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Research Paper

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Quality Evaluation of Artificially Ripened Banana under the Influence of Ethylene and its Mode of Application

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A B S T R A C T

A research study was done to find the effective method of banana ripening. The fruits were treated with four doses of Ethephon (200, 400, 600 and 800 ppm), three methods of application (placing cotton dipped Ethephon inside the poly bag, plugging cotton dipped Ethephon at the neck of a poly bag and dipping the fruits in an aqueous Ethephon solution) and one control. The experiment was laid out in a Factorial completely randomized design against other treatments (control). Analysis of data showed that there was significant effect in methods of application over the physiological loss in weight, shelf life, total sugar, reducing sugar, total soluble solids and titratable acidity. Significant difference was also observed in interactions between doses and methods over the fruit firmness, fruit weight, palatability and all chemical characteristics. Fruits treated with 600 ppm gave better total sugar (10.81%), TSS (21.97°Brix) and titratable acidity (0.3%). Among the methods of application fruits that was ripen by released of Ethylene through cotton dipped Ethephon plugged at the neck region of the poly bag gave better shelf life and less weight loss than that of dipping method. The untreated fruits are poor in flavour and quality.

Key words: Banana, Ripening, Ethylene, Storage, Fruit quality

Banana (*Musa paradisiaca* L.) of family Musaceace is the 4th important food crop in the world in terms of gross value. It is produced in the tropical and sub-tropical regions, mostly in developing economies. It is cultivated in 5.00 million hectares with a total production of 103.63 million tonnes worldwide (FAO 2013). In India banana and plantain are generally grown in Tamil Nadu, Kerala, Karnataka, Andhra Pradesh, Maharashtra, Gujarat, Orissa, Bihar, eastern U.P., West Bengal, Assam and North eastern states with considerable socioeconomic and cultural importance. It is the most consumed fruit crop accounting for 36.6% of total fruit production from 11.1% arable area, with a total production of 29.7 million tonnes banana from 0.802 M ha. (NRCB 2015). It takes time for banana if left ripen on the plant and moreover, leads to splitting of fruit peels, uneven ripening which results in poor colour and aroma (Khader 1990). Therefore, artificial ripening is often done in the ripening of the fruit. It can be mainly considered as a commercial strategy to cut down the detrimental losses in transportation. Thus, to further boost the production of this crop, adequate ripening technology needs a great attention. Generally, in the market's banana are ripened by calcium carbide that is prohibited by PFA (2003) due to the fact that it cause health problems. Thereby we need different methods to develop in order to obtain a uniformly ripened fruit with a good quality as well as safe to consume. In this research study, effort was made to study the effect of ethylene and its mode of application on ripening of banana.

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MATERIALS AND METHODS

The experiment entitled "Quality evaluation of artificially ripened banana under the influence of ethylene and its mode of application" was carried out during 2016 at the Laboratory of Department of Crop Improvement Horticulture and Agricultural Botany, Palli Siksha Bhavana, Visva Bharati University, West Bengal. The Banana variety 'Kanthali' was used for the investigations. Treatments consist of four doses of Ethephon 39% SL (D1:200 ppm D2:

400 ppm D3:600 and D4:800 ppm) with three methods of application (M_1: Placing cotton dipped Ethephon inside the poly bag M_2: Plugging cotton dipped Ethephon at the neck of a poly bag and M_3: Dipping the fruits in an aqueous Ethephon solution) and one control. Each treatment was replicated three times in a factorial complete randomized design against control.

The parameters studied were physical characteristics (colour development, physiological loss in weight, fruit firmness, palatability and shelf life) and chemical characteristics (total sugar, reducing sugar, total soluble solids, titratable acidity). The data collected on different characters were subjected to statistical analysis.

RESULTS AND DISCUSSION

Analysis of data showed that different doses of Ethephon had a significant effect over both physical and chemical characteristics as depicted in (Table 1). D_1 (200 ppm) gave minimum physiological loss in weight (17.95%) on 10 DAA and higher shelf life (9.8 days). Application of ethephon causes increase in weight loss in banana during ripening which is likely due to rise in respiration rate of the fruit (Mahajan *et al*. 2008). Higher value of palatability (4.6, 7.7, and 7.3 on the 4 DAA, 7 DAA and 10 DAA respectively) and reducing sugar (2.45% and 8.49% on the 4 DAA and 7 DAA) was recorded in D_2 which is of 400 ppm. Doses of 600 ppm showed higher value of total soluble solids (21.97°Brix) in D_3 followed by D_2 (21.84°Brix). Maximum total sugar (10.81%) in D_3 followed by D_2 (10.65%) on the 10 DAA, maximum titratable acidity was recorded in D_1 in all the three days of observations i.e. 4 DAA (0.24 %), 7DAA (0.29%) and 10 DAA (0.22%). Ethylene is known in promoting the flavour quality and formation of aroma volatile in climacteric fruit (Pratt *et al.* 1969, Medlicott *et al*. 1987, Kulkarni *et al*. 2004, Bangerth *et al*. 2012).

