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Effect of Different Packaging Materials on Ripening and Shelf-life of Unripe Mango (*Mangifera indica* L.) Fruits cv. Dashehari

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ABSTRACT

The present investigation was aimed at assessing the effect of packaging material on self-life and quality of mango (*Mangifera indica* L. cv. Dashehari). The experiment was laid out in the completely randomized design with three replications. Each replication was comprised of eight treatments consisting of different packing material viz., newspaper, CFB (corrugated fibre box), tissue paper, banana leaf, gunny bags, sugarcane leaf and paddy straw to induce the shelf life of mango. The different treatment of packing material viz., newspaper, CFB box, tissue paper, banana leaf, gunny bags, sugarcane leaf and paddy straw significantly influenced the morphological and biochemical parameters of mango. The treatment T_2 (CFB box) was found the best treatment as compared to all the treatments and it gave the maximum morphological and biochemical parameters at different storage periods, whereas the minimum morphological and biochemical parameters were recorded in treatment T_0 (Control).

Key words: Physico-chemical, biochemical parameters, corrugated fibre box, storage

INTRODUCTION

Mangifera indica L. belongs to Anacardiaceae family and it is believed that its genus is originated from Indo-Burma region (Singh *et al.*, 2018a). Its fruit is considered as "King" among all the fruits. Globally, India ranks largest producer of mangoes with 24 million tonnes production during the year 2020 (FAO, 2022). India is prominent exporter of fresh mangoes to the world and has exported 27,872.78 MT of the worth of Rs. 327.45 crores/ 44.05 USD millions during the year 2021-22 (APEDA, 2022). However, post-harvest losses in mango at different stages of transportation, storage, wholesale, retail trade, etc. are estimated 25.51% (Ali *et al.*, 2019). After harvest, mango fruit goes under a series of degradative physiological and biochemical changes that occur during ripening, which are initiated by autocatalytic production of ethylene and increase in respiration (Kharwade *et al.*, 2022). The spoilage of fruits can be controlled by reducing the storage temperature 10-15°C cooler than the outside temperature and maintaining about 90% relative humidity.

Packaging is an essential and indispensable component at different steps of post-harvest handling and adopted specially to reduce transportation losses (Singh *et al.*, 2018b). Retail packaging is one of the key strategies for preserving food freshness and quality and reducing food losses (Wikström *et al.*, 2018).The purpose of the present study was to study the effect of packaging material on the shelf life of the unripe mango at ambient condition.

MATERIALS AND METHODS

The present investigation was carried out during May, 2022 at Post-harvest Management Laboratory, School of Agriculture, ITM University, Gwalior. The immature mango fruits (cv. Dashehari) were purchased from the local fruit market Gwalior in a single lot. Further these fruits were sorted for uniform size, disease and injury free. The fruits were

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cleaned with tap water and were left for few minutes to remove the water on the surface. The experiment was laid out in the completely randomized design with three replications. The seven treatments viz., newspaper (T_1), CBF box (T_2), tissue paper (T_3), banana leaf (T_4), gunny bags (T_5), sugarcane leaf (T_6) and paddy straw (T_7) along with control (T_0) were packed and stored in the ambient condition. The data recorded for various parameters were assessed on 2 days interval i.e. 0, 3, 6, 9, 12, 15, 18 and 21 days during the period of experimentation. The fruit weight (g), height (cm) and diameter (cm) were analyzed by using weighing balance and vernier caliper in each treatment, respectively. Specific gravity was analyzed by the ratio of the density of fruit to the density of the water at a specified temperature and expressed as g/cc. The physiological loss in weight (PLW%) was calculated by the per cent weight reduction with respect to initial and final weight following Dahiya and Singh (2018). Decay loss was calculated on weight basis. Weight of decayed fruits included the total weight of fruits decayed up to that date of observation. The per cent decay loss was calculated by using the formula suggested by Singh *et al.* (2018c). The weight was measured by using a laboratory level weighing scale having 0.01 g accuracy. The qualitative parameters viz., pH, titratable acidity (%), TSS (°B), TSS: acid ratio and ascorbic acid (mg/100 g) were analyzed by the methods as suggested by Singh *et al.* (2018d). The results obtained during the investigation were statistically analyzed through analysis of variance at 5% level of significance (Bender, 2020).

