Studies on the Pectinesterase Activity and Some Chemical Constituents of Some Pakistani Mango Varieties during Storage Ripening

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Changes in pectinesterase (PE) activity, pectin fractions, and some other chemical constituents in four mango varieties during storage ripening have been studied. The peels have higher PE activity and ash content than the pulp in all the varieties. Anwar Ratual and Chaunsa varieties have respectively maximum and minimum total pectins, and the sodium hydroxide soluble fraction is the main pectin fraction in all the varieties. The moisture content increases in both the pulp and peels during ripening. The Brix value and carotenoids increase up to day 6 after which these tend to decline in all the varieties. The carotenoids mainly reside in the pulp. Vitamin C increases in all the varieties up to day 5 and then starts declining. At the maximum level it varies from 77.4 to 128.2 mg/100 g.

Mango is one of the most important commercial fruit crops in Pakistan. It is a good source of vitamins A and C and certain minerals. Its skin and flesh color varies from variety to variety, depending on the amount of carotenoid pigments. The fruit softens very rapidly during ripening and becomes mushy and unfit for consumption. The firmness of mango is in part, as in other fruits, due to the presence of pectic substances. The softening is the result of degradative changes in the pectic substances due to the activity of pectic enzymes.

Studies on pectinesterase activity and pectin fractions of other fruits have been reported (Rouse et al., 1964, 1965; Nagel and Patterson, 1967; Rouse and Atkins, 1955; Gee et al., 1959; McCready and McComb, 1952; Hultin and Levine, 1965; Tahir et al., 1975; Rahman et al., 1975), but no such information is available concerning Pakistani mango varieties. The compositional changes in some Pakistani mango varieties during storage ripening have been reported previously (Elahi and Khan, 1973). This paper deals with the changes in pectinesterase activity and pectin fractions during storage ripening of four mango varieties. Changes in some other chemical constituents are also studied.

EXPERIMENTAL SECTION

Reagents and Apparatus. All the reagents used were of analytical grade. Apple pectin of 250 grade (BDH) was used as a standard. pH was measured by a pH meter (Model 23A, Electronic Instruments, Ltd., Richmond Surrey).

Preparation of Samples. Four mango varieties, viz., Anwar Ratual, Langra, Chaunsa, and Dusehri were harvested at the fully mature but unripened stage from trees on July 16, 1975, from Bucha Garden near Lahore and thirty mangoes of each variety were allowed to ripen separately as described earlier (Elahi and Khan, 1973). The peels and pulp of each variety were separated carefully, and the determinations were made on each part after an interval of 1 day starting from the day of harvesting.

Pectinesterase activity was measured according to Nagel and Patterson (1967). Vitamin C was estimated by the method of Barakat et al. (1955). Pectin fractions were determined according to Rouse et al. (1955). Total pectin represents the sum of three pectin fractions. Carotenoids were estimated by the method described earlier (Shah and Elahi, 1971) which is as follows.

A definite weight (20 g) of each of peels and pulp was extracted with a 1:1 mixture of petroleum ether (60–80 °C) and acetone for 5 min in a Waring blender and filtered. The residue was reextracted with the same solvent mixture until the latter was colorless. All the extracts were combined, acetone was removed by washing with water, and the petroleum ether layer was dried over anhydrous sodium sulfate and made to a definite volume (250 mL).

A definite volume (10 mL) of this extract was chromatographed by using a column of sugar. Carotenoids were eluted with petroleum ether, made to a definite volume, and estimated spectrophotometrically in terms of β-carotene. All other determinations were made according to standard methods of the Association of Official Agricultural Chemists (1975). The results reported in this paper are the average of duplicate determinations and are included in Figures 1 and 2 and Tables I–V.

RESULTS AND DISCUSSION

Figure 1 represents the changes in pectinesterase (PE) activity in the peels and pulp of some mango varieties during storage ripening. At the time of picking, i.e., day 1, Langra has the highest and Anwar Ratual has the lowest PE activity in both the peels and pulp. It will be observed that peels have higher PE activity than the pulp at all the stages in all the varieties during storage ripening. PE activity in the peels of Langra and Chaunsa varieties decreases up to day 4 after which it increases up to days 5 and 6. The PE activity in Chaunsa peels tends to decline on day 7. The PE activity increases from the time of picking and reaches its peak value on days 4 and 5 and day 2 in the peels of Anwar Ratual and Dusehri varieties, respectively. The PE activity decreases after reaching its peak value in the peels of Anwar Ratual while peel PE activity of the Dusehri variety exhibits no consistent pattern.