Table 1 Physical and chemical characteristics of banana under different doses of ethephon and its method of application during ripening

Doses	Physical loss in weight (%)				Titratable acidity (%)			
	4 DAA	7 DAA	10 DAA	Methods	4 DAA	7 DAA	10 DAA	Methods
200 ppm	2.79	11.62	17.95	M_1	0.24	0.29	0.22	M_1
400 ppm	3.66	10.17	18.13	M_2	0.22	0.25	0.22	M_2
600 ppm	5.22	9.20	18.55	M_3	0.20	0.23	0.19	M_3
800 ppm	3.94	10.55	21.76	S.Ed (±)	0.19	0.19	0.10	S.Ed (±)
Control	0.30	9.19	12.83		0.201	0.21	0.32	
S.Ed (±)	0.31	0.74	1.28		0.005	0.005	0.005	
	Fruit firmness (Force = kg)				Reducing sugar (%)			
200 ppm	1.79	0.68	0.47	M_1	1.91	5.23	7.55	M_1
400 ppm	1.89	0.84	0.72	M_2	2.45	8.49	7.54	M_2
600 ppm	2.11	0.85	0.53	M_3	1.78	4.88	6.61	M_3
800 ppm	2.42	0.85	0.40	S.Ed (±)	2.45	3.09	5.12	S.Ed (±)
Control	5.28	3.96	3.25		2.04	3.22	2.56	
S.Ed (±)	0.12	0.05	0.06		0.09	0.18	0.16	
	Palatability (n = 10 panelist)				Total sugar (%)			
200 ppm	4.1	7.4	6.1	M_1	4.81	7.76	8.17	M_1
400 ppm	4.6	7.7	7.3	M_2	5.07	10.01	10.65	M_2
600 ppm	4.6	7.1	6.4	M_3	3.69	9.55	10.81	M_3
800 ppm	3.6	7.1	2.7	S.Ed (±)	4.17	6.75	8.57	S.Ed (±)
Control	1	7	6		3.25	4.16	7.14	
S.Ed (±)	0.31	1.20	0.27		0.24	0.27	0.44	
	Total Soluble Solids (°Brix)							
200 ppm	15.01	18.75	20.64	M_1	15.74	20.33	21.62	
400 ppm	15.33	19.19	21.84	M_2	14.78	19.36	21.46	
600 ppm	15.16	19.34	21.97	M_3	14.16	18.91	21.01	
800 ppm	14.08	20.84	21.00	S.Ed (±)	0.44	0.89	0.15	
Control	9.04	12.43	17.53					
S.Ed (±)	0.51	1.03	0.17					

***DAA: days after application**

It was observed that methods of application had a significant effect on the weight loss in fruits, shelf life, total sugar, reducing sugar, total soluble solids and titratable acidity in banana (Table 1). Lesser weight loss was observed in M_2 (9.06%) (released of ethylene through cotton dipped Ethephon placed inside the poly bag) followed by M_1 (11.01%) (released of ethylene through cotton dipped Ethephon plugged at the neck of a poly bag) and more weight loss was recorded in M_3 (11.08%) (dipping method) on 7 DAA and on the 10 DAA there was no significant difference. Maximum shelf life (8.9 days), reducing sugar (7.08%) was observed in M_2, whereas maximum total sugar

(10.44) was recorded in M_3 and total soluble solids (21.62°Brix) in M_1. Similar findings were recorded by Dhall and Singh (2013) where they observed that treatment with ethylene gas gave minimum rotting which means more shelf life than the ones dip in aqueous solutions of ethephon and also the same with Mahajan *et al*. (2008, 2010) (Fig 1).

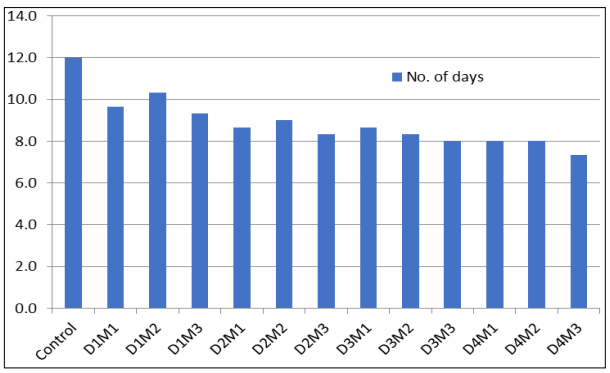

Fig 1 Effect of ripening process on banana shelf life

Among the different treatment combinations, it was observed there was significant effect over the fruit firmness, fruit weight, palatability, total sugar, reducing sugar, total soluble solids and titratable acidity (Table 2). Dose 200 ppm had a better softness and palatability in combination with methods of applications where D_1M_3 (1.65 kg) has the lower fruit firmness at 4 DAA, highest palatability rating was seen in D_1M_2 (8). Doses 400 ppm and 600 ppm gave better chemical characteristics in combinations with methods of application where highest total sugar was seen in D_3M_3 (12.07%) on 10 DAA and D_2M_3 (9.84%) being the highest reducing sugar at 7 DAA. Maximum total soluble solids were observed in D_3M_1 (22.27°Brix) and lowest acidity value was attained in D_4M_3 in all the three days i.e. 4 DAA (0.18%), 7 DAA (0.19%) and 10 DAA (0.13%). It was also observed that there was significant effect between the untreated fruits which was control and the treated ones. Highest fruit firmness, less weight loss and lower palatability and other chemical characteristics was recorded in control ones.

