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Evaluation Of Different Packaging Materials On Bio-Chemical Parameters Of Sapota Fruit Under Controlled Conditions

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Abstract: The investigation was carried out in Horticulture Laboratory in school of Agriculture, Lovely Professional University, Punjab. Sapota fruits cv. Kalipatti were harvested at physiological mature stage. After harvesting, fruits were packed in different types of packaging materials and kept at a temperature range of 10±2ºC. Packaging materials used in this investigation are LDPE (25µ), HDPE (20µ), shrink film (10µ) and cling film (15µ and 23µ). Later, the fruits were examined for the physiological loss in weight (PLW) and bio-chemical properties such as TSS, Titrable acidity, Ascorbic acid, and Sugars. The fruits were kept in controlled temperature and analyzed after 2 days storage interval. The shelf life of fruits was found to be best in the packed fruits, where they lasted for 15 days. In control i.e., without packaging the fruits survived for 9 days only. Among all the packaging materials, shrink film proved to be most effective in maintaining the superior quality of sapota fruits. The mean PLW was the least among all the treatments in Shrink film (2.43%) followed by Cling film of 15µ (2.60%). Maximum mean PLW was found in the control (22.93%). Most of the bio-chemical parameters recorded during investigation were found to be best in shrink film as compared to all other films used for the experimentation.

Keywords: Sapota, Shelf-life, Shrink film, Storage.

1. INTRODUCTION

India ranks 1st in the production of sapota in the world. In India, sapota is commonly known as 'Chikku' and it is cultivated for its fruit. Sapota is cultivated commercially in many states of India such as Gujarat, U.P, W.B, Punjab, Andhra Pradesh and Haryana. As per NHB, 2016, the total area under sapota is around 1,20,740 hec. with total production of 14.57 lakh tonne. Sapota is mainly cultivated in tropical and subtropical climatic conditions. In some countries like Guatemala, Mexico, sapota is grown commercially for the production of 'Chuckle' which is milky latex harvested from the bark of the trees. Chuckle is used as principle agent in chewing gums (Annonymus, 2011). Sapota is highly known for its delicious taste, nutritive value, pleasant aroma and sweet pulp with granular texture. (Mohammad *et. al*., 2014). Sapota is good source of sugar (Bose and Mitra, 1990). Thus, it is used for production of squash, osmodehydrated slices, jellies, and jams (Reddy, 1959; Kumar, P. (2019); Kumar, D., Rameshwar, S. D., & Kumar, P. (2019); Dey, S. R., & Kumar, P. (2019); Kumar et al. (2019); Dey, S. R., & Kumar, P. (2019); Kumar, P., & Pathak, S. (2018); Kumar, P., & Dwivedi, P. (2018); Kumar, P., & Pathak, S. (2018); Kumar et al.,2018; Kumar, P., & Hemantaranjan, A. (2017); Dwivedi, P., & Prasann, K. (2016). Kumar, P.

(2014); Kumar, P. (2013); Kumar et al. (2013); Prasann, K. (2012); Kumar et al. (2011); Kumar et al. (2014).

Kalipatti cv. sapota having oval shape with mild and sweet fragment was chosen for the present examination because of its great quality and acceptability. It can be consumed as table fruit or can be processed for making various products like wine, dry sapota, etc. (Aradhya and Policegourd, 2016). Sapota is highly perishable fruit and climacteric in nature, thus after harvesting it exhibits sudden raise in respiration (Chundawat, 1998). There is excess post-harvest loss in sapota which is around 20-30 percent (Salunkhe and Desai, 1984). And this loss extends to 30-35 percent in India because of improper storage, transportation, packaging, harvesting and distribution (Khurana, and Kanawjia, 2006).

Modified packaging and Controlled atmosphere storage can help in increasing the post-harvest life of fruits (Baldwin *et al*., 1995). Possibly storage life can only be increased by lowering respiration rate and transpiration rate, along with proper check of the microbial infection in fruits. Shelf life of fruits can be increased by using polythene bags and proper ventilation. Kariyanna and Reddy (1993) concluded that shelf life increases because of accumulation of carbon dioxide within cover and its preservation effect. By checking respiration rate and microbial activity, storage life can be extended. Thus, a study was conducted to find the best packaging material for better quality and shelf life of sapota fruit.

