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RIPENING OF DASHEHARI MANGO WITH ETHEPHON AND CALCIUM CARBIDE

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ABSTRACT
Cardboard boxes containing mango fruits were packed with calcium carbide@ 1, 2, 3g/kg in a small newspaper pouch and for ethephon solution, fruits were dipped in 250, 500 and 1000 ppm aqueous solution for 10 minutes. Decay loss was observed on 8th and 10th day of storage in all the treatments. Total soluble solids (TSS) increased with increase in period of storage up to 4th and 6th day of storage respectively in all the treatments and decreased thereafter whereas acidity and ascorbic acid decreased with increase in the period of storage in all the treatments. Fruits treated with calcium carbide@3g/kg had higher physiological loss in weight (PLW) (34.3%), decay loss (12.5%) and TSS (10.6°Brix) and fruits ripened with ethephon@ 250ppm had lowest PLW (24.7%), decay loss (5.4%) and TSS (9.6°Brix) at the end of storage. Ascorbic acid was minimum in calcium carbide treated fruits@3g/kg (16.5mg/100g) whereas fruits ripened with ethephon@250ppm had maximum ascorbic acid content (21.3mg/100g) on 10th day of storage. Control fruits had high acidity content (0.313%) whereas minimum acidity content was recorded in calcium carbide treated fruits (0.213%) at the end of storage. Fruits ripened with ethephon @ 250 ppm showed better ripening and sensory qualities.

INTRODUCTION

Rapid ripening process of mango fruits after harvest is also responsible for shorter shelf life which is a major constriction for efficient handling and transportation (Jawandha *et al*., 2013) as a result producer gets lower return. The bulk of the mango produced is generally consumed as fresh fruit in ripe form. Ripening is a physiological process which makes the fruit edible, palatable and nutritious (Wills *et al*., 2007). Ethylene is one of the natural ripening hormones which is responsible for accelerating the normal process of maturation, senescence and ripening. The use of ethylene gas helps in achieving faster and more uniform ripening of fruits (Kader, 2002). Ethylene gas is commercially applied in the form of liquid i.e. Ethephon. In case of ethephon, the ripening is slightly cumbersome, the fruit sellers have to either dip the fruits in a solution or pass through fumes of this chemical (Siddiqui and Dhua, 2009; Kulkarni *et al*., 2004). Mohamed and Abu Goukh (2003) reported that ethylene released from ethephon was more effective in triggering ripening of fruits. Unsaturated hydrocarbons, particularly acetylene etc. can also promote ripening and induce color changes effectively (Siddiqui and Dhua, 2009). Commercially, this acetylene gas is produced from cheap chemical, calcium carbide. Calcium carbide has carcinogenic properties and is used in gas welding (Rahman *et al*., 2008). Recent findings related to carbide poisoning have reported headache, dizziness, mood disturbance, sleepiness, mental confusion, memory loss, cerebral oedema and seizure (Per *et al*., 2007).

Mango (*Mangifera indica* L.), a tropical fruit, belongs to family Anacardiaceae. It is considered to be best of all indigenous fruits and acknowledged as "King of Indian fruits". It belongs to genus *Mangifera*. Mango is one of the most important and choicest fruit crop in India having a great cultural, socioeconomic and religious significance since ancient times (Netravati *et al*., 2015). Dashehari is leading cultivar of North India and its fruit is harvested during summer season when ambient temperature is high that rapidly deteriorates the quality of produce. Mango is one of the most extensively exploited fruit because of its flavor, fragrance and juice content. It is a good source of fiber, sugars, vitamins and minerals along with anti-oxidants. Thus the fruits ripened with calcium carbide are usually insipid and losing its natural taste. Therefore, a detailed study on this aspect was undertaken to compare the ripening changes caused by ethephon and calcium carbide in Dashehari mangoes.