Table 2 Combine effect of different doses of ethephon and methods of application on the physical and chemical parameters of banana during ripening

Treatment	Weight loss (%)			Fruit firmness (force = kg)			Palatability rating (n= 10 panelist)		
	4 DAA	7 DAA	10 DAA	4 DAA	7 DAA	10 DAA	4 DAA	7 DAA	10 DAA
200 PPM M_1	1.79	12.01	15.17	2.01	0.77	0.33	3.7	7.0	5.3
200 PPM M_2	3.75	12.00	18.98	1.71	0.70	0.60	4.0	8.0	6.3
200 PPM M_3	2.85	10.86	19.70	1.65	0.58	0.48	4.7	7.3	6.7
400 PPM M_1	3.38	10.62	17.86	2.23	0.84	0.73	4.0	7.7	7.7
400 PPM M_2	3.71	8.40	18.60	1.74	0.77	0.65	4.3	7.7	7.3
400 PPM M_3	3.89	11.50	17.93	1.70	0.91	0.78	5.3	7.7	7.0
600 PPM M_1	4.66	8.52	19.62	2.21	0.93	0.67	4.7	7.7	6.0
600 PPM M_2	4.85	8.11	15.62	2.04	0.84	0.44	4.3	7.0	7.7
600 PPM M_3	6.15	10.97	20.40	2.08	0.79	0.50	4.7	6.7	5.7
800 PPM M_1	3.41	12.90	21.38	2.17	0.84	0.41	3.7	7.0	3.0
800 PPM M_2	3.12	7.75	21.14	2.73	0.93	0.38	3.3	7.0	2.0
800 PPM M_3	5.29	10.99	22.75	2.37	0.79	0.40	3.7	7.3	3.0
S.Ed (±)	0.53	1.29	2.22	0.21	0.08	0.10	0.54	0.34	0.47

…… *Table 2 Continued*……

Total soluble solids (°brix)			Titratable acidity (%)			Reducing sugar (%)			Total sugar (%)		
4 DAA	7 DAA	10 DAA	4 DAA	7 DAA	10 DAA	4 DAA	7 DAA	10 DAA	4 DAA	7 DAA	10 DAA
15.10	19.32	20.68	0.29	0.30	0.25	1.12	3.87	8.00	5.43	6.46	8.82
15.50	18.10	19.93	0.22	0.29	0.22	2.84	6.38	7.50	5.21	10.23	8.00
14.43	18.83	21.32	0.23	0.28	0.20	1.79	5.45	7.14	3.78	6.60	7.69
15.77	19.70	21.67	0.23	0.27	0.24	1.89	7.40	7.51	3.87	8.21	9.39
15.50	17.37	22.03	0.21	0.25	0.21	3.92	8.22	8.22	7.18	9.07	11.70
14.73	20.50	21.83	0.22	0.23	0.20	1.54	9.84	6.90	4.16	12.77	10.87
15.80	19.93	22.27	0.21	0.25	0.21	1.95	5.27	6.14	2.96	9.54	8.84
14.47	20.80	21.73	0.19	0.23	0.17	2.03	4.94	7.81	4.68	10.03	11.54
15.20	17.30	21.90	0.20	0.21	0.18	1.35	4.44	5.88	3.42	9.09	12.07
16.30	22.37	21.87	0.19	0.19	0.07	2.56	3.20	4.61	4.11	4.84	7.90
13.67	21.17	22.13	0.20	0.20	0.09	1.57	2.60	4.80	3.82	8.82	6.68
12.27	19.00	19.00	0.18	0.19	0.13	3.22	3.48	5.96	4.58	6.60	11.13
0.88	1.79	0.30	0.22	0.29	0.22	0.15	0.31	0.27	0.41	0.46	0.76

*DAA: days after application

It can be concluded that ethylene and its method of application influenced the ripening and quality of banana during storage. The fruits ripen within 5-6 days when treated with ethylene, while it takes more than 8 days in case of untreated ones. Doses of 400 ppm and 600 ppm recorded better flavour, optimum total sugar, reducing sugar, total soluble solids and titratable acidity. Banana fruits that was ripen by released of ethylene through cotton dipped Ethephon plugged at the neck region and placing inside the poly bag gave better shelf life and lesser weight loss.

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