2. MATERIALS AND METHODS

The investigation was carried out at horticulture laboratory of Lovely Professional University, Phagwara Punjab, in June, 2017. Physiological mature fruits were harvested from the plants by using secateurs and transported to the Horticulture laboratory, LPU. From the harvested fruits uniform fruits were sorted on basis of physical appearance. Mechanically damaged and blemished fruits were rejected for the investigation. Harvesting was done during the month of June. Harvested fruits were pre-cooled under fan. Then, the fruits were washed under running tap water and kept for drying in shade. After complete drying, fruits were packed in the packaging materials. The packaging films used in this experimentation were purchased from Ludhiana commercial market. The materials include LDPE (25 micron), HDPE (20 micron), Shrink film (10 micron) and Cling film (15 & 23 micron) was used as a packaging material.

This investigation was laid out in Completely Randomized Design (CRD). In each treatment 18 fruits were selected and packed. The packed fruits and unpacked control were kept in the controlled temperature. Observations were taken after 2 days of storage interval up to 18 days.

There are total 6 treatments taken under observation for investigation. Each treatment was replicated three times. Details of treatments are: T_0 (Control), T_1 (LDPE of 25µ), T_2 (HDPE of 20µ), T_3 (Shrink film of 10µ), T_4 (Cling film of 15µ), T_5 (Cling film of 23µ). Randomly selected fruits in each treatment of the experimentation were used for assessing the shelf life and chemical parameters of fruits. The bio-chemical parameters recorded during the investigation are: TSS (Total Soluble Solids) which was evaluated by use of refractometer (Erma, Japan) and expressed as ºBrix, Ascorbic Acid (mg/100g), Titratable acidity (%), Total Sugars, Reducing sugars, Non-reducing sugars, TSS Acid ratio and Sugar Acid. Total sugar and reducing sugar were evaluated by method which was set out by Mazumdar and Majumder (2003). The ascorbic acid and acidity were estimated by a method given by Rangana (1979). The comparisons were made at C.D at 5% level of significance.

3. RESULTS AND DISCUSSION

Maximum mean of TSS was recorded in T_4, which was 19.40%, followed by T_5 (19.10%) and minimum value was recorded in T_0 (7.87%), among treatments. In general, total soluble solids of sapota increases with increasing period of storage but after few days of storage it starts decreasing. Maximum mean TSS (20.00%) was observed on 6th days of storage and minimum (14.32%) TSS was observed on 15th day. Increase in TSS of fruits up to 9th day of storage was correlated with the increase in physiological loss in weight and then started decreasing up to 15th day of storage due to utilization of sugars in respiration. Table 1 represents the Total soluble solids (TSS) of sapota fruits under various treatments. These results are in conformity with the previous findings of Panwar (1980) in ber. This might be due to the lesser PLW and slow conversion of starch into sugars.The findings are in with agreement with the earlier reports of Venkatesha and Reddy (1994) in guava and Meena *et al.* (2009) in ber.

Table 1: Effect of various packaging material on TSS (ºBrix) on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	18.24	21.10	0.00	0.00	0.00	7.87
LDPE of 25µ	17.61	19.44	20.79	18.29	16.28	18.48
HDPE of 20µ	17.79	19.72	20.94	18.04	17.51	18.80
Shrink film of 10µ	17.51	19.57	20.41	18.37	16.40	18.44
Cling film of 15µ	18.10	20.21	21.37	19.23	18.08	19.40
Cling film of 23µ	17.84	19.97	21.12	18.87	17.72	19.10
Mean (Storage duration)	17.84	20.00	17.43	15.47	14.32	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.695		0.346		0.245	
Storage duration	0.634		0.316		0.224	
Treatments x Storage duration	1.553		0.775		0.548	

Maximum mean value of titrable acidity was recorded in T_5 (0.279%) followed by T_1 (0.255%) and minimum value was found in T_0 (0.129%). On 3rd day of storage, maximum value of acidity was 0.283% and minimum was 0.146% on 15th day of storage. On 3rd day of storage, T_0 recorded maximum value 0.350%. While T_3 recorded minimum value of 0.110% on 12th and 15th day of storage. Table-2 represents the values of titrable acidity during storage periods in various packaging materials. Generally, with increase in storage period, titrable acidity of sapota decreases irrespective to packaging materials used. This might be due to the increase in activity of enzyme invertase, which is responsible for the conversion of acid into sugars and due to the utilization of acids in metabolism. Results of titrable acidity are in conformity with reports of Yadav *et al.* (2010) in kinnow, and Damodaran *et al.* (2001) in sapota.

