Biological Forum – An International Journal **13(4): 857-865(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Post Harvest Effect of Chemicals, Hormones along with Organic Coatings on Prolonging Storability and Biochemical Constituents of Sugar Apple (*Annona squamosa* L.)

Abhay Bisen[1*], Shwati Pardhi[2] and Rahul Dongre[3]
[1]Assistant Professor, Department of Horticulture,
College of Agriculture and Research Station, Korba, IGKV-495445, (Chhattisgarh), India.
[2]SMS, Department of Plant Pathology,
Krishi Vigyan Kendra, Raipur, IGKV-492012, (Chhattisgarh), India.
[3]Assistant Professor, Department of Horticulture,
College of Agriculture, JNKVV-482004, Jabalpur (Madhya Pradesh), India.

(Corresponding author: Abhay Bisen)*
(Received 21 September 2021, Accepted 13 November, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Sugar apple (*Annona squamosa* L.) belongs to family annonaceae, is an arid zone fruit grown in India. Being a climacteric fruit, it is highly perishable with very short shelf life of 1 to 2 days after ripening. Hence, it is a major drawback and challenge for farmers. An experiment was conducted during the month of October 2015-16 to analyse the effect of chemicals along with organic coatings on storability and quality attributes of sugar apple fruits. Fruits of *Annona squamosa* were harvested manually at physiological light green fully matured stage, washed by fresh water to remove dust particles. Subsequently, fruits were selected randomly as per requirement. Apply various recommended chemicals and hormones, each of two doses namely $CaCl_2$ 1 and 2%, NAA 50 and 100 ppm, GA_3 50 and 100 ppm and $KMnO_4$ 0.01 and 0.05% along with organic coatings of Aloe vera gel 50 and 100%, Sago 5 and 10% and Paraffin wax 5 and 10%). Thus total treatments were 15 including control. After applying all the aforementioned treatments, fruits were kept under observation at ambient condition (25–32 °C, 60–75% RH) for 8 days and analyzed various physical and chemical attributes i.e. PLW, marketable fruits retained, unmarketable fruits, marketable fruits retained over control, TSS, acidity, ascorbic acid and total sugar content. Data were recorded and analysed with CRD statistical design. The results showed that among the treatments organic coating especially paraffin wax had significantly ($p \leq 0.05$) effect on various parameters i.e. minimum reduction of the physiological weight loss (17.64%) as well as maximum marketable fruits retained (80.85%), minimum unmarketable fruits (19.45%) and maximum marketable fruits retained over control (80.85%). Quality traits also found better i.e. total soluble solids (35°Brix), ascorbic acid (44.13 mg/100g pulp), acidity (0.17%) and total sugar (25%) of fruits.

Keywords: Sugar apple, Shelf life, Post harvest, Fruits, Storage and Physico-chemical.

INTRODUCTION

Sugar apple (*Annona squamosa*, L.) also known as custard apple, Sitaphal sharifa belongs to Annonaceae family. It is indigenous to tropical America and found in tropical, subtropical and arid zones of the world. Out of 100 species of Annona, only 5 species, namely the custard apple, cherimoya, soursop, bullock's heart and atemoya are of commercial importance (Jain *et al.,* 2019). In India, production of custard apple is 298.01 thousand tonnes (http://apeda.in). It is also used as an antioxidant, anti-diabetics, hepatoprotective, cytotoxic activity, gene-toxicity, antitumor activity and used as antilice agent (Pandey and Barve, 2011) It is most suited for arid condition. There is huge loss during storability and transportation due to its highly perishable nature. At room temperature in Central India the storability of this fruit is only three to four days thus it is not economically viable to commercialize in the distance market. For the ease of commercialization and enhanced availability, it is essential to preserve the natural plant products like fruits after their harvest (Krishna and Rao, 2014). Due to shorter shelf life and high softness after ripening, results heavy transportation losses. It is one of the major reasons in low production of the fruit crop. Therefore, it is matter of priority to develop such technology which enables to extend the post harvest shelf life of sugar apple, and maintain the nutrition level. The sugar apple is a climacteric in nature as they increase respiratory activity and

production of ethylene during ripening (Jawadagi *et al.,* 2013). The increase of respiratory activity is accompanied by rapid modifications in its chemical composition, which alter the taste, aroma, firmness of the pulp and skin colour. The softening and reduction of firmness of the fruit are the main reasons for the decrease in quality and the major drawback to developing an export market for this fruit (Jholgiker and Reddy, 2007).

