retarded growth, impaired reproduction, inadequate RBC production, infections etc and carotenoids having provitamin A have amazing beneficial effect on human health [6], [7]. Galic acid and hydrolysable tannins are particularly found as major phenolic compounds in mango [8], [9]. Recent studies on mangifera indica L. reveal antioxidative and antiproliferative activities, tyrosinase inhibitory activity, in haemorrhagic activity and antidermonacrotic activities of pulp, peel and seed kernel of different cultivars of mangoes [10]-[13]. S. Kittiphoan [14] has published a review on the utilization of mango seed showing the presence of several minerals, amino acid and other valuable nutritional chemicals in the mango seed kernel and hence it can be used as functional food ingredient. Apart from these extraordinary human health activities mango seed kernel extract has also exhibited antsnake venoms and potent antibacterial activities [15], [16]. The antioxidant properties of pulp and peels of mango or any other fruits and vegetables are associated with the presence of phytochemicals including phenolic, flavanoid and anthocymins in the mango. In last decade the critical evaluation of these phytochemicals in fruits and vegetable have been reported in literature [17]-[20]. the level of antioxidant activity of phytochemicals are greatly affected by the genetics, location and environment growing condition like moisture, fertilization, pest and disease burden as well as processing methods and storage of fruits [21], [22]. The literature is thus full of studies made on pulp, peel and seed kernel of different varieties of mangoes. However, the report on the comparative study of phytochemical content in different

cultivars of mango in Bihar is quite scanty. Hence the present study was contemplated to evaluate and compare the phytochemical contents in the pulp and peel of four different cultivars of mango which is Amrapali, Maldah, Jardalu and Sinduri popularly four in Bihar.

2. Study Areas

Different cultivars of mangoes (*Mangifera indica* L.) are popular in different parts of Bihar and hence the study area covers the whole Bihar. Mango fruits of different cultivars viz. Amrapali, Maldah, Jardalu and Sinduri were harvested from Amgola Market Muzaffarpur, Digha Market of Patna, TM university campus, Bhagalpur and Kedarnath Market, Gaya respectively. About 20 fruits of green matured stage GM of each cultivars were used as sample. Sample were divided into two equal parts: first part consisting of 1 mango of each cultivar were analyzed in GM stage and rest part were rapped in paper and well covered by paper for ripening. After allowing the GM mangoes to ripen at room temperature for three days or until 100% yellow colour of fully ripe (FR) stage was reached. After cleaning all the different cultivars of mangoes they were separated into peels, pulps and seed kernel, their small cut pieces were stored in polyethylene terephthalate in freezer for further analysis.

The various parts of mangoes samples from four cultivars were analysed for physicochemical characteristic like moisture content by the reported method [23], colour using colorimeter, pH using pH meter by reported method [24]. For the estimation of other parameters at first ethanolic extract from mango peels and pulp was prepared for which dried samples of different mangoes were taken and about 200 grams of finely chopped

Table 1
Values of different Physiochemical parameters of all the four cultivars of Mangoes of Bihar

Mango Cultivar	pH	Moisture Content	Colour	Reducing Sugar	Total Phenolics GAE/100gm	Total Carotenoids mg/kg/100gm
1. Amrapali A. Green Mature (GM) (a) Peel (b) Pulp	5.00 4.22	62.31% 70.87%	Green Off white	Negligible 15.32(a)	135.35 40.00	Negligible Negligible
B. Fully Ripe (FR) (a) Peel (b) Pulp	5.71 6.26	71.15% 76.32%	Yellowish green Yellow	7.32(a) 19.00(a)	335.89 78.00	29.31 27.00
2. Maldah A. Green Mature (GM) (a) Peel (b) Pulp	4.87 4.00	67.50% 70.82%	Green Off white	Negligible 14.35(a)	139.00 25.00	Negligible Negligible
B. Fully Ripe (FR) (a) Peel (b) Pulp	5.62 6.32	71.00% 74.92%	Yellowish green Yellow	10.00(a) 23.12(a)	300.00 40.00	24.12 22.34
3. Jardalu A. Green Mature (GM) (a) Peel (b) Pulp	4.88 4.12	60.15% 68.92%	Green Off white	Negligible 14.32(a)	109.86 24.00	Negligible Negligible
B. Fully Ripe (FR) (a) Peel (b) Pulp	5.35 6.00	72.00% 78.31%	Yellowish green Yellow	5.53(a) 17.78(a)	305.00 44.00	15.36 20.45
4. Sinduri A. Green Mature (GM) (a) Peel (b) Pulp	4.70 4.18	57.42% 62.34%	Reddish green Off white	Negligible 12.55(a)	98.76 20.00	2.86 Negligible
B. Fully Ripe (FR) (a) Peel (b) Pulp	5.46 6.32	71.31% 74.35%	Reddish green Yellow	4.84(a) 16.25(a)	269.85 30.29	17.42 21.67