PE activity decreases in the pulp of Langra up to day 7 while it decreases from days 1 to 4 in the pulp of Dusehri after which it increases up to day 6 and then declines. The PE activity of pulp of Anwar Ratual tends to decrease on day 2 after which it increases up to day 6 and then declines on day 7. Changes in PE activity of Chaunsa pulp are irregular. It was observed that the mangoes of all the four varieties were ripe, sweet, and slightly soft on days 6 and 7 and were unripe and hard from days 1 to 5. It is obvious from Figure 1 that the changes in PE activity of both peels and pulp do not follow any consistent pattern during ripening and therefore it is difficult to establish any core-

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Table I. Changes in Pectin Fractions of Pulp of Some Mango Varieties during Storage Ripening

ripening time, days	pectin fractions, % AGA,[e] of mango variety															
	Langra				Chaunsa				Dusehri				Anwar Ratual			
	1[a]	2[b]	3[a]	4[d]	1	2	3	4	1	2	3	4	1	2	3	4
1	0.15	0.07	0.35	0.57	0.13	0.08	0.30	0.52	0.18	0.05	0.44	0.67	0.10	0.06	0.61	0.77
2	0.16	0.07	0.39	0.62	0.12	0.08	0.32	0.52	0.20	0.07	0.44	0.71	0.11	0.06	0.65	0.82
3	0.20	0.09	0.42	0.71	0.15	0.10	0.37	0.62	0.24	0.10	0.49	0.83	0.14	0.08	0.67	0.89
4	0.24	0.10	0.34	0.58	0.18	0.11	0.39	0.68	0.20	0.12	0.46	0.78	0.18	0.11	0.71	1.00
5	0.21	0.10	0.41	0.72	0.14	0.10	0.32	0.56	0.26	0.11	0.35	0.72	0.10	0.13	0.72	1.04
6	0.22	0.12	0.37	0.71	0.20	0.12	0.31	0.63	0.31	0.12	0.39	0.82	0.25	0.16	0.70	1.11
7	0.25	0.11	0.31	0.67	0.22	0.11	0.26	0.59	0.31	0.12	0.35	0.78	0.25	0.15	0.70	1.10

[a] 1, water-soluble fraction. [b] 2, ammonium oxalate soluble fraction. [c] 3, sodium hydroxide soluble fraction. [d] 4, total pectin. [e] Anhdrogalacturonic acid.

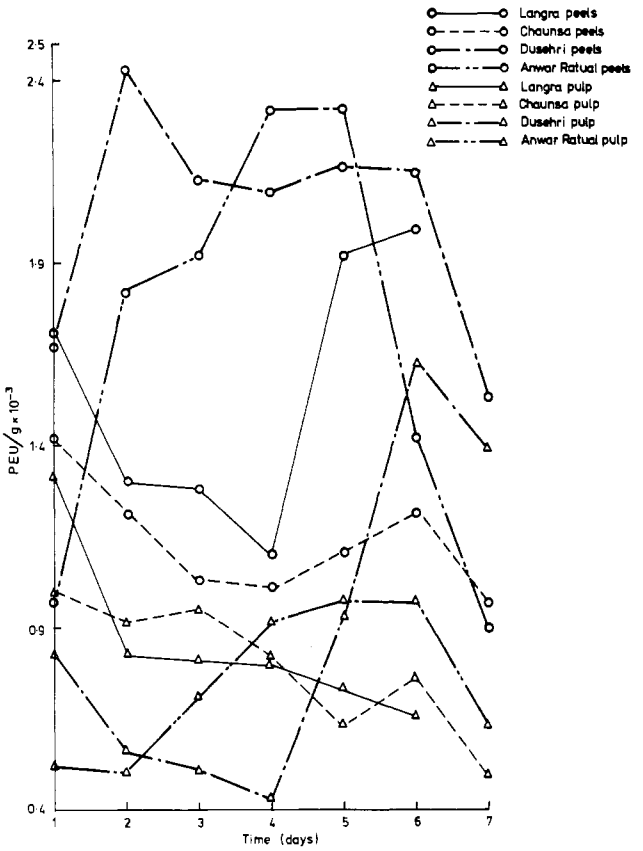

Figure 1. Changes in pectinesterase activity in peels and pulp of some mango varieties during storage ripening.

lationship between ripening and changes in PE activity of mangoes. In other fruits, i.e., banana (Hultin and Levine, 1965), pears (Nagel and Patterson, 1967), and oranges (Tahir et al., 1975), ripening has been associated with pectinesterase activity.

