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Effect of Packaging Material on Quality and Storability of Sapota (*Manilkara achras* (Mill.) *Fosberg*) var. Kalipatti

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ABSTRACT

Freshly harvested, well matured sapota fruits of var. Kalipatti were subjected to different post harvest treatments viz., 50µ LDPE (T_1), 75 µ LDPE (T_2), 100 µ LDPE (T_3), and control (T_4) with 3 replications in Factorial CRD design and stored in ambient condition (Temp: minimum 27^0C , maximum 38^0C, and RH: 85-90%). Observations were recorded on physiological loss of weight (%), TSS (^{0}Brix), titratable acidity (%), reducing sugar (%), total sugar (%), TSS: Acid ratio (%), organoleptic quality and physical parameters at three days intervals. The results revealed that sapota var. Kalipatti fruits packed in 100µ LDPE (T_3) proved to be the best treatments followed by 75µ LDPE (T_2) among all the treatments under ambient condition which improves the quality and storability of fruits and also reduced the post–harvest losses without adversely affecting the fruit quality of sapota. As the 100µ LDPE (T_3) shows the lowest PLW (%), lowest titratable acidity (%), and highest TSS (^{0}Brix), reducing sugar (%), total sugar (%), TSS: Acid ratio (%), and Organoleptic quality compare to other treatments. In general, PLW (%) and titratable acidity (%) continuously decreased during storage while, reducing sugar (%) and total sugar (%) increased up to 6th day of storage; there after it steadily decreased during subsequent period of storage. Organoleptic rating revealed superiority of T_3 and T_2 over other treatments while the control fruits were not acceptable on 9th day.

Key words: *Biochemical characters, LDPE bags, organoleptic quality, Storage, Cricket Ball.*

INTRODUCTION

Sapota (*Manilkara achras* (Mill.) Fosberg) is one of the prominent fruits in India and belongs to family Sapotaceae. Sapota is a native of Mexico and Central America and now widely cultivated throughout tropics for its delicious fruits. India is the largest producer of sapota followed by Mexico, Guatemala and Venezuela. In India sapota is grown in about 107 '000 ha, with a production of 1294 '000 MT [1]. A Kalipatti variety of the sapota having oval shape with sweet and mildly fragment was selected for the present study due to its good quality and overall acceptability. Sapota is the highly perishable fruit. It is consumed either table fresh or by processing into products like sapota leather, wine, dried sapota, etc[2]. Sapota is a climacteric fruit and exhibits sudden raise in respiration after harvest[3].

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Shelf life of the sapota fruit deteriorates as soon as the climacteric peak is reached. Sapota suffers from heavy post-harvest losses to the extent of 20-30 per cent in India[4]. Therefore, there is a need to regulate its ripening so as to improve its shelf life. As the sapota has a very short storage life, it needs to be preserved until reaches to the market and food processing plant for further processing. Due to its short shelf-life, in India as much as 30-35 per cent of fruits perish as post harvest losses during harvesting, storage, grading, transportation, packaging and distribution thus incurring a precious loss about Rs. 70,000 crores is in terms of not only revenue but also health as fruits play a vital role in human nutrition[5]. The shelf life of sapota depends on different factors like packaging material and atmospheric temperature. The extension in storage life is possible by checking respiration and microbial activity in the sapota fruit. To fulfill this requirement a study was conducted to see the effect of packaging material on shelf life of sapota fruit.

MATERIALS AND METHODS

The present study was carried out in the laboratory of Department of Post Harvest Technology of Horticultural Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, during the period from May 2016 to June 2016. Well developed fruits of sapota var. Kalipatti are harvested at well mature stage from the well maintained orchard at Amtala, 24 Parganas (South), West Bengal, and fruits free from mechanical damage and blemishes were sorted out.