MATERIALS AND METHODS

Present investigations were carried out in post harvest laboratory of the Department of Horticulture, CCSHAU, Hisar. Mango fruits cv. Dashehari of uniform size, color and free from blemishes were harvested at green mature stage from the orchard of the Horticulture department with the help of secateurs keeping small intact pedicel with each fruit. Fruits were packed in cardboard boxes with newspaper as cushioning material. Each box was packed with calcium carbide@ 1, 2, 3g/kg in a small newspaper pouch which was kept in the cardboard box in the centre. For ethephon solution, fruits were dipped in 250, 500 and 1000 ppm aqueous solution for 10 minutes and then fruits were air dried before packing in cardboard boxes. Each box was treated as one replicate and all the treatments were replicated four times. Fruits were stored at room temperature (40 ± 4ºC). Three fruits at random were taken from fourth replication for analysis of quality parameters such as total soluble solids, acidity, ascorbic acid etc. Physio-chemical analysis of fruits was done at alternate days of storage. PLW was calculated by subtracting final weight of fruits from initial weight of the fruits in the package and then expressed as percent weight loss with reference to the initial weight (Srivastava and Tandon 1968.). Specific gravity was calculated by water displacement method. Acidity content was estimated by titrating juice of fruits against 0.1 N NaOH solution using phenolphthalein as an indicator (AOAC 1980).The percent decay loss was estimated by the method of Srivastava and Tandon (1968). Total soluble solids in fruits were recorded by using Abbe's hand refractometer. Ascorbic acid was determined by the titration method of AOAC (1990). Factorial CRD design was used for statistical analysis. Significance was tested at 5% level of critical differences (CD).

RESULTS AND DISCUSSION

Data depicted in Table 1 indicated that PLW increased with increase in period of storage in all the treatments. Higher PLW in all the treatments was due to enhanced rate of various physiological and degradative processes. On 2nd day of storage, the minimum physiological loss in weight was observed in water dipped fruits (4.2%) followed by controlled fruits without water dipping (4.4%) whereas maximum physiological loss in weight was observed in calcium carbide treated fruits @ 3g/kg (5.6%) followed by ethephon treated fruits @ 250 ppm (5.1%) however calcium carbide treated fruits @ 1g/kg and 2g/kg also showed higher physiological loss in weight (4.9%). On 4th day, the maximum physiological loss in weight was observed in the fruits treated with calcium carbide @ 3g/kg (11.0%) and minimum physiological loss in weight was observed in water dipped fruits (9.3%). On 6th day of storage, the similar trend was observed with minimum loss in control and water dipped fruits (15.4%) and maximum loss in the fruits treated with calcium carbide @ 3g/kg (17.1%). On 8th day of storage, maximum physiological loss in weight was observed in calcium carbide treated fruits @ 3g/kg (23.2%) whereas minimum physiological loss in weight was observed in ethephon treated fruits @ 250 ppm (20.6%). On 10th day of storage, water dipped fruits showed maximum physiological loss in weight (35.5%) whereas minimum physiological loss in weight was observed in ethephon treated fruits @ 250 ppm (24.7%). These results of increase in physiological loss in weight with water dipping are also in conformity with the findings of Thangraj and Irulapan (1988). However higher concentration of ethephon i.e. 500 and 1000 ppm enhanced the physiological loss in weight to 28.2% and 30.1%, respectively.

No decay loss was observed up to 6th day of storage in all the treatments (Table 1). The various micro flora could not rupture the fruit surface that's why there was no decay loss up to 6th day of storage. The fruits treated with calcium carbide had the maximum decay loss on 8th and 10th day of storage followed

Table 1: Physiological loss in weight (%) and decay loss (%) of Mango cv. Dashehari as affected by ethephon and calcium carbide (CaC_2)

Treatments	Physiological loss in weight (%) Period of storage (D)					Decay loss (%) Period of storage (D)	
(T)	2	4	6	8	10	8	10
CaC_2 @ 1g/kg	4.9	10	16	20.7	31.3	4.9	6.6
CaC_2 @ 2g/kg	4.9	10	15.6	21.3	27.3	6.5	8
CaC_2 @ 3g/kg	5.6	11	17.1	23.2	34.3	8.3	12.5
Ethephon @250ppm	5.1	10.8	16.4	20.6	24.7	3.8	5.4
Ethephon @500ppm	4.6	10.1	16.3	22.2	28.2	4.7	6.2
Ethephon @1000ppm	5	10.5	16.7	22.9	30.1	8.1	8.5
Control	4.4	9.5	15.4	20.8	29.6	4.7	5.3
Water dipped	4.2	9.3	15.4	21.3	35.5	6	6.7
CD at 5%	0.5	0.5	0.7	1.1	1.2	0.5	1