Figure 2 shows the changes in the Vitamin C content of pulp of mango varieties during ripening. Vitamin C increases up to day 5 in Langra and Anwar Ratual varieties and then declines. It increases in Dusehri up to day 6 and decreases on day 7. In Chaunsa variety it increases up to day 3 and declines on day 4, followed by an increase on day 5 and then a decline up to day 7.

It has been reported (Ramasarma and Banerjee, 1940) that during ripening at room temperature (30–40 °C) vitamin C in the pulp diminishes from the green to the half-ripe stage and rises to a steady value during storage at room temperature or 0 °C. In the present studies vitamin C increases in all the varieties during ripening at room temperature up to certain stage and then starts declining. Vitamin C content ranges from 59 to 97 mg/100 g at the time of picking and between 77.0 and 128.2

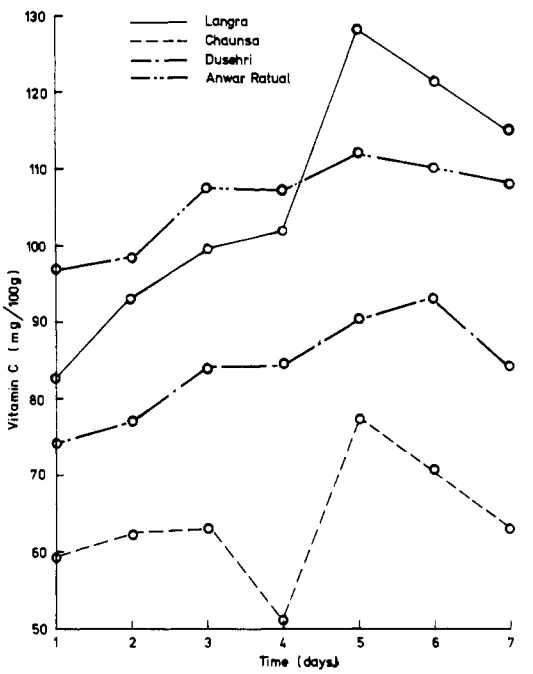

Figure 2. Changes in vitamin C of pulp of some mango varieties during storage ripening.

Table II. Moisture Content of Peels and Pulp of Some Mango Varieties during Storage Ripening

ripening days, days	% moisture content of mango variety							
	Langra		Chaunsa		Dusehri		Anwar Ratual	
	peels	pulp	peels	pulp	peels	pulp	peels	pulp
1	59.7	75.3	58.7	76.7	59.9	77.6	60.3	76.9
2	59.9	75.5	58.8	76.8	60.0	77.9	60.4	77.3
3	60.1	76.4	58.9	77.7	60.2	78.6	60.5	77.8
4	60.2	78.1	58.9	78.7	60.3	78.9	60.5	78.8
5	60.3	78.4	60.1	78.9	60.4	79.5	60.6	79.1
6	60.5	79.1	60.2	79.5	60.5	79.9	60.7	79.6
7	60.5	79.7	60.2	79.9	60.5	80.2	60.7	79.9

mg/100 g at the maximum level. It has been reported (Munsell, 1946) that the vitamin C content of 28 varieties ranges from 9.13 to 130.81 mg/100 g, which closely corresponds with the present results.

Table I shows that the sodium hydroxide soluble fraction is the main pectin fraction and, in case of Anwar Ratual variety, is greater than the combined total of water soluble and ammonium oxalate soluble fractions at all stages of ripening. Anwar Ratual has the maximum and Chaunsa the minimum of both total pectins and sodium hydroxide soluble fraction at the time of picking and during ripening. Although all the fractions tend to increase during ripening, the rate of increase is different in all the varieties. This

Table III. Changes in Degree Brix of Pulp of Some Mango Varieties during Storage Ripening

ripening time, days	°Brix of mango variety			
	Langra	Chaunsa	Dusehri	Anwar Ratual
1	3.80	4.00	4.60	4.00
2	5.40	6.40	7.20	7.40
3	8.80	8.20	10.00	10.15
4	12.20	11.40	13.20	13.00
5	13.20	13.00	14.40	14.10
6	14.60	14.20	15.60	15.2
7	14.20	14.00	15.00	14.6