RESULTS AND DISCUSSION

The different treatment of packing material viz., newspaper (T_1), CBF box (T_2), tissue paper (T_3), banana leaf (T_4), gunny bags (T_5), sugarcane leaf (T_6) and paddy straw (T_7) and control (T_0) significantly influenced the morphological parameters of mango (Table 1). The treatment T_2 (CFB box) was found the best treatment as compared to all the treatments as the fruits under this packaging have maintained the physical quality attributes (viz., fruit weight, fruit length, fruit width and specific gravity) with the minimum shrinkage at 0, 3, 6, 9, 12, 15, 18 and 21 days after storage (Table 2). However, the minimum fruit weight, fruit length, fruit width, fruit volume and

Table 1. Effect of packaging material on fruit size (length and width) of unripe mango fruits

Treatment	Fruit length (cm)								Fruit width (cm)							
	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
T_0	9.9	9.86	9.84	9.78	9.74	9.7	9.66	9.62	6.60	6.58	6.56	6.5	6.46	6.42	6.38	6.35
T_1	10.43	10.37	10.35	10.29	10.38	10.34	10.28	10.24	7.43	7.41	7.39	7.32	7.28	7.24	7.18	7.14
T_2	10.8	10.78	10.76	10.68	10.64	10.6	10.55	10.51	7.80	7.76	7.74	7.69	7.64	7.6	7.56	7.52
T_3	10.29	10.25	10.23	10.16	10.24	10.2	10.15	10.11	7.29	7.27	7.25	7.19	7.15	7.11	7.04	7
T_4	10.12	10.09	10.07	10.06	10.12	10.08	10.02	9.98	7.00	6.97	6.95	6.91	6.89	6.85	6.85	6.82
T_5	10.62	10.57	10.55	10.48	10.46	10.42	10.35	10.31	7.61	7.56	7.54	7.48	7.45	7.41	7.31	7.27
T_6	9.95	9.91	9.89	9.83	9.85	9.81	9.75	9.71	6.86	6.83	6.81	6.75	6.71	6.67	6.6	6.57
T_7	10.72	10.67	10.65	10.62	10.58	10.54	10.46	10.42	7.72	7.68	7.66	7.58	7.54	7.5	7.44	7.41
S. Em(±)	0.047	0.032	0.043	0.036	0.037	0.031	0.032	0.028	0.057	0.052	0.052	0.045	0.035	0.042	0.036	0.042
C. D. (P=0.05)	0.141	0.095	0.129	0.109	0.112	0.092	0.097	0.083	0.17	0.156	0.155	0.135	0.104	0.126	0.109	0.127

Table 2. Effect of packaging material on fruit weight and specific gravity of unripe mango fruits

Treatment	Fruit weight (g)								Specific gravity (g/cc)							
	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
T_0	260.30	255.81	251.01	239.18	231.98	222.18	212.28	202.18	1.036	1.035	1.034	1.032	1.03	1.025	1.023	1.02
T_1	279.50	278.06	273.26	260.26	253.06	243.26	232.82	222.72	1.04	1.039	1.038	1.037	1.036	1.032	1.03	1.027
T_2	290.30	289.06	284.26	273.23	263.92	254.12	243.15	233.05	1.043	1.042	1.041	1.04	1.039	1.035	1.033	1.03
T_3	272.60	271.66	269.46	256.46	249.41	239.61	229.41	219.31	1.039	1.038	1.038	1.037	1.035	1.03	1.028	1.025
T_4	268.40	266.54	261.74	248.74	241.25	231.45	221.55	211.45	1.038	1.037	1.037	1.035	1.034	1.029	1.026	1.024
T_5	283.30	280.82	276.26	263.03	255.83	246.03	237.13	227.03	1.041	1.04	1.039	1.038	1.037	1.033	1.031	1.028
T_6	264.70	259.04	254.24	241.24	234.04	224.24	214.34	204.24	1.037	1.036	1.036	1.035	1.033	1.028	1.026	1.023
T_7	286.80	285.52	281.24	268.49	261.83	252.03	242.13	232.03	1.042	1.041	1.04	1.039	1.038	1.034	1.032	1.029
S. Em(±)	1.543	1.543	1.291	1.208	1.914	1.202	1.455	1.222	0.001	0.001	0.001	0.001	0.002	0.002	0.001	0.002
C. D. (P=0.05)	4.627	4.625	3.871	3.622	5.74	3.603	4.363	3.663	0.003	0.004	0.003	0.003	0.005	0.006	0.004	0.005