Sapota fruits after preparation were subjected to different treatments. The treatment consists of T_1=50μLDPE packaging T_2=75μLDPE packaging T_3=100μLDPE packaging T_4=Control (without packaging). Each treatment was replicated three times and each replicate consist of six fruits and the experiment was laid out in Factorial Completely Randomized Design. The treated fruits were stored in cool, dry place on racks at room temperature in the laboratory of post harvest technology of horticultural crops, during the period from May 2016 to June 2016. The maximum and minimum temperature during the period at ambient condition varied from 38.15^{0}C and 27.24^{0}C respectively and relative humidity from 85 to 90% during the period of storage. Observations were recorded on physiological loss in weight, physical parameters, total soluble solids, titratable acidity, sugars (total and reducing sugar), TSS: Acid ratio. Organoleptic evaluation was carried out on the basis of fruit appearance (color), taste and aroma. For determining the physiological loss in weight, fruits were numbered and weighed individually on the day of observation. It was expressed as percentage of the original fresh weights of the fruit. Physical characters of fruits ie., changes in surface colour of fruits from light brown to dark and fruit texture from hard to semi-hard and soft was recorded at different (3) days of storage.

Total soluble solid contents was estimated with a hand refractometer (Erma, Japan) and expressed as ^{0}Brix. Titratable acidity was determined as percentage citric acid according to method described in[6]. Organoleptic evaluation was recorded of physical characters of fruits *viz,* fruit appearance (colour), taste, and flavour by a panel of judges as per "hedonic scale" (1-9 point), which is as follows : extremely desirable (ED)=9, very much desirable (VMD)=8, moderately desirable (MD), slightly desirable (SD)=6 neither desirable (ND) nor undesirable (UD) =5 slightly undesirable (SUD)=4 moderately undesirable (MUD)=3 very much undesirable (VMUD)=2 , and extremely undesirable (EUD)=1, [14]. The analysis of data obtained in experiment was analyzed by Factorial Completely Randomized Design with two factors, i)treatments and ii) storage period by adopting the statistical procedures of Gomez and Gomez[7].

RESULTS AND DISCUSSION

Physiological loss of weight (PLW %) of different treatments during storage of sapota fruits is presented in Table-1. Weight losses increased significantly in all the treatments with increase in storage period. However, the increase had been at a reduced rate in all the treated fruits as compared to control. PLW was significantly different for treatment, duration of storage while treatment × duration interaction was non-significant at 5% level. Mean PLW of treatment during the period of storage up to 9 days was highest (2.207%) in control and lowest (1.286%) in T_3 (100µ LDPE). Irrespective of treatment mean PLW increase significantly with the enhancement of storage duration from 1.099% on 3rd day to 2.109% on 9th day of storage. It was found that throughout the period of storage, PLW was significantly low in T_3 (100µ LDPE) followed by T2 (75µ LDPE), T1 (50µ LDPE). On 9th day of storage the PLW of T_3, T_2 and T_1 were 1.286%, 1.333% and 1.517% respectively compared to 2.207% in T_4 (control) which is highest among all the treatments.

Data related to total soluble solids (TSS 0Brix) of sapota fruits as affected by different packing materials were presented in Table-1. There was a significant raise in TSS of fruits initially from 0th day to 9th day of storage. Initial TSS of fruit i.e. on the day of treatment (0th day of storage) was observed to be 18.2^{o}Brix. Among the treatments highest TSS was recorded in T_3 (100 µ LDPE) (24.634) which was on par with T_2 (75 µ LDPE) (23.10) while lowest TSS was recorded in T_4 (control) (22.245) which was on par with T_1 (50µ LDPE) (22.267). There was a significant raise in the TSS of fruits initially and then declined.

Titrable acidity (%) values of sapota influenced by different packing materials at room temperature were presented in Table –1. There was a significant decline in titrable acidity from 0th day to 9th day of storage on the 0th day of storage titrable acidity was 0.292% while titrable acidity was 0.183% on 9th day of storage. Among the treatments lowest acidity was recorded in T_3 (100 µ LDPE) (0.205%) which was preceded by $_{T2}$ (75 µ LDPE) (0.210) while the highest is recorded in T4 (control) (0.248) which was followed by T_1 (50 µ LDPE) (0.214). further, the interactions between treatments and days of storage were found to be non significant. On all the days of storage highest titrable acidity was recorded by T_4 (control) where as lowest titrable acidity was recorded by T3 (100µ LDPE).

. TSS: Acid ratio as affected by different post harvest treatments during storage are shown in Table -2. There was a significant increase in TSS: Acid ratio at consecutive intervals of storage from 3rd day (83.229) to 9th day (109.035). Among the treatments T_3 (100 µ LDPE) recorded highest (113.646) TSS: Acid ratio whereas T_4 (control) recorded lowest (101.503) TSS: Acid ratio which differed significantly from other treatments.