The postharvest losses can be minimized by extension of shelf life through checking the rate of transpiration, respiration, microbial infection and protecting membranes from disorganization (Bisen and Pandey, 2008). Post harvest applications of calcium salts and Azadirachta decoction extend the shelf life of many fruits by maintaining PLW and minimizing the rate of respiration, protein breakdown and disease incidence (Bhooriya *et al.,* 2019). Application of various films and coatings modify the fruit atmosphere at micro level, reduce weight loss during transport and storage and extends shelf life. It can also reduce growth of micro organisms (Patel *et al.,* 2017). Better result might be achieved by use of edible organic and inorganic coatings like growth regulators, wax emulsion, potassium and calcium chemicals, irradiation, anti transparent substances, gel, oil, lipid, starch, packaging and wrapping materials and different type of storage used as postharvest treatments to enhance shelf life and reduce post harvest losses. Modern advance facilities of storage are not generally within the reach of a majority of small and marginal Indian farmers. Even they are not able to effort the costly machineries. Therefore, alternative low-cost eco friendly technologies need to be standardized for reducing post harvest losses Thus, present comparatively study entitled "post harvest effect of chemicals, hormones along with organic coatings on prolonging storability and biochemical constituents of sugar apple (*Annona squamosa* L.) The experiment is framed out to find out suitable post harvest treatment to increase shelf life and delayed ripening of sugar apple fruits.

MATERIALS AND METHODES

The present investigation was conducted at Pt. Shiv Kumar Shastry College of Agriculture and Research Station, Rajnandgoan, Indira Gandhi Krishi Vishwavidyalaya during the year 2015-16. The experiment was carried out to study the storability of sugar apple fruits at ambient condition (25–32 °C, 60–75% RH). Fresh and fully matured uniform sized, free from diseases and mechanical injury sugar apple fruits were procured from the Kanker district and surrounding area of the Rajnandgaon for the study. The fruits were coated with various concentrations of aloevera gel (100% and 50%), sago (5% and 10%), paraffin wax (5% and 10%), $CaCl_2$ (1% and 2%) NAA (50 ppm and 100 ppm), GA_3 (50 ppm and 100ppm), $KMnO_4$ (0.1% and 0.05%) for a 1 minute and equal portion was taken with distilled water as control. Thereafter, the coated sugar apple fruits were placed on white paper sheet for air drying in shade at room temperature. The duration for experiment was 8 days and data were recorded on alternate days up to last day of storage, however, records of sampling on 2^{nd}, 4^{th}, 6^{th} and 8^{th} day have been mentioned. The experiment was laid out in Completely Randomized Design with three replications. The physiological weight loss of (PLW) was recorded on weight basis, TSS was determined by hand refractrometer and expressed in °Brix, acidity and ascorbic acid levels in fruits by a method suggested by Ranganna, (1986). Total, reducing and non-reducing sugars levels were determined by Nelson Somogyi method (Nelson, 1994). A Complete Randomized Experiment Design (CRD) was adopted for statistical analysis of data (Critical difference at 5% level) related to storage studies were determined by Gomez and Gomez (1985).

RESULTS AND DISCUSSION

A. Physiological loss in weight (%)

Significant variations were observed in respect of physiological weight loss in all the treatments. The physiological weight loss of sugar apple fruits increased with the storage period. Fruits coated with paraffin wax (10%) recorded minimum (5.93, 9.87, 14.25 and 17.64%) physiological loss in weight after 2, 4, 6 and 8 days of storage period, respectively (Table 1). Paraffin wax (10%) coating found significantly superior over all the treatment followed by paraffin (5%) 7.19, 13.32, 23.98 and 21.87% at above same storage periods. Gohlani and Bisen (2012) similar result found in custard apple during storage period. This observation may be attributed to the provision of physical barriers by coating material to transpirational losses from fruit surface. Application of paraffin wax, retarding the rate of physiological weight loss, which may be due to plugging of grooves in between the carpel's of the fruits, as they are the potential sites for excessive transpirational loss. Retardation in transpirational losses on treatment of permeable edible coating has been reported in custard apple (Patel *et al*., 2011).