Where (a) = mg glucose per g of sample

samples were homogenized with 100 ml of 95% ethanol at high speed for five minutes. Thereafter the homogenates were placed in water bath maintained at 80°C for an hour with an occasional shaking. It was cooled at room temperature and the supernatants were recovered and filtered through Whatmann filter paper no. 4 and it was stored at 0°C for further analysis.

A. Determination of total phenolic content

All the chemicals used were of analytical grade. The total phenolic content (TPC) was determined by Folin-Ciocalteu reagent using an external Calibration curve with Galic Acid for its quantification and the results were expressed milligram Galic Acid Equivalents (GAE) per gram of the sample [25], [26].

B. Carotenoids extraction and quantification

For the quantification of carotenoids, it was first extracted from the pulp and peels of GM and FR stages of all the four mango cultivars by samponification of Panfili et al., [27]. It was quantified by the combination of normal and reverse phase HPLC method. The element obtained from HPCL in normal hexane was used for the estimation of total carotenoids in it on spectrophotometer at 450 nm wavelength using a 1 cm cell.

C. Reducing Sugar

The reducing properties of the different cultivars of mangoes is associated with the presence of potential aldehyde or keto group of certain types of carbohydrates present in the pulp and peels of mangoes. The reducing sugar of all the four cultivars of mangoes in both GM and FR stages was determined by the method of Neilson [28] which is based on absorbance at 520 nm of coloured complex between copper oxidized sugar and arsinomolybdate. It is expressed in milligram glucose per gram of sample.

3. Result and Discussion

In the present study the four different cultivars of mangoes which is Amrapali, Maldah, Jardalu and Singuri popularly found in different parts of Bihar state have been analyzed for different parameters like pH, moisture content (MC), Reducing Sugar (RS), Total phenolics and Total carotenoids and their comparison has been presented in table 1 and 2.

4. Physicochemical Properties

pH: The pH of all the four mango cultivars at GM stage and FR stage have been presented in table 1, which reveals that both the peel and pulp of GM stage of mangoes of all the four varieties record less pH than that of fully ripe mangoes. The second significant information is also unveiled from the study that in GM stage of all the four cultivars of mango the pH of peel is found greater than that of pulps while for FR stage of all the varieties the pulp recorded higher pH than peels. It shows that in GM stage of all the mangoes the pulp has a higher acidity than the peels. The increase in pH of both pulp and peels of GM mangoes to that of FR mangoes reveals the decrease in acidity of peels and pulps with ripening of the mangoes. The result is in good agreement with the reported values of pH in different

Table 2
Colorimetric values of Peels and Pulps for all the four cultivars in GM and FR