Table 2: Effect of various packaging material on Titrable acidity (%) on sapota var. Kalipatti during storage

Treatments	**After 3**	**After 6**	**After**	**After 12**	**After 15**	**Mean**

(Packaging Materials)	**days**	**days**	**9 days**	**days**	**days**	**(Treatments)**
Control	0.350	0.297	0.00	0.00	0.00	0.129
LDPE of 25µ	0.290	0.273	0.260	0.227	0.227	0.255
HDPE of 20µ	0.300	0.283	0.217	0.170	0.150	0.224
Shrink film of 10µ	0.180	0.140	0.127	0.110	0.110	0.133
Cling film of 15µ	0.240	0.220	0.180	0.170	0.150	0.192
Cling film of 23µ	0.340	0.297	0.270	0.250	0.240	0.279
Mean (Storage duration)	0.283	0.252	0.176	0.154	0.146	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.019		0.009		0.007	
Storage duration	0.017		0.009		0.006	
Treatments x Storage duration	0.042		0.021		0.015	

T_4 recorded the highest mean value (10.52%) of vitamin C, followed by T_2 (10.42%) and T_1 (10.14%) and minimum mean value in T_0 (3.22). In general, vitamin C of sapota decreases with increasing period of storage. Maximum vitamin C (11.76%) value was observed on 3rd day of storage. While on 15th day, minimum value (6.98%) was recorded. The maximum (14.01%) and minimum (7.86%) was recorded on 3rd and 15th of storage respectively. Table-3 represents the values of vitamin C of various treatments under packaging materials. Oxidation and irreversible conversion of L-ascorbic acid content to ascorbic acid content in the presence of enzyme ascorbinase might contribute to the reduction of ascorbic acid content. Higher retention of vitamin C content was observed in fruits wrapped by polyethylene of different thickness as compared to control due to the low physiological loss in weight accompanied by low respiration rate and transpirational losses. These findings are in agreement with those obtained by Venkatesha and Reddy (1994) in guava and Sudha *et al.* (2007) in sapota.

Table 3: Effect of various packaging material on Vitamin C (mg/100 g) on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	8.09	8.06	0.00	0.00	0.00	3.22
LDPE of 25µ	11.82	11.09	10.00	9.16	8.68	10.14
HDPE of 20µ	12.68	12.17	9.70	8.83	8.72	10.42
Shrink film of 10µ	14.01	10.17	9.41	8.49	8.12	10.04
Cling film of 15µ	13.09	12.50	9.67	8.90	8.50	10.52
Cling film of 23µ	10.83	10.83	9.41	9.17	7.86	9.62
Mean (Storage duration)	11.76	10.80	8.03	7.42	6.98	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.644		0.321		0.227	
Storage duration	0.588		0.293		0.207	
Treatments x	1.439		0.718		0.508	

Storage duration			

Maximum mean value (141.34) of TSS:acid ratio was recorded in T_3 followed by T_4 (102.50), while, T_0 recorded the minimum value (24.49). Generally, there is increase in TSS: acid ratio of sapota with increase in storage period, up to 9th days but after that TSS:acid ratio decreases continuously in all the treatments with increasing storage period. Highest TSS:Acid ratio (87.70) was found on 9th days of storage and lowest TSS:Acid ratio (65.71) was found on 3rd day. The ratio of TSS:acid of fruits increases or decreases according to the packaging materials or treatments with increasing period of storage. Table-4 represents the values of TSS:acid ratio of treatments. The increase in TSS: acid ratio with storage period has also been reported by Joubert (1970) in litchi and Navjot (2005) in peach during storage. Minimum TSS:Acid ratio was found in control and maximum TSS:Acid ratio was found in T_3. This might be due to the higher TSS and lower acidity. These findings are in conformity with reports of Hussein *et al*. (2003) in apple.