The maximum physiological weight loss was recorded under control (11.12, 22.88, 27.15 and 32.95%) after 2, 4, 6 and 8 days of storage followed by $KMnO_4$ (0.05%). On the country, the height percentage of physical loss in weight occurred in control condition (Fig. 1). This might be resulted from higher rates of transpiration, respiration and evaporation. These results are in conformity with the findings of Jagadeesh *et al.* (2001) in guava fruits. It was also observed that coated samples showed minimum shrinkage and weight loss in comparison with un-coated samples. Similar result also found by Anushka Mitra *et al.* (2021) in apple. It was interesting to note that among the coating material, fruits treated with paraffin wax showed maximum resistance for physiological weight loss.

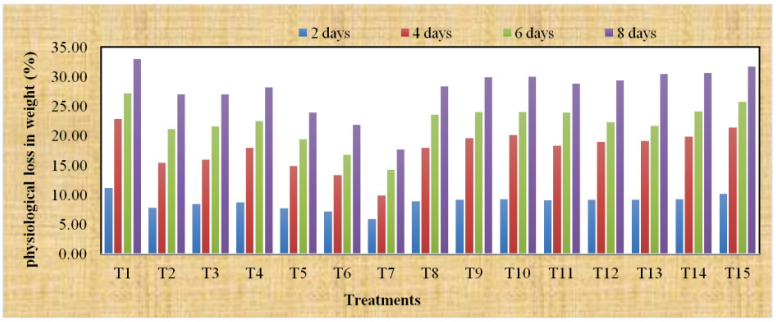

Fig. 1.

B. Retention of marketable fruits (%)

Table 1 indicated that the 100 % marketable fruits were retained till 2 days without deteriorating their quality traits when fruits treated with paraffin wax (10 and 5%), aloevera gel (100 and 50%), sago (10 and 5%) , $CaCl_2$ (2%), NAA (100 ppm) and $KMnO_4$(0.1%) while minimum (91.66%) in control. 100 % percent marketable fruits were retained till 4 days after storage in paraffin wax (10 and 5%) without deteriorating the quality. Whereas, inimum (66.66%) marketable fruits retained at 4 days after storage in control.

Retention of marketable fruits at 6 days after storage, the maximum (94.44%) marketable fruits were recorded in paraffin wax (10%) followed by paraffin wax (5%). Whereas, minimum (25%) marketable fruits retained at 6 days after storage in control. Similarly, when the storage period was enhanced up to 8 days, the maximum (80.55%) marketable fruits were retained under paraffin wax (10%) followed by (52.77%) in paraffin wax (5%) (Fig. 2). Similar result finding by Pandey *et al.*, (2010) in guava fruits. The cause of extended shelf life of fruits under paraffin wax coating may be due to reduction in the rate of water loss with lesser ripening of the fruits and slowing down of the change in colour. Whereas, minimum retention of marketable fruits was recorded under control. This might be due to the unsealing of lenticels that are responsible for higher rate of transpiration and respiration, which are subjected to the physiological activities. This finding was in line with Haribabu *et al.* (1990) in custard apple and Karanjalker and Kumar (2015) in guava fruits.

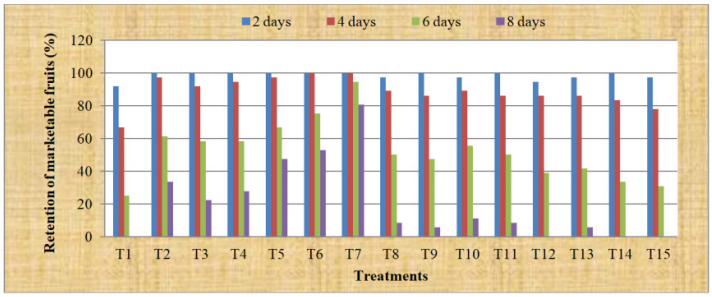

Fig. 2.

