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EFFECT OF ASCORBIC ACID AND CALCIUM CHLORIDE ON CHILLING INJURY OF BANANA

Banana is sensitive to chilling injury when the fruits are stored at a temperature less than 13°C (Pantastico *et al.*, 1975). The development of chilling injury symptoms of banana results in discoloration of peel and failure of ripening leading to a hard texture of the pulp. Attempts have been made to reduce chilling injury of many fruits by post harvest treatments (Chalutz *et al.*, 1985; Chan, 1988; McDonald *et al*, 1990). The application of calcium (Scott and Wills, 1975) and antioxidants is known to reduce the incidence of chilling-induced disorders (Wills *et al.*, 1981; Geduspan and Peng, 1987). With this background, the present work was undertaken to study the effect of pre-treating cold stored banana with $CaCl_2$ and ascorbic acid on fruit quality and ripening in three varieties of banana.

The experiment was carried out during the summer of 1998 at the National Research Centre for Banana, Trichy. The experimental plants were raised in the farm of the institute under standard management conditions which included application of NPK @ 250g N, 75g P_2O_5 and 450g K_2O per plant in three split doses, irrigation at weekly intervals through trenches and adoption of plant protection methods. The soil was sodic saline with the pH ranging from 8.0 to 9.0. The experimental plots were weeded manually and desuckering at 45 days interval was practiced.

Mature bunches from two dessert varieties of banana viz., Karpuravalli, Robusta and one cooking variety, Monthan were harvested and brought to laboratory. The bunches were dehanded, washed in cold water and air-dried. Individual fingers were separated out and grouped in three equal parts containing 24 fruits each. The fruits were dipped in either 1% $CaCl_2$, 1% ascorbic acid or distilled water (control) for 3 min and dried in air. These fruits were packed in polythene bags, sealed and stored in cold (10°C). Samples were drawn out at 5, 10, 15 and 30 days for recording of observations on chilling damage. Scoring for injury symptoms was done as detailed below on a scale of 1 to 6 before and after ripening and the data were statistically analyzed.

Parameter	Scoring index for visual quality					
	1	2	3	4	5	6
Appearance of spots	Full	80%	60%	40%	20%	None
Decay	Full	80%	60%	40%	20%	None
Discoloration	Full	80%	60%	40%	20%	None
Blackening	Full	80%	60%	40%	20%	None
Texture	Hard	80%	60%	40%	20%	Very soft

The data showed that Robusta was highly sensitive to cold storage followed by Karpuravalli and Monthan. The rate of blackening and discoloration was higher in Robusta as compared to Karpuravalli and Monthan (Table 1). The differences were visible at the end of 5th day and became more pronounced by 10th day. At the end of 15th day, Robusta fruits had a scoring of 3.50 and 2.61 for blackening and discoloration respectively, while the corresponding figures for Karpuravalli were 5.16 and 4.94 and for Monthan 5.27 and 5.55. By the end of 30 days, Monthan scored a better rating than both Robusta and Karpuravalli (Table 2). Although the scoring was further improved by application of $CaCl_2$, the best results were obtained with ascorbic acid (Table 2).

The fruits ripened normally within 7 days once they were removed from the cold storage chamber to the open. It was of interest to note that the process of ripening was not inhibited even after 30 days of storage at 10°C although the visual quality of the fruit was adversely affected. Ascorbic acid treatment gave fruits of better quality than those of $CaCl_2$ treated or control fruits (Table 3). Robusta was the most affected and Monthan the least (Table 4 and 5).

Table 1. Scoring for peel colour before ripening

	Blackening			Discoloration		
	Robusta	Karpuravalli	Monthan	Robusta	Karpuravalli	Monthan
Control	3.33	4.00	5.12	2.75	3.66	5.50
$CaCl_2$	3.50	4.29	5.54	2.58	4.20	5.25
Ascorbic acid	4.33	4.75	5.91	4.00	4.58	5.79
SEd	0.151	0.157	0.117	0.136	. 0.162	0.186
CD (0.05)	0.336	0.351	0.261	0.303	0.361	NS

Table 2. Visual quality of fruits before ripening as affected by duration of storage at 10°C

	Blackening				Discoloration			
	Days of storage				Days of storage			
	5	10	15	30	5	10	15	30
Robusta	5.11	4.83	3.50	1.33	5.11	3.50	2.61	1.22
Karpuravalli	5.55	5.27	5.16	1.38	5.50	4.83	4.94	1.27
Monthan	5.89	5.50	5.27	5.14	5.83	5.61	5.55	5.05
SEd	0.10	0.17	0.20	0.14	0.13	0.16	0.15	0.21
CD (0.05)	0.23	0.37	0.44	0.31	0.29	0.36	0.33 .	0.47
Control	5.27	4.83	4.11	2.38	5.22	4.38	4.00	2.33
$CaCl_2$	5.44	5.05	4.50	2.66	5.39	4.16	4.16	4.66
Ascorbic acid	5.83	5.72	5.33	3.11	5.83	5.44	4.94	2.88
SEd	0.18	0.18	0.18	0.14	0.19	0.15	0.18	0.21
CD (0.05)	0.40	0.40	0.41	0.31	0.43	0.33	0.41	0.47

