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EFFECT OF EHTYLENE AND CALCIUM CARBIDE ON RIPENING OF MANGO (*MANGIFERA INDICA* L.) DURING STORAGE AT AMBIENT TEMPERATURE

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ABSTRACT

Mature green fruits of mango cv. Dashehari were subjected to various prestorage treatments viz., ethephon @ 250 ppm, 500ppm and 1000ppm, calcium carbide @1g/kg, 2g/kg and 3g/kg and water dipped for 10 minutes. The fruits were surface dried and placed in cardboard boxes stored in ambient conditions. Total sugars and reducing sugars increased with increase in period of storage up to 4th and 6th day of storage respectively, in all the treatments and decreased thereafter whereas cellulose and pectin decreased with increase in the period of storage in all the treatments. Among the different treatments, calcium carbide @ 3g/kg had highest total as well as reducing sugars (10.0% and 2.9%, respectively) whereas control fruits had lowest reducing as well as reducing sugars (8.4% and 2.5%, respectively) at the end of the storage. Pectin and cellulose content was maximum in control fruits (0.61% and 0.90%, respectively) whereas fruits treated with calcium carbide @ 3g/kg showed minimum pectin and cellulose (0.41% and 0.52%, respectively) content during storage.

INTRODUCTION

Ripening of fruit generally is not completed on the tree because natural ripening is a long process. Ethylene is one of the natural ripening hormones. Ethylene gas is commercially applied in the form of liquid i.e. Ethephon. Mohamed and Abu Goukh (2003) reported that ethylene released from ethephon was more effective in triggering ripening of fruits. Ripening of green mangoes was accelerated by 2-chloroethyl phosphonic acid (ethephon). The benefits of ethylene-induced ripening were recently reported for "Ataulfo" mangoes (Montalvo *et al*., 2007). Ethephon releases ethylene gas, which naturally facilitates the ripening of fruits without any harmful effects (Sudhakar, 2006).

Unsaturated hydrocarbons, particularly acetylene etc. can also promote ripening. Calcium carbide produces acetylene gas which is an analogue of ethylene and quickens the ripening process. This method of ripening by calcium carbide is used in most of the climacteric fruits (fruits which are picked when mature & ripened off the tree i.e. only after harvesting) like mango and banana (Siddiqui and Dhua, 2009). Calcium carbide has carcinogenic properties and is used in gas welding (Rahman *et al.,* 2008). Acetylene gas released from calcium carbide may affect the neurological system including prolonged hypoxia (Lewis Sr, 2004).

Mango (*Mangifera indica* L.) is one of the most important and choicest fruit crop in India (Gill *et al*., 2015) . It is having a great cultural, socio- economic and religious significance since ancient times (Netravati *et al*., 2015). Owing to its origin in Indo-Burma (Myanmar) region, possessing delicious fruit quality with richness in vitamins and minerals, accessibility to common man, liking by the masses and coverage of large area under cultivation ranging from near coastal areas to the Himalayan foot hills, mango has assigned the status of the 'King of the fruits' in India. Mango being a climacteric fruit, often harvested at the mature, hard green pre-climacteric stage which undergoes numerous biochemical changes during ripening within 9-12 days at ambient temperature (Anju *et al*., 2014). The colour change of mango is a reliable parameter to determine the extent of fruit ripening (Ninio *et al.,* 2003) and is beneficial in assessing the extent of ripening. The present study was undertaken to compare the effect of ethephon and calcium carbide on the ripening of Dashehari mangoes.

MATERIALS AND METHODS

The mature fruits of mango cv. Dashehari of uniform size and free from any external defects were harvested early in the morning from the orchard of the Horticulture department, CCS HAU, Hisar. 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 ambient temperature. Biochemical analysis of fruits was done at 0, 2, 4, 6, 8 and

10th day of storage. Three fruits at random were taken from fourth replication for analysis of quality parameters such as reducing sugars, total sugars, cellulose etc. Total sugars and reducing sugars were estimated by the method of Hulme and Narain (1931). Water soluble pectin was determined by "calcium pectate method" (Rangana, 1977). Cellulose was estimated by the method of Van Soest (1967).