C. Unmarketable fruits (%)

It is cleared (data which is presented in Table 1) that those fruits were treated with paraffin wax (10 and 5%), aloevera gel (100 and 50%), sago (5 and 10%), $CaCl_2$ (2%), NAA (100 ppm) and $KMnO_4$(0.1%) found 100% consumable and marketable at 2 days of storage. Whereas, maximum (8.34%) fruits become unmarketable due to uncoated under control.

Paraffin wax (10 and 5%) were found unmarketable (0%) up to 4 days of storage but 33.34 % fruits were found unmarketable under control followed by $KMnO_4$ (0.05%). The maximum (75%) unmarketable fruits were recorded up to 6 days period in case of control followed by (69.45%) unmarketable fruits counted under $KMnO_4$ (0.05%). When the storage period was enhanced up to 8 days, the maximum (100%) unmarketable fruits were found in control, GA_3 (50 ppm), $KMnO_4$ (0.1%) and $KMnO_4$ (0.05%) treated fruits. While minimum (19.45%) unmarketable fruits was retained under paraffin wax (10%) followed by paraffin wax (5%).

No fruits were found unmarketable up to 4 days of storage under the paraffin wax (10%). Up to 8 days minimum (19.45%) fruits were found unmarketable under the same treatment. Paraffin wax (10%) found significantly effective as marketable quality of fruits was not lost even, when the fruits stored for 8 days (Fig. 3). The minimum retention of unmarketable fruits under this treatment may be due to the retention of flavour, appearance, taste, texture, colour and quality of fruits in a natural way. Whereas, when those fruits were treated with $KMnO_4$ (0.1 and .05%), GA_3 (50 ppm) and control, the gradual deterioration in quality parameters as well as physical characters up to 8 days. This might be due to rapidly degradation of chlorophyll, higher rate of enzymatic activities and respiration, softening of tissue on the surface of the fruits during storage period and consequently, all fruits were unmarketable. These results Bisen *et al.* (2012) found that in kagzi lime and Mahajan *et al.* (2005) in kinnow fruits.

Table 1: Post harvest effect of chemicals, hormones along with organic coatings on physical parameters of sugar apple fruits (*Annona squamosa* L.) biochemical constituents of sugar apple.