The results on total sugars of sapota fruits as influenced by different packing materials were presented in Table- 2. There was a significant raise in the total sugars of fruits initially and then declined. The increase in the total sugars was up to 6th day in all the treatments then after 6th days of storage total sugars were decreased. Total sugars of 8.93% were recorded on the day of treatment (0th day of storage). Among all the treatments T_3 (100 µ LDPE) showed highest (11.302) total sugars which on par with T_2 (75 µ LDPE) (10.830) whereas lowest (6.390) total sugars was observed in T_4 (control).

The results on reducing sugars of Sapota fruits as influenced by different packing materials were presented in Table – 2. During storage, reducing sugar gradually increases in 3rd day and 6th day in all the treatments. After 6th days of storage reducing sugar content has been decreased in all the treatments. Among different treatments highest (8.283) reducing sugars was recorded in T_3 (100 µ LDPE) which was on par with T_2 (75 µ LDPE) (7.757) whereas lowest (6.185) reducing sugars was recorded in T_4 (control) which was on par with T_1 (50 µ LDPE) (7.394).

Effect of different packing treatments on organoleptic score (10 point scale) for sapota are presented in Table-3. There was a significant difference in organoleptic score among different treatments.

Highest Organoleptic score was recorded in T_3 (100µ LDPE) (7.566) followed by T_2 (75µ LDPE) (7.114), which on par with T_1 (50µ LDPE) (6.808) while the lowest score was observed in T_4 (control) (5.743). Colour of fruit on 3rd and 9th day of storage has been showed in Fig-(1 &2) which indicated that T_3 is best treatment.

LDPE behave both as moisture and gaseous barrier, preventing water loss (transpiration) and suppressing respiration by CO_2 accumulation and partial depletion of O_2[8]. The delayed ripening of fruits packaged in polyethylene bag can be attributed to slower senescence, respiration and ethylene liberation rate by oxidizing ethylene to ethylene glycol[9] and polygalacturonase activity[10]. Further, it may be due to higher level of carbon-dioxide accumulation in the bag by restricted permeation of oxygen and carbon-dioxide thereby minimizing the rate of respiration. The polyethylene bag acts as a barrier for smooth passage of diffusion of moisture to the atmosphere[11]. Similar results were reported with mango[12] and[13] in papaya.

The physiological loss in weight results mainly due to respiration and transpiration losses and also by other metabolic processes. In the present study, the physiological loss in weight (PLW) of the fruits indicated a gradual and continuous increase during the storage irrespective of treatments and the increase in PLW can be attributed to aforesaid reasons. Loss in weight of sapota fruits during storage was earlier reported by [14, 15, 16, and 17]. However In var. Kalipatti the rate of increase in the PLW was low in T_3 (100µ LDPE) and T2 (75µ LDPE) compared with the other treatments. The low in T_3 (100µ LDPE), T2 (75µ LDPE) and T1 (50µ LDPE) might be due to low rate of transpiration and respiration compared to T4 (control). The physiological loss in weight can be considered as an indication for the progress of ripening in climacteric fruit, higher the PLW, more was the ripening[18].

In the present study under ambient storage the TSS of all the treatments increased up to 9th day and then decreased. Similar results of initial rise and then decline in the TSS contents was reported by[19] in sapota and[20] in mango. The increase in TSS was mainly attributed to the conversion of starch and other polysaccharides into soluble forms of sugars [21, 22, 23]. The subsequent decrease in TSS at the advanced stage is owing to the increased rate of respiration in later stages of storage which is due to its faster utilization in oxidation process through Krebs cycle.

Among different treatments, the fruits packed in 100µ LDPE bag showed less decrease in percent of acidity as compared to unpacked (control) fruits. This may be due to lower respiration rate and delayed ripening because of less ethylene production rate when compared to unpacked (control) fruits. This could be attributed to the conversion of acids into sugars[24] and utilization of organic acids during respiration[25, 22]. Similar decrease in acidity content of sapota fruits with the increase in storage periods was reported earlier by[18, 26, 27]. The reduction in the acidity during storage is probably due to catabolism of citrate and malate and the pace of catabolism increases with the temperature[28]. These findings are in close proximity with the findings of[29, 30] in sapota and[31] in passion fruit.

TSS-Acid ratio of sapota fruits increased continuously throughout the storage period. Though TSS had shown initial increase followed by decrease, the TSS: acid ratio increased. This might be due to that the magnitude of decrease in acidity is more compared to decrease in TSS in the later stages of storage. Similar results obtained by[32, 27] in sapota.