RESULTS AND DISCUSSION

Reducing sugars in mango fruits (Table 1) increased with increase in the period of storage up to 4th day and decreased from 6th to 10th day of storage. Minimum reducing sugars were observed on the initial (0) day of storage (1.6%) in all the treatments. On 2nd day of storage, reducing sugars increased to 2.9% and then 3.6% on the 4th day of storage whereas on 6th day of storage, this value decreased to 3.4%, 3.1% on the 8th day and 2.7% on 10th day of storage when considered on mean basis irrespective of treatments. Among the interaction, maximum reducing sugars were observed in fruits ripened with calcium carbide @ 3g/kg on the 4th day of storage (4.2%) whereas minimum reducing sugars were observed on the initial (0) day of storage (1.6%). Decrease in reducing sugars from 6th day onwards was might be due to utilization of reducing sugars as respiratory fuel. These results are also in conformity with the results of Doreyappa and Huddar (2001) and Mann and Dhillon (1974) in mango.

Maximum reducing sugars were observed in calcium carbide treated fruits. This might be due to reason that calcium carbide treated fruits had more conversion of starch in to sugars. Similar results have also been reported in mango by Bhullar (1982) and Mann and Dhillon (1974). In control fruits, minimum reducing sugars were observed. This may be because of slow conversion of starch to sugars in control fruits. Similar results were also reported by Bhullar (1982) and Mann and Dhillon (1974).

Minimum total sugars were observed on the initial (0) day of storage (3.8%) in all the treatments (Table 1). Total sugars of fruits increased up to the 4th day of storage and decreased on 6th and 10th day of storage. Among different treatments, maximum total sugars were observed in calcium carbide treated fruits @ 2g/kg (10.0%) whereas control fruits had minimum total sugars at end of the storage (8.4%) at the end of the storage. Similar increase in sugars with increasing period of storage in beginning and decreased in later stage is also reported in Rasthali banana (Singh and Arora, 2000; Babu and Yadav, 2002). Calcium carbide @2g/kg treated fruits had a higher content of total sugars up to 6th day and retained even on 8th and 10th day of storage. This may be due to the reason that in beginning the metabolism was very fast as a result of which more sugars were formed as compared to control fruits however, in later stages these sugars might not been utilized in appropriate amount so higher sugars were retained in calcium carbide treated fruits. Similar results were reported by Kulkarni *et al*. (2004), Krishanamurthy *et al*. (1960), Bhullar (1982) and Sethi (1987).

Maximum decrease in cellulose content (Table 2) was

Table 1: Reducing and total sugars (%) of Mango cv. Dashehari as affected by ethephon and calcium carbide (CaC_2)

Treatments (T)	Reducing sugars (%) Period of storage (D) 0	2	4	6	8	10	Mean	Total sugars (%) Period of storage (D) 0	2	4	6	8	10	Mean
CaC2 @ 1g/kg	1.6	3	3.8	3.6	3.3	2.8	3	3.8	6.5	11.9	11.0	10.0	9.0	8.7
CaC2 @ 2g/kg	1.6	3.3	4.1	3.6	3.1	2.9	3.1	3.8	6.9	12.2	11.5	10.9	10.0	9.2
CaC2 @ 3g/kg	1.6	3.4	4.2	3.3	3	2.7	3.1	3.8	7	12.5	11.4	10.8	9.9	9.2
Ethephon @250ppm	1.6	2.9	3.2	3.3	3.1	2.7	2.8	3.8	6.8	10.9	10.7	10.1	9.3	8.6
Ethephon@500ppm	1.6	3.1	3.8	3.5	3	2.8	2.9	3.8	7	11.3	10.5	9.9	9.2	8.6
Ethephon@1000ppm	1.6	3.2	3.9	3.6	2.8	2.6	2.9	3.8	7.3	11.7	10.6	9.7	9	8.7
Control	1.6	2.1	2.9	3.2	2.9	2.5	2.9	3.8	5.8	9	9.3	8.8	8.4	7.5
Water dipped	1.6	2.2	3.1	3.5	3.1	2.7	2.5	3.8	5.9	9.1	9.3	8.9	8.5	7.6
Mean	1.6	2.9	3.6	3.4	3.1	2.7		3.8	6.6	11	10.5	9.9	9.1	
CD at 5%	T = 0.2	D = 0.1	TxD = 0.2					T = 0.1	D = 0.1	TxD = 0.3				