Treatments	Physiological loss in weight (%)				Retention of marketable fruits (%)				Unmarketable fruits (%)				Marketable fruits retained over control (%)			
	Storage in days				Storage in days				Storage in days				Storage in days			
	2	4	6	8	2	4	6	8	2	4	6	8	2	4	6	8
Control	11.12	22.88	27.15	32.95	91.66	66.66	25.00	0.00	8.34	33.34	75.00	100.00	-	-	-	-
Aloevera gel(100%)	7.85	15.39	21.08	26.96	100	97.22	61.11	33.33	0.00	2.78	38.89	66.67	8.34	30.56	36.11	33.33
Aloevera gel (50%)	8.48	15.99	21.55	27.03	100	91.66	58.33	22.22	0.00	8.34	41.67	77.78	8.34	25.00	33.33	22.22
Sago (5%)	8.70	17.51	22.47	28.15	100	94.44	58.33	27.78	0.00	5.56	41.67	72.22	8.34	27.78	33.33	27.78
Sago (10%)	7.61	14.86	19.36	23.94	100	97.22	66.66	47.22	0.00	2.78	33.34	52.78	8.34	30.56	41.66	47.22
Paraffin wax (5%)	7.19	13.32	16.79	21.87	100	100	75.00	52.77	0.00	0.00	25.00	47.23	8.34	33.34	50.00	52.77
Paraffin wax (10%)	5.93	9.87	14.25	17.64	100	100	94.44	80.55	0.00	0.00	5.56	19.45	8.34	33.34	69.44	80.55
$CaCl_2$ (1%)	8.86	17.99	23.58	28.36	97.22	88.88	50.00	8.33	2.78	11.12	50.00	91.67	5.56	22.22	25.00	8.33
$CaCl_2$ (2%)	9.21	19.60	23.98	29.91	100	86.11	47.22	5.55	0.00	13.89	52.78	94.45	8.34	19.45	22.22	5.55
NAA (50 ppm)	9.23	20.11	24.03	30.02	97.22	88.89	55.55	11.11	2.78	11.11	44.45	88.89	5.56	22.23	30.55	11.11
NAA (100 ppm)	9.13	18.27	23.88	28.77	100	86.11	50.00	8.33	0.00	13.89	50.00	91.67	8.34	19.45	25.00	8.33
GA_3 (50 ppm)	9.18	18.94	22.32	29.37	94.44	86.11	38.88	0.00	5.56	8.34	61.12	100.00	2.78	19.45	13.88	0.00
GA_3 (100 ppm)	9.17	19.16	21.63	30.40	97.22	86.11	41.66	5.55	2.78	13.89	58.34	94.45	5.56	19.45	16.66	5.55
$KMnO_4$(0.1%)	9.28	19.86	24.08	30.60	100	83.33	33.33	0.00	0.00	16.67	66.67	100.00	8.34	16.67	8.33	0.00
$KMnO_4$ (0.05%)	10.15	21.42	25.73	31.73	97.22	77.77	30.55	0.00	2.78	22.23	69.45	100.00	5.56	11.11	5.55	0.00
SEm±	0.49	1.88	2.27	2.66	1.60	3.79	4.47	4.24	1.23	3.51	4.11	4.96	1.50	3.95	4.49	4.41
CD at 5% level	1.43	5.45	6.58	7.70	4.63	10.96	12.93	12.25	3.63	10.14	12.66	14.22	4.53	11.91	12.36	12.53

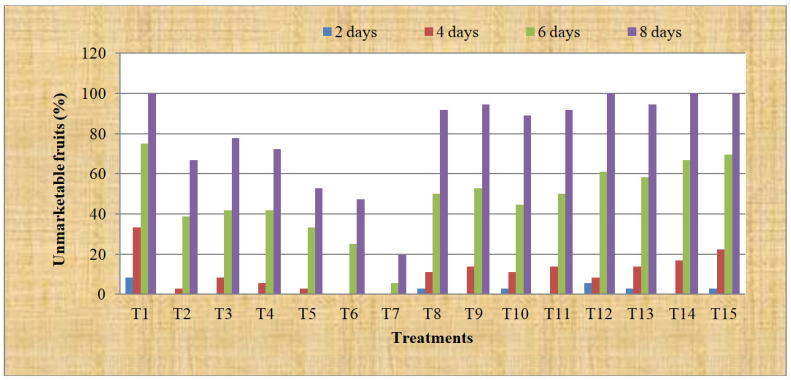

Fig. 3.

D. Marketable fruits retained

The data indicated that when the fruits were treated with paraffin wax (10 and 5%), aloe vera gel (100 and 50%), sago (10 and 5 %), $CaCl_2$ (2%), NAA (100 ppm) and $KMnO_4$ (0.1%) treatments retained 8.34% marketable fruits over control up to 2 days of storage (Table 1). While when storage period was prolonged up to 4, 6 and 8 days the highest (33.34, 69.44 and 80.55%) retention percentage of fruits over control were recorded under paraffin wax (10%) followed by (33.34, 50 and 52.77%) marketable fruits retained over control under paraffin wax (5%) coated fruits at same storage days (Fig. 4).