Table 3. Visual quality parameters after ripening

	Appearance of spots			Decay			Discolouration			Texture		
	Rob-usta	Kar-pura-valli	Mon-than	Rob-usta	Kar-pura-valli	Mon-than	Rob-usta	Kar-pura-valli	Mon-than	Rob-usta	Kar-pura-valli	Mon-than
Control	2.54	2.96	3.79	2.79	3.87	4.00	2.00	3.08	3.58	3.79	4.71	4.08
$CaCl_2$	2.58	3.17	4.42	3.21	3.83	4.54	2.25	3.25	4.17	3.87	4.71	4.08
AA	3.50	3.58	4.50	4.50	4.21	4.71	2.96	3.46	4.54	4.37	4.92	4.50
S.Ed.	0.15	0.17	0.11	0.08	0.26	0.17	0.09	0.14	0.19	0.14	0.12	0.12
CD (0.05)	0.34	0.37	0.25	0.18	NS	0.39	0.20	0.31	0.43	0.30	NS	0.27

The data clearly showed that variation in cold sensitivity exists between Monthan, a cooking variety and the two dessert varieties namely, Karpuravalli and Robusta. Monthan was relatively more tolerant to cold. Ascorbic acid treatment was equally effective for all the three varieties, although it was not able to check the injury symptoms completely. Antioxidants, such as ascorbic acid, are reported to prevent the oxidation of unsaturated fatty acids in membrane lipids by scavenging free radicals thereby reducing low temperature induced disorders (Gough *et al.*, 1973; Geduspan and Peng, 1987). Calcium application also helps in reducing the incidence of chilling-induced damage in banana. Calcium might probably act by its ability to complex with the carbohydrates in the peel, which could delay the incidence of cold injury. The present study on storage of dessert and cooking type bananas at 10°C showed differences in the degree of chilling injury among varieties. The cooking variety Monthan exhibited greater tolerance to cold. Application of

$CaCl_2$ and ascorbic acid reduced the chilling injury symptoms in all the three varieties. The process of ripening was not inhibited even after 30 days of storage at 10°C.

Table 4. Appearance of spots and decay of ripened fruits after storage at 10°C

	Appearance of spots				Decay			
	Days of storage				Days of storage			
	5	10	15	30	5	10	15	30
Robusta	4.17	3.28	2.56	1.50	3.89	3.94	3.72	2.44
Karpuravalli	4.33	4.05	3.28	1.22	4.83	4.67	4.67	2.00
Monthan	4.73	4.61	4.56	3.06	4.78	4.56	4.45	3.89
SEd	0.178	0.182	0.165	0.130	0.093	0.161	0.183	0.121
CD (0.05)	0.397	0.406	0.367	0.290	0.207	0.359	0.409	0.270
Control	3.83	3.61	3.05	1.67	4.05	3.89	3.78	2.50
$CaCl_2$	4.50	3.78	3.50	1.78	4.50	4.39	4.00	2.67
AA	4.72	4.56	3.83	2.33	4.94	4.89	4.89	3.17
SEd	0.097	0.121	0.125	0.174	0.139	0.195	0.149	0.171
CD (0.05)	0.217	0.270	0.278	0.389	0.311	0.435	0.332	0.394

Table 5. Discolouration and texture of ripened fruits after storage at 10°C

	Discoloration				Texture			
	Days of storage				Days of storage			
	5	10	15	30	5	10	15	30
Robusta	3.67	3.39	1.44	1.11	4.16	4.28	3.22	3.83
Karpuravalli	3.94	4.00	3.94	1.17	5.28	5.11	4.83	3.89
Monthan	4.44	4.44	4.22	3.28	4.56	4.56	4.11	3.67
SEd	0.110	0.137	0.120	0.097	0.214	0.163	0.079	0.120
CD (0.05)	0.244	0.305	0.267	0.216	0.477	0.364	0.176	NS
Control	3.56	3.56	2.83	1.61	4.50	4.62	4.16	3.67
$CaCl_2$	4.16	3.89	3.11	1.78	4.61	4.44	4.05	3.78
AA	4.39	4.39	3.67	2.17	4.89	4.94	4.61	3.95
SEd	0.156	0.154	0.139	0.129	0.127	0.154	0.131	0.204
CD (0.05)	0.347	0.343	0.311	0.289	0.282	0.343	0.292	NS

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