Table 4: Effect of various packaging material on TSS:Acid ratio on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	52.11	70.33	0.00	0.00	0.00	24.49
LDPE of 25µ	60.73	69.43	79.92	79.49	70.74	72.07
HDPE of 20µ	59.28	68.00	95.18	106.11	109.44	87.60
Shrink film of 10µ	97.29	150.47	150.00	153.00	149.00	141.34
Cling film of 15µ	72.40	87.88	118.68	113.11	120.48	102.50
Cling film of 23µ	52.48	68.83	75.43	72.50	73.84	68.61
Mean (Storage duration)	65.71	85.82	87.70	87.37	87.24	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.694		0.346		0.245	
Storage duration	0.634		0.316		0.224	
Treatments x Storage duration	1.553		0.774		0.548	

Maximum mean value (12.32%) of total sugars was recorded in T_4 which was on par with the value of T5 (12.10%), and T_0 was observed with the minimum mean value (5.22%). Generally, there is increase in total sugars with increase in storage period up to 9 days but after that the total sugar quantity decreases continuously in all the treatments with increasing storage period. Maximum total sugar (13.12%) was observed on 6th day of storage and minimum (8.16%) total sugar was observed on 15th day. Table-5 represents the values of total sugars of different treatments. Total sugars of fruits increased significantly with the increase in storage period up to 9th day of storage due to the conversion of starch into sugars and then started decreasing due to degradative process. These results are in conformity with earlier reports in mango by Upadhyay and Tripathi (1985), in pear by Mohla et al. (2005) and in mango by Periyathambi (2006). The maximum total sugar was observed in T_4, whereas, the minimum total sugar was found in T_0 in different type of wrapping. The fruits wrapped in polyethylene films of different thickness of wrapping retained fewer total sugars as compared to control. This might be correlated with decrease in PLW in polyethylene wrapped fruits as

compared to control fruit. These findings are with reports of Venkatesha and Reddy (1994) in guava.

Table 5: Effect of various packaging material on Total Sugars on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	11.92	14.21	0.00	0.00	0.00	5.22
LDPE of 25µ	10.51	12.58	13.99	11.60	9.47	11.62
HDPE of 20µ	10.88	12.84	14.31	11.41	9.90	11.87
Shrink film of 10µ	10.30	12.76	13.79	11.69	9.53	11.60
Cling film of 15µ	11.24	13.32	14.69	12.24	10.13	12.32
Cling film of 23µ	10.99	13.09	14.48	11.97	9.99	12.10
Mean (Storage duration)	10.98	13.12	11.88	9.81	8.16	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.614		0.306		0.216	
Storage duration	0.560		0.279		0.198	
Treatments x Storage duration	1.373		0.684		0.484	

Maximum mean value (7.52%) was recorded in T_5 which was on par with the value of T_4 (7.49%), while the minimum mean value was recorded in T_0 (3.16%). Generally, with increase of storage period, there is rise in reducing sugars up to 9 days but after that the reducing sugar quantity decreases continuously in all the treatments with increasing storage period. Maximum reducing sugar (8.02%) was observed on 6^{th} days of storage and minimum reducing sugar (4.21%) was observed on 15^{th} day. Table-6 represents the values of reducing sugars of different treatments. Reducing sugars of fruits increased significantly with the increase in storage period up to 9th day of storage due to the conversion of starch into sugars and then started decreasing due to degradative process. The maximum value of reducing sugars was found in T_4, whereas, the minimum value of reducing sugars was found in T_0 in different type of wrapping. The fruits wrapped in polyethylene films of different thickness of wrapping retained fewer reducing sugars as compared to control. This might be correlated with decrease in PLW in polyethylene wrapped fruits as compared to control fruit.

Table 6: Effect of various packaging material on Reducing Sugars on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	7.29	8.57	0.00	0.00	0.00	3.17
LDPE of 25µ	6.77	7.81	8.40	7.82	4.74	7.10
HDPE of 20µ	6.98	7.69	9.04	7.53	4.99	7.10
Shrink film of 10µ	6.31	7.77	8.27	7.61	4.80	6.94
Cling film of 15µ	6.24	8.22	9.36	8.11	5.49	7.49
Cling film of 23µ	7.14	8.10	9.20	7.88	5.31	7.52

Mean (Storage duration)	6.79	8.02	7.38	6.50	4.21	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.144		0.072		0.051	
Storage duration	0.131		0.065		0.046	
Treatments x Storage duration	0.321		0.160		0.113	

Maximum mean value was recorded in T_4 (4.83%) followed by T_3 (4.64%) and minimum mean value in T_0 (2.06%). In general, non-reducing sugar of sapota increases with increasing period of storage up to 9th days but after that the non-reducing sugar quantity decreases continuously in all the treatments with increasing storage period. Maximum non-reducing sugar (5.10%) was recorded on 6th day of storage. While minimum value was recorded was 3.31% on 12th day of storage. Generally, there is rise in non-reducing sugars with increase in storage period up to 9 days, and later it starts to decrease. Table-7 represents the values of non-reducing sugars of different treatments. The non-reducing sugar content of fruits decreased with increasing period of storage in all treatments up to 15th day of storage. This can be because of conversion of non-reducing sugar into reducing sugar. Minimum non-reducing sugar was recorded in control and the maximum non-reducing sugar was recorded in T_4 on 9th day of storage.

