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Chilling injury and quality changes in Pachanadan (Pome, AAB group) banana during storage at low temperatures

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ABSTRACT

Pachanadan banana (Pome, AAB group) fruits stored at 10°C developed chilling injury (CI) symptoms characterized by pitting and black spots after 15 days of storage, while at 15 °C no chilling injury was noticed till 15 days. However, after 20 days of storage at 15 °C about 25% fruits exhibited CI symptoms. The ripening of fruits, at ambient temperature after taking out from 10 °C (on 15th day) was impaired, while those at 15 °C ripened normally even after 20 days of storage. The data on quality parameters *viz.,* total soluble solids, acidity, starch and total sugars also supported this observation. The study revealed that CI development is a function of temperature and duration of storage and Pachanadan banana is susceptible to CI even at 15 °C when stored beyond 20 days without any packaging.

Key words: Chilling injury, quality, storage, banana.

INTRODUCTION

Low temperature storage is considered to be the most effective method for maintaining the quality of most fruits and vegetables because it retards respiration, ethylene production, ripening, senescence, undesirable metabolic changes and decay (Hardenburg *et al.,* 2). Unfortunately, tropical fruits are highly sensitive to chilling injury (CI) during low temperature storage. Critical storage temperature varies from crop to crop and within different varieties of the same crop. Pachanadan banana (Pome, AAB group) is one of the important commercial varieties grown in southern India. The objective of the present investigation was to study the effect of different storage temperatures on development of CI symptoms and quality changes in Pachanadan banana during storage.

MATERIALS AND METHODS

Fully mature Pachanadan bananas were harvested, dehanded, treated with 500 ppm Bavistin solution for 10 min. and stored at 10° and 15°C with 70-75% relative humidity. Observations were recorded at 5 days interval for physical appearance, chilling injury symptoms, total soluble solids, acidity, total sugars, starch and post cold storage ripening behaviour. The standard procedures as outlined by Ranganna (7) and Sadasivam and Manickam (8) were adopted for analysis of TSS, acidity, total sugars and starch. The data were analyzed using Factorial RBD design (Chandel, 1).

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RESULTS AND DISCUSSION

Fruits stored at 10 °C developed chilling injury (CI) symptoms characterized by pitting and black spots after 15 days of storage, while at 15 °C no CI was noticed till 15 days (Table. 1). However by 25th day, 25% of fruits stored at 15 °C also developed CI. The ripening of fruits (characterized by yellow colour development and softening) at ambient temperature after taking out from 10 °C on 15th day was impaired, while those at 15 °C ripened normally even after 20 days of storage. Narayana and Singh (4) reported that Dashehari mango fruits stored at 12 °C ripened normally when transferred to ambient conditions, while those stored at 10° or 8°C exhibited ripening impairment characterized by slow ripening and poor colour development after holding for 2 and 4 weeks, respectively. Therefore, the temperature at which the fruit suffers chilling injury depends mostly on the storage temperature and the duration of storage at that temperature. Chilling injury symptoms characterized by browning of skin and development of discoloured sunken patches on the fruit appeared after 2 weeks when guava fruits were stored at 3°C. However, fruits stored at 5 °C did not exhibit any signs of injury till third week of storage (Narayana and Singh, 5).

The total soluble solids were 3.93 °Brix initially which rose to 8.26 °Brix on 20th day at 10°C, while in fruits stored at 15 °C, it was 24.33 °Brix. After ripening it was 26.53 °Brix at 10°C and 27.12 °Brix at 15°C stored fruits (Table 2). This clearly indicated that the post cold storage ripening behaviour varied depending on the temperature of storage. Similar observations were also recorded by Marrero and Paull (3) in banana.

Table 1. Effect of storage temperatures on physical changes in Pachanadan banana.