Table 2 :Total soluble solids (⁰Brix) and acidity (%) of Mango cv. Dashehari as affected by ethephon and calcium carbide (CaC_2)

Treatments	Total soluble solids (⁰Brix) Period of storage (D)							Acidity (%) Period of storage (D)						
(T)	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
CaC_2 @ 1g/kg	8.8	9.3	9.8	11.8	11.7	10.3	10.4	1.641	0.762	0.381	0.36	0.28	0.263	0.613
CaC_2 @ 2g/kg	8.8	10.3	11.1	12	11.1	10.5	10.5	1.641	0.652	0.351	0.331	0.232	0.232	0.571
CaC_2 @ 3g/kg	8.8	11.3	12.2	12.3	11.5	10.6	10.6	1.641	0.641	0.342	0.293	0.223	0.213	0.562
Ethephon @250ppm	8.8	9.4	10.3	10.3	10	9.6	9.7	1.641	0.711	0.441	0.38	0.29	0.27	0.623
Ethephon@500ppm	8.8	10.3	10.4	10.2	10.2	10	10	1.641	0.831	0.402	0.341	0.291	0.26	0.631
Ethephon@1000ppm	8.8	10.1	10.4	10.3	10.2	10.1	9.9	1.641	0.892	0.381	0.341	0.251	0.252	0.632
Control	8.8	9.4	10.1	10.2	9.8	10.5	9.8	1.641	0.721	0.57	0.39	0.35	0.313	0.631
Water dipped	8.8	9.6	11.2	11.3	10.6	10.2	10.3	1.641	0.661	0.42	0.372	0.36	0.323	0.632
Mean	8.8	9.9	10.5	11.1	10.5	10.4		1.641	0.731	0.401	0.352	0.291	0.27	
SE(m)	T= 0.2		D = 0.1		TxD = 0.2			T= 0.006		D = 0.006		TxD = 0.016		
CD at 5%	T = 0.3		D = 0.2		TxD = 0.6			T = 0.017		D = 0.019		TxD = 0.047		

Table 3: Ascorbic acid and specific gravity of Mango cv. Dashehari as affected by ethephon and calcium carbide (CaC_2)

Treatments(T)	Ascorbic acid (mg/100g) Period of storage (D)							Specific gravity Period of storage (D)						
	0	2	4	6	8	10	Mean	0	2	4	6	8	10	Mean
CaC_2 @ 1g/kg	31.0	24.0	19.8	18.7	18.4	18.3	21.6	1.13	1.01	1.01	1.00	0.91	0.90	0.98
CaC_2 @ 2g/kg	31.0	22.0	18.0	17.1	16.9	16.7	20.2	1.13	0.98	1.01	1.00	0.95	0.91	0.10
CaC_2 @ 3g/kg	31.0	20.3	17.3	16.8	16.7	16.5	19.6	1.13	0.98	0.97	0.97	0.94	0.93	0.99
Ethephon@250ppm	31.0	26.3	24.6	22.5	21.7	21.3	24.5	1.13	0.94	1.06	0.96	0.94	0.92	0.99
Ethephon @500ppm	31.0	25.8	22.6	21.0	20.1	20.1	23.4	1.13	1.02	1.01	1.00	0.99	0.95	1.02
Ethephon@1000ppm	31.0	23.5	20.0	19.8	19.4	19.3	22.4	1.13	0.98	0.96	0.94	0.92	0.91	0.98
Control	31.0	27.3	23.0	20.0	19.3	18.0	23.1	1.13	0.98	0.97	0.96	0.92	0.91	0.99
Water dipped	31.0	25.0	22.6	21.5	20.6	20.0	23.5	1.13	0.96	1.01	0.94	0.94	0.90	0.99
Mean	31.0	24.3	20.9	19.7	19.1	18.8		1.13	0.98	0.98	0.97	0.95	0.92	
SE(m)	T = 0.3		D = 0.3		TxD = 0.6			T = 0.01		D = 0.01		TxD = 0.01		
CD at 5%	T = 0.6		D = 0.7		TxD = 0.4			T = N.S.		D = 0.03		TxD = N.S.		

by ethephon treated fruits @1000 ppm. The fruits ripened with calcium carbide enhanced the metabolic processes which enhanced the ripening process of the fruits resulting in softening of fruits. These results are confirmatory with those obtained by and Chikkasubanna and Huddar (1982) and Ashwani and Dhawan (1995) in mango.