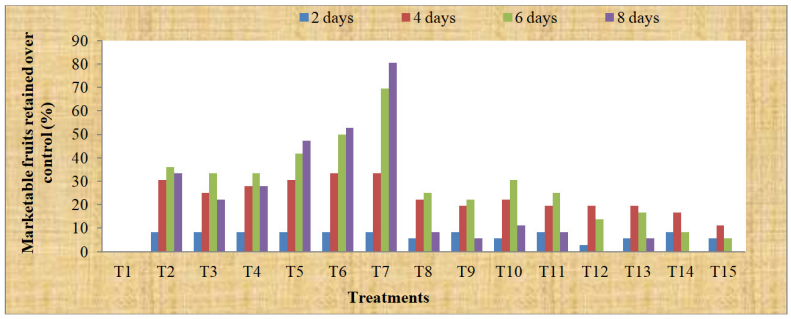

Fig. 4.

Maximum percentage of marketable fruits retained over control under paraffin wax coating due to slow rate of degradation in physiological weight and qualitative characters of fruits may be the factors resulted in retaining maximum marketable fruits in storage. Similarly, Thomas *et al.* (2005) reported that coating retard ethylene emission and enhance texture as compared to control. Whereas, control and $KMnO_4$ (0.05%) gave the minimum percent of marketable fruits retained over control under each stages (2, 4, 6 and 8 days) of storage as shown in the Table 1. Control and $KMnO_4$ (0.05%) treated fruits greatly reduce the percentage of marketable fruits and noticed, it was gave minimum value. Further, minimum value of control under the retention of marketable fruits over control was due to less retention of marketable fruits under untreated fruits. Similar observation were made by Mahajan *et al.* (2010) in pear and Hiwale and Singh (2003) in guava fruits.

E. Total soluble solid (°Brix)

Apparent the data from Table 2 that total soluble solids content in sugar apple fruits showed an increasing trend with the longer period of storage.

Increase in total soluble solids with different post harvest treatments was recorded in the present investigation but the effect of paraffin wax (10%) (35°Brix) was more pronounced followed by sago (10%) (34°Brix) than control (29°Brix) up to 8 days storage.

The increase in TSS up to 8 days might be due to conversion of reserved starch and other polysaccharides to soluble form of sugar with the advancement of storage period. Application of coating on fruits showed a marked effect on the rate of carbohydrate metabolism and changes in TSS. These results corroborates with the finding of Jholgiker and Reddy (2007) in custard apple and Shaifali and Manish Bakshi (2021) in guava. This might have led to slow down in the carbohydrate metabolism reflected in delayed starch depletion. On the other hand, the minimum (25.33, 26.67, 28.67and 29°Brix) total soluble solids were found of this experiment in control after 2, 4, 6 and 8 days of storage period respectively (Fig. 5). Untreated fruits recorded slow increase in TSS, which was probably due to the less concentration of pulp due to dehydration. Similar findings have been also advocated by Tuwar *et al.,* (1997); Patel *et al.* (2011) in custard apple.

Table 2: Post harvest effect of chemicals, hormones along with organic coatings on biochemical constituents of sugar apple (*Annona squamosa* L.)