Storage temperature (°C)	Duration in (days)	Physical observation at low temperature			Physical observation after shifting to RT		
		Colour	Texture	Pitting of fruits (%)	Ripening behaviour	Pitting/ Blackening (% fruits)	Taste
10	Initial	Green	Hard	Nil	Normal	Nil	Good
15	Initial	Green	Hard	Nil	Normal	Nil	Good
10	5	Green	Hard	Nil	Norami	Nil	Good
15	5	Green	Hard	Nil	Normal	Nil	Good
10	10	Green	Hard	Nil	Normal	Nil	Good
15	10	Green	Hard	Nil	Normal	Nil	Good
10	15	Green	Hard	100	Abnormal	100	Poor
15	15	Yellow	Semi-hard	Nil	Normal	Nil	Good
10	20	Green	Hard	100	Abnormal	100	Poor
15	20	Yellow	Soft	Nil	Normal	Nil	Good
10	25	Green	Semi-hard	100	Abnormal	100	Poor
15	25	Yellow	Soft	25	Normal	25	Good

Table 2. Effect of storage temperatures on TSS (°Brix) of Pachanadan banana.

Storage temp. (°C)	Storage Period (days)					
	Initial	5	10	15	20	25
10	3.93	4.53 (27.33)	5.93 (27.33	6.53 (26.86)	8.26 (26.53)	24.73 (24.21)
15	3.93	4.66 (25.60)	6.93 (25.73)	7.20 (27.33)	24.33 (27.12)	24.66 (27.03)
Mean	3.93	4.60 (26.47)	6.43 (26.53)	6.87 (27.09)	16.30 (26.83)	24.70 (25.62)

CD at 5% Treatment = 0.049 (0.189), Storage period = 0.086 (0.327); Interaction = 0.121 (0.464)

* Value in the parenthesis is of data after ripening under ambient conditions.

Table 3. Effect of storage temperatures on acidity (%) of Pachanadan banana.

Storage temp. (°C)	Storage period (days)					
	Initial	5	10	15	20	25
10	0.163	0.117 (0.404)	0.181 (0.373)	0.148 (0.355)	0.158 (0.357)	0.596 (0.576)
15	0.163	0.127 (0.409)	0.171 (0.373)	0.181 (0.355)	0.562 (0.557)	0.534 (0.584)
Mean	0.163	0.122 (0.407)	0.176 (0.373)	0.165 (0.355)	0.360 (0.457)	0.565 (0.580)

CD at 5% Treatment = 0.0024 (0.002), Storage period = 0.004 (0.004), Interaction = 0.005 (0.005)

* Value in the parenthesis are the data after ripening under ambient conditions.

The acidity was 0.163% initially which decreased to 0.117% at 5 days of storage at 10 °C and then rose to 0.181% at 10 days. After ripening, it was 0.355% in both the samples. On 20th day, the acidity of fruits at 10°C did not increase, while at 15 °C it rose to 0.562% (Table 3). Olorunda *et al.* (6) reported that in case of very severe chilling injury, the banana pulp may remain hard, acidic and astringent.

Table 4. Effect of different storage temperatures on total sugars (%) of Pachanadan banana.

Storage temp.	Storage Period (days)					
(°C)	Initial	5	10	15	20	25
10	0.56	0.92	1.04	1.24	1.76	18.00
15	0.56	1.03	1.17	1.36	19.60	20.53
Mean	0.56	0.98	1.11	1.30	10.68	19.27
CD at 5% Treatment = 0.104, Storage Period = 0.182, Interaction = 0.257						

Table 5. Effect of different storage temperatures on starch (%) content of Pachanadan banana.

Storage temp.	Storage Period (days)					
(°C)	Initial	5	10	15	20	25
10	27.20	25.53	23.20	19.46	17.13	1.64
15	27.20	24.33	20.00	17.60	1.56	0.24
Mean	27.20	24.93	21.60	18.53	9.35	0.94
CD at 5% Treatment = 0.092 Storage Period = 0.159 Interaction = 0.226						

The total sugars were 0.56% initially which increased to 1.24% on 15th day at 10 °C and 1.36% at 15 °C. On 20th day it rose to 1.76% at 10 °C and 19.60% at 15 °C (Table 4). The starch content was 27.20% initially which decreased to 17.13% in fruits at 10°C, while it was 1.56% at 15 °C after 20 days of storage (Table 5). This trend clearly indicated that the conversion of starch to sugars was retarded in fruits at 10 °C due to impaired ripening. Narayana and Singh (4) also observed similar changes as higher starch and lower total sugar contents in chill injured mango fruits. From this study, it was concluded that chilling injury development is a function of temperature and duration of storage and Pachanadan banana variety was susceptible to CI by 15th day when stored at 10°C and beyond 25 days when stored at 15 °C without any packaging.

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