Mango Cultivar	Colour Parameter		
	L* value	a* value	b* value
1. Amrapali			
A. Green Mature (GM)			
(a) Peel	48	13.47	16.25
(b) Pulp	52	3.12	17.45
B. Fully Ripe (FR)			
(a) Peel	62	2.96	47.51
(b) Pulp	73.92	1.54	59.69
2. Maldah			
A. Green Mature (GM)			
(a) Peel	45	12.01	30.62
(b) Pulp	50	5.83	19.12
B. Fully Ripe (FR)			
(a) Peel	72.34	03.16	44.86
(b) Pulp	78.92	3.32	41.04
3. Jardalu			
A. Green Mature (GM)			
(a) Peel	50.53	17.25	27.38
(b) Pulp	54.39	6.84	22.56
B. Fully Ripe (FR)			
(a) Peel	71.91	3.16	46.78
(b) Pulp	73.15	8.09	56.32
4. Sinduri			
A. Green Mature (GM)			
(a) Peel	45.59	8.65	23.00
(b) Pulp	54.86	6.82	23.50
B. Fully Ripe (FR)			
(a) Peel	60.67	2.89	37.69
(b) Pulp	72.98	0.75	49.44

parts of different cultivars of mangoes [29].

Moisture Content: The moisture content of the different parts of mangoes is found to have varied significantly between the different cultivars and the maturity stages. Moisture content of peels in GM stage of mango has been found 57.42% to 67.50% which is less than its pulp that varies from 62.34 to 70.82%. After ripening each cultivar of mangoes have recorded higher percentage of moisture content both in peels and pulps, in peels it runs from 71.00% to 72.00% in peels and 74.35% to 78.31% in pulp. However, the moisture content of the pulps and peels of all the cultivars tested was found within the range of the values previously reported [30].

Reducing Sugar: The peels of all the four varieties of mangoes show negligible amount of reducing sugar in green mature stage. But their pulps recorded reducing sugar varying from 12.55 to 15.32 mg glucose per gram of sample with highest in the pulp of GM Amrapali 15.32 mg glucose per gram of sample followed by Maldah with 14.35 mg glucose per gram of sample. The least value of reducing sugar is recorded by GM Sinduri cultivar with 12.55 mg glucose per gram of sample. After ripening the pulp of all the four cultivars recorded higher value of reducing sugar which is highest for Maldah (23.12 mg glucose per gram of the sample) followed by Amrapali (19.00 mg glucose per gram of sample). Jardalu recorded 17.78 mg glucose per gram sample while it 16.25 mg glucose per gram of sample for Sinduri in FR stage thus the reducing sugar content varies significantly in the pulp of FR stage of these mangoes in the order Maldah > Amrapali > Jardalu > Sinduri. Unlike the peels of GM mangoes, the peel of FR mangoes of each variety recorded considerable amount of reducing sugar which, however also show the same order i.e. Maldah (10.00) >

Amrapali (7.32) > Jardalu (5.53) > Sundari (4.84). From these data it may be concluded that there is certain increase in carbohydrate content in pulp but it depends on the different varieties of the mango [31].

Total Phenolics: The total phenolics in the peels and pulps of GM and FR stages of different mango cultivars have been shown in table-1. In GM mango peels of different mangoes cultivars varies from 98.76 to 39.00 GAE per 100 grams of sample while in pulps of GM mango cultivars it varies from 20.00 to 40.00 GAE per 100 grams of the sample. In GM stage the highest value of phenolics has been recorded in the peels of Maldah while the lowest value goes to Sinduri cultivar but in the case of pulp of GM of different varieties of mangoes the phenolic contents in maximum in Amrapali while it minimum again in Sinduri. In all the varieties of mangoes in GM stage the phenolic content in peels is much greater than that of pulp. The similar trend has also been reported by Ajila *et al.*, [32] and Monaco *et al.*[33]. On ripening in all the four cultivars of mangoes there is significant enhancement of phenolic content both in peels and pulps. In FR stage of mangoes the phenolics content ranges from 335.89 to 269.85 GAE per gram of the sample the highest value is recorded in the peels of FR Amrapali followed by the peels of FR Jardalu (305.00 GAE/100g) and peels of FR of Maldah cultivar records very close (300 GAE/100g) to the Jardalu. The Sinduri varieties reports 269.85 GAE/100g of phenolic content which is lowest among four varieties. The FR pulp of all the four varieties of mangoes have been found to have recorded phenolic content values from 78.00 (in Amrapali) to 30.29 GAE/100g in Sinduri again Maldah and Jardalu have been found to have recorded phenolic contents very close to each other that is 40.00 and 44.00 GAE/100g respectively. In FR stage also like the GM stage of mango the phenolic content in peels has been observed much greater than that of pulp. Thus it may be concluded that the content of total phenolics is higher in mango peels than in pulp at both the GM and FR stages of mangoes which is in a good accord with the earlier reported studies [34], [35]. Higher phenolic content has also been reported in pomegranate and apple peels as compared to their pulp [36], [37].