Table 7: Effect of various packaging material on Non-reducing Sugars on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	4.64	5.66	0.00	0.00	0.00	2.06
LDPE of 25µ	3.76	4.77	5.60	3.79	4.72	4.52
HDPE of 20µ	3.90	5.17	5.28	3.89	4.91	4.62
Shrink film of 10µ	3.90	5.00	5.52	4.08	4.73	4.64
Cling film of 15µ	5.00	5.10	5.32	4.10	4.66	4.83
Cling film of 23µ	3.84	5.00	5.39	4.10	4.68	4.60
Mean (Storage duration)	4.16	5.10	4.51	3.31	3.94	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.070		0.035		0.025	
Storage duration	0.064		0.032		0.023	
Treatments x Storage duration	0.156		0.078		0.055	

Maximum mean value (88.86) was found in T_3, and minimum value was recorded in T_0 (16.29) In general, sugar: acid ratio of sapota increases with increasing period of storage up to 9th days but after that the sugar:acid ratio decreases continuously in all the treatments with increasing storage period. Maximum sugar:acid ratio (59.50) was found on 9th day of storage, while minimum value (40.17) was recorded on 3rd day of storage. Generally, with increase in storage period, sugar-acid ratio of sapota increases up to 9th day after that decreases, irrespective of packaging material used. Table-7 represents the values of Sugar-acid ratio of different treatments. The total sugar present in the fruit maintained the quantity of simple sugar due to this the ratio increase or decrease during the period of storage with respect to

acid quantity (ChitraMani & Kumar, P. (2020); Sharma, M., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020); Naik, M., & Kumar, P. (2020); Kumar, P., & Naik, M. (2020); Kumar, P., & Dwivedi, P. (2020); Devi, P., & Kumar, P. (2020); Kumari, P., & Kumar, P. (2020); Kaur, S., & Kumar, P. (2020); Devi, P., & Kumar, P. (2020); Sharma, K., & Kumar, P. (2020); Kumar, S. B. P. (2020); Devi, P., & Kumar, P. (2020); Chand, J., & Kumar, P. (2020).

Table 8: Effect of various packaging material on Sugar:Acid ratio on sapota var. Kalipatti during storage

Treatments (Packaging Materials)	**After 3 days**	**After 6 days**	**After 9 days**	**After 12 days**	**After 15 days**	**Mean (Treatments)**
Control	34.07	47.38	0.00	0.00	0.00	16.29
LDPE of 25µ	36.24	44.90	53.78	50.43	41.13	45.30
HDPE of 20µ	36.23	44.29	65.04	67.12	61.81	54.90
Shrink film of 10µ	57.22	98.08	105.00	97.33	86.64	88.86
Cling film of 15µ	44.97	57.91	81.57	72.00	67.53	64.80
Cling film of 23µ	32.30	45.10	51.69	46.00	41.59	43.33
Mean (Storage duration)	40.17	56.28	59.50	55.49	49.79	
Factors	**C.D. at 5%**		**SE(d)**		**SE(m)**	
Treatments	0.695		0.346		0.245	
Storage duration	0.634		0.316		0.224	
Treatments x Storage duration	1.553		0.775		0.548	

4. CONCLUSION

From this investigation in sapota cv. Kalipatti, it can be concluded that the various packaging materials used for storing fruits at controlled conditions, T_3 (shrink film) has reported the best results in terms of shelf life and the quality. Shrink film reported with the lowest mean PLW (%) among all the treatments. The bio-chemical parameters such as TSS, Acidity, Vitamin C, and sugars were found to be best as compared with all other packaging materials. Highest Sugar:Acid ratio and TSS:Acid ratio was observed in T_3. Therefore, among all the packaging materials, Shrink Film is advisable for packaging of sapota fruits.

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