specific gravity were recorded in treatment T_0 (control). It may be due to use of different packing material which reduce the respiration and transpiration rate of the fruits, and ultimately reduce the water loss and fruit weight. The effect of packing material mainly CFB box found most effective for monitoring volume loss during ripening by reducing water loss, respiration and transpiration rate of the fruits by toughness of rind cell and it reduced the weight loss of the fruits and shrivelling of the fruits during ripening (Anmol and Singh, 2020; Singh *et al.*, 2018b).

Among all the treatments, the pH increased significantly, while the declining trend was recorded in acidity content during 21 days of the storage (Table 3). There was a gradual decline in TSS and TSS: acid ratio from 0 day (16.44) to 21st day (33.74) of storage irrespective of treatments was noticed (Table 4). However, statistically non-significant difference was noted for TSS:acid ratio. Among the treatments imposed, at 21st day after storage fruits packaged in CFB box (T_2) maintained the TSS and acidity during storage which was at par with T_7 and was followed by T_1, T_5 and T_3. It was reported that different packaging methods created a semi-permeable film on fruit surface which limited fruit respiratory metabolism and thereby slowed the decline of ascorbic acid (Anmol and Singh, 2020; Kumar *et al.*, 2019).

The declining trend was recorded in ascorbic acid content during 21 days of the storage which could be associated with the breakdown of ascorbic acids in simple sugars by utilizing the water of the fruits resulting in loss of fruit weight (Table 5). However, among the treatments, the fruits packaging in CFB box (T_2) resulted in minimum loss of ascorbic acid and fruit weight. The difference may be due to the variability inefficiency of these packaging materials in minimizing enzymatic activities to reduce breakdown of ascorbic acid and decrease in the physiological loss in weight of fruits and decay or spoilage percentage in fruits (Dahiya and Singh, 2018).

Table 3. Effect of packaging material on biochemical parameters (pH and acidity) of unripe mango fruits

Treatment	pH								Acidity (%)							
	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
T_0	3.78	3.8	3.83	3.86	3.91	3.97	4.03	4.08	0.52	0.50	0.46	0.43	0.4	0.36	0.32	0.29
T_1	3.88	3.9	3.93	3.97	4.02	4.06	4.12	4.15	0.55	0.52	0.49	0.46	0.43	0.39	0.35	0.32
T_2	3.93	3.95	3.98	4.02	4.06	4.1	4.15	4.18	0.58	0.55	0.52	0.48	0.45	0.41	0.37	0.34
T_3	3.87	3.89	3.92	3.95	4	4.05	4.1	4.13	0.54	0.52	0.48	0.45	0.42	0.38	0.34	0.31
T_4	3.84	3.88	3.91	3.94	3.99	4.04	4.09	4.12	0.53	0.51	0.47	0.44	0.41	0.37	0.33	0.31
T_5	3.88	3.91	3.94	3.97	4.03	4.07	4.13	4.16	0.55	0.53	0.49	0.46	0.43	0.39	0.35	0.32
T_6	3.82	3.86	3.89	3.92	3.98	4.02	4.07	4.10	0.53	0.50	0.46	0.44	0.41	0.37	0.33	0.30
T_7	3.9	3.93	3.96	3.99	4.04	4.08	4.14	4.17	0.56	0.54	0.5	0.47	0.44	0.4	0.36	0.33
S. Em(±)	0.014	0.011	0.015	0.015	0.013	0.014	0.013	0.017	0.01	0.011	0.011	0.009	0.007	0.007	0.008	0.01
C. D. (P=0.05)	0.043	0.034	0.045	0.044	0.038	0.041	0.039	0.051	0.031	0.033	0.032	0.027	0.022	0.021	0.025	0.031

Table 4. Effect of packaging material on biochemical parameters (TSS and TSS : Acid ratio) of unripe mango fruits