Total Carotenoids: The total carotenoids in the peel and pulp of all the four mango cultivars in GM stage has been found negligibly small (less than 1.00 mg percent) except sinduri which records 2.86 mg per 100 grams of the sample in its peels, perhaps which is responsible for its red green colour in GM stage. The FR stage of all the four varieties show significant variation in their total carotenoids content in both their peels and pulps. The peels of Amrapali and Maldah possess more carotenoids *i.e.* 29.31 and 24.12 mg per 100 g respectively while the peels of Jardalu and Sinduri in FR stage contain relatively less amount of carotenoids *i.e.* 15.36 and 17.42 mg/100 g respectively. In the pulp, the carotenoids value varies from 20.45 mg/100 g in Jardalu to 27.00 mg/100 g in Amrapali. Thus the pulp of Amrapali contains the highest value of carotenoids followed by Maldah (22.34 mg/100 g) and then comes Sinduri (21.64 mg/100 g). In the case of Amrapali and Maldah the carotenoids value decreases from peel (29.31 and 24.12 mg/100 g) to 27.00 and 22.34 mg/100 g respectively

while the value increases from 15.36 and 17.42 mg/100 g to 20.45 and 21.67 mg/100 g in Jardalu and Sinduri cultivars. Thus it's obvious that carotenoids are evenly distributed among varieties of mangoes [38]. Similar variation in carotenoid content has been reported for different varieties like chausa, Fazli, Rasपुरi, Badami *etc.* [39].

Colour Parameter: The colorimetric values are expressed in terms L*, A*, B* values which has been mentioned in table-2 for the peels and pulps in GM stage and FR stage of all the four cultivars *i.e.* Amrapali, Maldah, Jardalu and Sinduri. L* value is the measurement of shining or luminosity which may vary from 0 for black to 100 for white. The positive value of A* indicates in the direction of redness while negative A* towards greenness. In the case of B* positive B* value indicates towards yellowness while its negative value indicates towards blueness. The perusal of the values of colorimetric parameter clearly indicates that the L* value of GM stage of all the four varieties falls around 50 showing their good shining in GM stage but with ripening in all the four varieties the L* values increase and go to 60 and above for both peel and pulp it clearly indicates that shining of all the four varieties studied here gets enhanced with ripening. The A* values of GM mangoes of all the four varieties is negative which is indicative of their green colour in GM stage however on ripening the A* value either becomes less negative or positive. It indicates the change of colour from green in GM stage to yellow or red in FR stage for both peels and pulps in all the four varieties. Similarly, the B* value of all the four varieties increases from peel and pulp of GM stage to that of FR stage which are responsible for change in their colour to yellow or red or purple on ripening. The positive value of A* and B* with higher value of L* are indicative of higher content of carotenoids in Amrapali and Maldah cultivars [40].

5. Conclusion

From the present studies of four cultivars of mangoes popularly found in different region of Bihar state revealed that all the four cultivars contain the appreciable amount of various phytochemicals like reducing sugar, total phenolics, carotenoids in their peels and pulps in both GM and FR stages. However, there has been a significant variation in different parameter for all the four cultivars. The variation has also been considerably found from peels to pulps in both GM and FR stages and from GM stage to FR stage. Some phytochemical like total phenolics have been found more in peels than pulp in both the GM and FR stages. In Amrapali and Maldah the carotenoid content has been observed to have decreased from peels to pulp in FR stage while for Jardalu and Sinduri cultivars the carotenoids content gets increased from peels to pulp. On the basis of the present studies all the four cultivars have represented a potential source of natural phenolics, carotenoids and reducing sugar but Amrapali and Maldah have been found the richer source of nutrition.

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