Table 2: Cellulose (%) and pectin (%) in Mango cv. Dashehari as affected by ethephon and calcium carbide (CaC_2)

Treatments (T)	Cellulose (%) Period of storage (D) 0	2	4	6	8	10	Mean	Pectin (%) Period of storage (D) 0	2	4	6	8	10	Mean
CaC2 @ 1g/kg	2.02	1.8	1.63	0.9	0.7	0.62	1.28	1.89	1.86	1.37	0.85	0.49	0.48	1.16
CaC2 @ 2g/kg	2.02	1.71	1.42	0.8	0.61	0.7	1.23	1.89	1.87	1.32	0.84	0.46	0.42	1.13
CaC2 @ 3g/kg	2.02	1.61	1.33	0.71	0.61	0.52	1.13	1.89	1.86	1.3	0.79	0.42	0.41	1.11
Ethephon @250ppm	2.02	1.9	1.41	1.1	0.9	0.71	1.34	1.89	1.85	1.44	0.9	0.64	0.59	1.22
Ethephon@500ppm	2.02	1.81	1.23	1.02	0.81	0.7	1.26	1.89	1.85	1.41	0.86	0.62	0.6	1.2
Ethephon@1000ppm	2.02	1.71	1.03	0.9	0.8	0.62	1.18	1.89	1.83	1.4	0.87	0.61	0.59	1.2
Control	2.02	1.9	1.8	1.52	1.12	0.9	1.55	1.89	1.88	1.57	1.02	0.62	0.61	1.26
Water dipped	2.02	1.91	1.62	1.33	1.11	0.81	1.47	1.89	1.87	1.5	1.01	0.59	0.53	1.23
Mean	2.02	1.78	1.43	1.05	0.85	0.71		1.89	1.85	1.41	1.02	0.62	0.53	
CD at 5%	T = 0.03	D = 0.03	TxD = 0.09					T = 0.03	D = 0.01	TxD = 0.03				

observed in fruits ripened with calcium carbide @ 3g/kg (0.52%) on the 10th day of storage whereas minimum decrease in cellulose content was observed in control fruits on 10th day of storage (0.90%). In calcium carbide treated fruits cellulose content showed faster decrease as compared to ethephon treated fruits and control fruits. This may be due to the reason that in fruits ripened with calcium carbide ripening process was found to be fast. All the metabolic activities had gone on faster rate as compared to other fruits. So the enzymatic activities also occurred at faster rate which made the fruit soft earlier than those of fruits ripened with ethephon and control fruits. Similar decrease in cellulose content have also been reported in mango (Yashoda *et al*., 2006), ber (Sharma and Siddiqui, 2004), strawberry (Rosli *et al*., 2004).

Data presented in table 2 shows decrease in pectin content in mango fruits with increase in the period of storage in all the treatments. Among the different treatments, minimum pectin content was observed in fruits treated with calcium carbide @ 3g/kg (1.11%) followed by calcium carbide @ 2g/kg (1.13%) whereas maximum cellulose content was observed in control fruits (1.26%) and water dipped fruits (1.23%) when considered irrespective of period of storage. During ripening, activity of pectin esterase increased which degraded the pectin content and made the fruits soft. Similar decrease in pectin content has also been reported by Tandon and Kalra (1984), Roe and Bruemmer (1981) and Yashoda *et al*. (2006).

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