In the present investigation, under ambient storage conditions, the sugars (reducing and total sugar) increased initially and then decreased at the later stages of storage in all the treatments. It was observed that increase in sugars was slow in T_3 (100µ LDPE), T_2 (75µ LDPE) under ambient storage conditions. This might be due to reduced rate of respiration in these treatments. These findings are in close agreement with the findings of [33, 23].There was a gradual increase in total sugar and reducing sugar content which reached its maximum at table ripe stage and thereafter decreased gradually. Similar reports of increase in sugar during initial stages and reduction in further stages of storage was observed by[34] in sapota cv. Pala.

Table 1: Effect of packaging material on PLW (%), TSS (^{0}Brix), Acidity (%) of sapota var. Kalipatti during storage

Treatment	PLW (%)			TSS (^{0}Brix)			Acidity (%)		
	Days			Days			Days		
	3rd	6th	9th	3rd	6th	9th	3rd	6th	9th
T_1(50µ LDPE)	0.974	1.554	2.024	21.06	22.5	23.20	0.237	0.220	0.184
T_2(75µ LDPE)	0.847	1.267	1.884	20.66	23.7	24.90	0.244	0.214	0.174
T_3(100µ LDPE)	0.830	1.230	1.797	22.96	24.8	26.10	0.247	0.207	0.160
T_4(control)	1.747	2.140	2.734	18.60	23.2	24.86	0.280	0.250	0.214
Mean	1.099	1.548	2.109	20.82	23.6	24.77	0.252	0.223	0.183
	T	S	T × S	T	S	T × S	T	S	T × S
S. Em±	0.051	0.044	0.088	0.182	0.15	0.316	0.006	0.005	0.01
CD at 5%	0.149	0.129	NS	0.532	0.46	0.923	0.018	0.015	NS

Table 2: Effect of packaging material on TSS:Acid ratio , Total sugar (%), Reducing sugar (%) of sapota var. Kalipatti during storage

Treatment	TSS:Acid ratio			Total sugar (%)			Reducing sugar (%)		
	Days			Days			Days		
	3rd	6th	9th	3rd	6th	9th	3rd	6th	9th
T_1(50µ LDPE)	76.6	109.1	144.7	10.58	11.3	10.71	6.197	8.280	7.704
T_2(75µ LDPE)	87.7	108.0	136.5	10.55	11.2	10.72	7.057	8.637	7.577
T_3(100µ LDPE)	86.1	109.3	145.4	10.92	11.7	11.21	7.127	9.444	8.277
T_4(control)	82.3	99.45	122.7	10.37	8.79	0.000	5.497	6.877	6.180
Mean	83.2	106.5	137.3	10.60	10.7	8.164	6.470	8.31	7.435
	T	S	T × S	T	S	T × S	T	S	T × S
S. Em±	2.97	2.58	5.15	0.062	0.05	0.108	0.074	0.064	0.128
CD at 5%	8.69	7.53	NS	0.18	0.15	0.316	0.216	0.187	0.374

Table 3: Effect of packaging material on organoleptic evaluation of sapota var. Kalipatti during storage

Treatment	Storage period (days interval)			Mean
	3rd day	6th day	9th day	
T_1(50µ LDPE)	7.21	7.07	6.14	6.808
T_2(75µ LDPE)	7.40	7.15	6.79	7.114
T_3(100µ LDPE)	7.98	7.61	7.11	7.566
T_4(control)	7.05	6.96	3.22	5.743
Mean	7.409	7.197	5.818	6.808
	Treatment	Storage Duration	Treatment × Storage Duration	
S.Em (±)	0.0578	0.0501	0.1002	
C.D at 5 %	0.1689	0.1462	0.292	

CONCLUSION

From the present investigation, in var. Kalipatti, it can be concluded that among the different packaging materials(treatments) stored at ambient conditions the T_3(100µ LDPE) showed the highest Organoleptic score, TSS ,Sugars(total and reducing) and Sugar to Acid ratio and lowest PLW(%) without adversely affecting the quality in compared to other treatments. Therefore among the different packaging materials, 100µ LDPE is advisable compared to other packaging materials for packaging of sapota fruits under study, because of their higher organoleptic score and quality during storage.

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