The total soluble solid content of fruits increased up to 6th day and decreased on 8th and 10th day of storage (Table 2). The increase in TSS with the advancement of storage period might be due to conversion of reserved starch and other polysaccharides into soluble form of sugar (Gohlani and Bisen, 2012). However on 8th day of storage, these substances might have been utilized in metabolic processes as a result of which content of total soluble solid decreased. Decrease in total soluble solid content during later stages has also been reported in mango by Gill *et al.* (2015) and Kittur *et al.* (2001). Among the different treatments, the maximum total soluble solids were observed in fruits treated with calcium carbide@3g/kg (10.6°Brix) followed by calcium carbide @ 2g/kg (10.5°Brix) and calcium carbide @ 1g/kg (10.4°Brix). Water dipped fruits have higher content of total soluble solids as compared to control fruits whereas minimum total soluble solids were observed in fruits treated with ethephon @ 250 ppm (9.7°Brix), when considered irrespective of period of storage. Among the interaction, maximum total soluble solids (12.3°Brix) were observed in calcium carbide treated fruits @3g/kg on 6th day of storage whereas minimum total soluble solids were observed on initial (0) day of storage (8.8°Brix). Among the different chemicals, the calcium carbide treated fruits had highest total soluble solid content. This may be due to the reason that calcium carbide might have enhanced the metabolic processes responsible for conversion of insoluble substances into soluble substances whereas the control fruits had minimum total soluble solid content because the rate of various matabolic processes was slow in these fruits. So the conversion of insoluble substances into soluble substances was at slower pace. These results are also in conformity with the findings of Ghosh *et al.* (1985).

No significant decrease was observed in specific gravity among the fruits treated with different treatments (Table 3). Among the interaction, maximum decrease in specific gravity was observed in fruits ripened with ethephon @ 250 ppm, control and calcium carbide treated fruits @ 2g/kg (0.91) on 10th day of storage whereas minimum decrease in specific was observed in fruits ripened with ethephon @ 500 ppm (0.95) on 10th day of storage. Similar results of decrease in specific gravity during storage have also been reported by Kulkarni *et al.* (2004).

Acidity content of fruits decreased with increase in the period of storage (Table 2). This is obvious because various acids were utilized in the process of ripening. Similar results of decrease in acidity have also been reported by Singh *et al.* (2013b) in mango. The decrease in acidity content during ripening was slow in water dipped and control fruits whereas the acidity content decreased at faster rate in calcium carbide treated fruits exhibiting accelerated ripening of calcium carbide treated fruits over control. Similar observations were also reported by Bhullar (1982) and Nagaraj *et al.* (1984). Ethephon treated fruits had slow decrease in acidity content as compared to fruits ripened with calcium carbide. This may be due to the reason that the process of ripening was slower in the fruits ripened with ethephon as compared to calcium carbide. Similar trend of decrease in acidity content have also been reported by Kulkarni *et al.* (2004) in mango. Ascorbic acid content of mango fruits decreased with increase in the period of storage in all the treatments (Table 3). The decreasing trend in ascorbic acid content in aonla during storage is also reported which could be attributed to the rapid conversion of L-ascorbic acid into dehydro-ascorbic acid in presence of ascorbic acid oxidase enzyme (Nayak *et al.*, 2011). Among different treatments, maximum decrease in ascorbic acid was observed in fruits treated with calcium carbide@3g/kg (19.6mg/100g) followed by calcium carbide@2g/kg (20.2mg/100g). Similar results of decrease in ascorbic acid have also been observed by Ghosh *et al.* (1985) in mango. Ethephon treated fruits also showed significant loss in ascorbic acid content however this decrease was slow as compared to calcium carbide. This is obvious as calcium carbide increased all metabolic processes faster than ethephon.

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