Treatment	TSS (^{0}Brix)								TSS : Acid ratio							
	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
T_0	8.52	8.79	8.92	9.15	9.21	9.38	9.54	9.67	16.44	17.83	19.61	21.5	23.22	26.16	29.94	33.74
T_1	8.71	8.93	9.2	9.23	9.32	9.57	9.61	9.87	15.95	17.15	18.97	20.25	21.88	24.74	27.71	31.39
T_2	8.81	9.1	9.3	9.3	9.42	9.65	9.7	9.99	15.3	16.49	18.02	19.35	20.9	23.39	26.03	29.35
T_3	8.65	8.92	9.16	9.21	9.31	9.53	9.6	9.86	15.93	17.21	19.14	20.49	22.2	24.95	28.1	31.84
T_4	8.61	8.89	9.03	9.2	9.28	9.47	9.59	9.75	16.27	17.65	19.3	20.95	22.69	25.51	28.97	31.84
T_5	8.76	9.01	9.22	9.25	9.36	9.6	9.66	9.9	15.84	17.07	18.88	20.14	21.8	24.53	27.51	31.01
T_6	8.6	8.86	8.97	9.17	9.26	9.43	9.57	9.72	16.37	17.71	19.32	21.07	22.85	25.66	29.18	32.88
T_7	8.79	9.06	9.25	9.26	9.38	9.62	9.67	9.97	15.65	16.89	18.68	19.86	21.51	24.16	26.99	30.56
S. Em(±)	0.027	0.033	0.027	0.023	0.02	0.018	0.023	0.04	0.287	0.356	0.425	0.44	0.519	0.574	0.783	1.073
C. D. (P=0.05)	0.08	0.099	0.082	0.07	0.059	0.053	0.07	0.12	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

Table 5. Effect of packaging material on PLW and ascorbic acid content of unripe mango fruits

Treatment	Physiological loss in weight (PLW %)							Ascorbic acid (mg/100g)							
	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days	0 Day	3 Days	6 Days	9 Days	12 Days	15 Days	18 Days	21 Days
T_0	1.71	3.56	8.1	10.87	14.63	18.44	22.32	19.5	19.27	19.01	18.67	18.24	17.86	17.45	17.08
T_1	0.49	2.21	6.86	9.44	12.95	16.68	20.3	22.4	22.17	21.91	21.57	21.14	20.76	20.35	19.98
T_2	0.43	2.08	5.88	9.09	12.46	16.25	19.72	24.42	24.19	23.93	23.59	23.16	22.78	22.37	21.44
T_3	0.34	1.14	5.9	8.49	12.09	15.83	19.53	21.49	21.26	21	20.66	20.23	19.85	19.44	19.07
T_4	0.68	2.47	7.32	10.11	13.76	17.44	21.21	20.77	20.54	20.28	19.94	19.51	19.13	18.72	18.35
T_5	0.87	2.48	7.15	9.7	13.16	16.3	19.86	23.54	23.31	23.05	22.71	22.28	21.9	21.49	20.6
T_6	2.13	3.95	8.86	11.58	15.28	19.01	22.84	20.01	19.78	19.52	19.18	18.75	18.37	17.96	17.59
T_7	0.42	1.92	6.37	8.69	12.11	15.56	19.08	23.86	23.63	23.37	23.03	22.6	22.22	21.81	20.9
S. Em(±)	0.119	0.165	0.307	0.181	0.188	0.254	0.262	0.105	0.11	0.115	0.112	0.189	0.195	0.194	0.3
C. D. (P=0.05)	0.357	0.495	0.92	0.544	0.563	0.761	0.786	0.314	0.329	0.346	0.335	0.567	0.586	0.583	0.901

CONCLUSION

The different treatments of packing material viz., newspaper, paddy straw, tissue paper, banana leaf, gunny bags, sugarcane leaf and CFC box significantly influenced the physical, physiological and biochemical parameters of mango fruits during storage. The treatment T_2 (CFB) was found the best treatment as compared to others. The mango fruits packed in CFB showed maximum retention of fruit quality attributes and biochemical parameters including the physiological loss in weight during the storage of fruits under ambient condition.

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