Table IV. Changes in pH of Peels and Pulp of Some Mango Varieties during Storage Ripening

no.	description of sample	pH at ripening time						
		day 1	day 2	day 3	day 4	day 5	day 6	day 7
1	Langra peel	4.84	4.90	4.55	3.20	4.0	6.10	5.50
2	Chaunsa peel	4.20	4.25	4.95	3.30	4.2	5.80	5.20
3	Dusehri peel	4.90	4.95	5.05	3.40	4.1	6.50	5.20
4	Anwar Ratual peel	3.41	3.65	5.05	3.25	3.90	5.80	5.50
5	Langra pulp	3.05	3.00	3.56	2.40	3.6	4.90	5.30
6	Chaunsa pulp	3.86	3.90	4.50	3.55	4.9	5.60	5.90
7	Dusehri pulp	3.10	3.55	5.15	2.50	4.1	4.35	4.50
8	Anwar Ratual pulp	3.00	3.05	3.55	3.00	4.6	5.50	4.90

trend has been observed in other fruits: melon (Rosa, 1928), banana (Von Loesecke, 1950), citrus (Sinclair and Joliffe, 1961), and strawberries (Neal, 1965).

Table II indicates that the moisture content of both peels and pulp of all the varieties increases during ripening though at a different rate. Anwar Ratual and Dusehri varieties have the maximum moisture content in peels and pulp, respectively, at the time of harvesting.

It is evident from Table III that the Brix value increases during ripening in all the varieties up to day 6 after which it tends to decrease. Dusehri has the highest Brix value both at the time of picking and at the maximum level. The Brix value increases at different rates in all the varieties.

Table IV shows the variation in the pH of both peels and pulp of mango varieties during storage ripening. At the time of picking Anwar Ratual has the minimum pH in both the peels and pulp. The pulp of all the varieties except Langra registers increase in pH up to day 3. It will be observed that the pH of both peels and pulp of all the varieties except the pulp of Anwar Ratual is minimum on day 4 after which it increases up to day 7.

Table V shows that the carotenoid content of the pulp and peels of all the varieties increases up to day 6 after which it tends to decrease during storage ripening. It has been reported (Ramasarma and Banerjee, 1940) that the carotene content increases throughout ripening. The rate of increase of carotenoids is different in all the varieties. Anwar Ratual has maximum carotenoids in the pulp both at the time of harvesting and at the maximum level.

The peels and pulp of Chaunsa and Dusehri and of Langra and Anwar Ratual varieties have almost equal amounts of carotenoids during ripening. The carotenoid content of pulp is greater than that of peels in all the varieties. In citrus fruits the cartoenoids mainly reside in the peels (Shah and Elahi, 1971) while in mangoes, as reported above, these mainly reside in the pulp.

Table V. Changes in the Total Carotenoid Content of Peels and Pulp of Some Mango Varieties during Storage Ripening

ripening time, days	content,[a] mg %, of mango variety			
	Langra	Chaunsa	Dusehri	Anwar Ratual
1	0.35/0.05	0.26/0.04	0.28/0.03	0.38/0.04
2	0.55/0.07	0.41/0.06	0.45/0.06	0.52/0.06
3	1.08/0.08	0.98/0.08	0.92/0.09	0.85/0.1
4	1.84/0.11	1.64/0.15	1.75/0.20	1.45/0.14
5	2.62/0.18	2.12/0.22	2.65/0.23	2.36/0.22
6	3.45/0.26	2.84/0.31	2.81/0.28	3.84/0.25
7	3.25/0.26	2.35/0.29	2.22/0.29	3.24/0.22

[a] Top figures represent carotenoid content of pulp. Bottom figures represent carotenoid content of peel.

The ratio of cartenoids in the peels and pulp varies from 6.5 to 9.5 at the time of harvesting, but at the maximum level it is increased and varies from 9.0 to 15.4.

Changes in ash content of both peels and pulp of all the four varieties have also been studied. The ash content of peels is more than that of pulp. The ash content (percent) of peels and pulp of Langra, Chaunsa, Dusehri, and Anwar Ratual is 0.94/0.29, 0.64/0.38, 0.89/0.38, and 0.88/0.28, respectively. The top and bottom figures represent peels and pulp, respectively. Because of the almost constant concentration of ash during ripening in the peels and pulp of all the mango varieties, their individual amounts on different days are not reported.

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