Treatments	Total soluble solid (^{O}Brix)				Ascorbic acid (Mg/100g)				Acidity (%)				Total sugar (%)			
	Storage in days				Storage in days				Storage in days				Storage in days			
	2	4	6	8	2	4	6	8	2	4	6	8	2	4	6	8
Control	25.33	26.67	28.67	29.00	35.73	33.60	28.70	20.80	0.40	0.36	0.32	0.30	15.44	17.64	20.14	17.83
Aloevera gel(100%)	28.00	31.67	32.67	33.00	45.07	40.80	29.60	25.00	0.34	0.28	.27	0.23	22.49	24.50	25.42	21.11
Aloevera gel (50%)	27.00	31.00	32.00	32.67	49.60	45.87	41.20	28.13	0.34	0.30	0.29	0.24	21.52	23.04	24.27	19.99
Sago (5%)	27.00	29.00	30.67	31.00	56.53	51.30	43.67	34.60	0.35	0.32	0.30	0.25	22.32	24.15	25.26	21.00
Sago (10%)	28.33	32.00	33.33	34.00	62.13	54.93	49.27	40.00	0.33	0.27	0.26	0.22	23.42	24.30	25.38	21.53
Paraffin wax (5%)	28.00	30.67	31.67	32.33	57.07	49.97	43.73	33.60	0.32	0.27	0.25	0.20	25.26	26.20	27.06	23.17
Paraffin wax (10%)	30.00	33.33	34.33	35.00	64.00	61.07	55.73	44.13	0.29	0.26	0.21	0.17	27.16	29.50	30.88	25.00
$CaCl_2$ (1%)	26.00	28.00	30.00	30.67	58.47	51.73	45.07	35.47	0.35	0.31	0.29	0.26	20.37	21.40	23.23	18.75
$CaCl_2$ (2%)	27.00	28.00	31.33	31.67	50.93	41.53	36.33	27.87	0.38	0.33	0.30	0.29	21.99	23.44	24.30	20.34
NAA (50 ppm)	27.33	29.33	31.33	32.00	47.73	40.27	36.40	26.53	0.36	0.32	0.29	0.27	23.03	24.08	25.00	20.83
NAA (100 ppm)	28.00	30.33	30.67	31.33	51.20	50.13	48.00	31.00	0.36	0.32	0.30	0.28	22.12	23.51	24.54	20.34
GA_3 (50 ppm)	29.00	30.00	31.00	31.00	42.33	38.27	30.10	27.00	0.37	0.33	0.30	0.29	23.23	23.86	25.19	20.83
GA_3 (100 ppm)	29.33	29.67	30.33	31.00	55.33	52.93	41.53	27.40	0.35	0.32	0.28	0.23	21.52	22.43	23.86	19.27
$KMnO_4$(0.1%)	28.00	30.33	31.00	31.33	37.47	36.47	31.13	22.93	0.35	0.33	0.29	0.28	19.21	21.61	22.32	17.88
$KMnO_4$ (0.05%)	27.00	28.00	29.00	30.00	41.27	37.07	33.20	25.27	0.36	0.32	0.27	0.23	20.83	21.87	23.44	18.18
SEm±	0.524	0.571	0.584	0.699	1.422	1.926	1.842	2.065	0.017	0.007	0.013	0.017	0.366	0.392	0.474	0.622
CD at 5% level	1.512	1.649	1.686	2.019	4.108	5.562	5.320	5.965	0.050	0.020	0.038	0.049	1.058	1.132	1.368	1.796

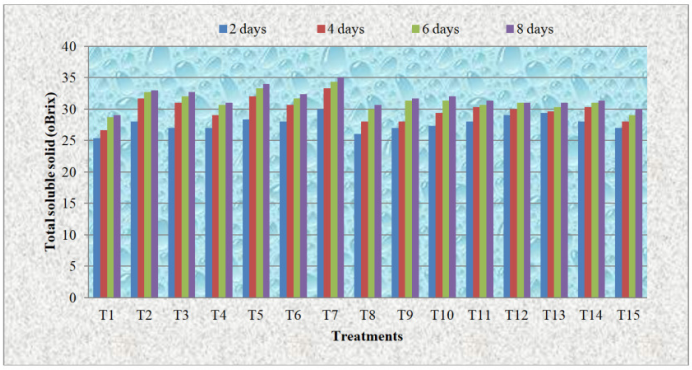

Fig. 5.

***Ascorbic acid* (mg/100g).** The mean data pertaining to ascorbic acid of sugar apple fruits pulp are presented in Table 2. It was recorded that the ascorbic acid content decreased significantly upto 8 days. It might be mainly due to oxidation phenomenon. These results are in close with the findings of El- Monem *et al.* (2003) in custard apple. The highest (64, 61.7, 55.73 and 45.21 mg/100g) ascorbic acid was recorded under paraffin wax (10%) followed by (62.13, 54.93, 49.27 and 40 mg/100g) in sago (10%) coated fruits at 2, 4, 6, and 8 days of storage respectively, significantly higher than control (Fig. 6). Maximum vitamin 'C' content may be due to metabolic changes and increase in percentage of acidity. The minimum (35.70, 33.60, 28.70 and 20.80 mg/100g) ascorbic acid content of fruit was recorded under control at same storage periods, which possibly might be due to rapid conversion of ascorbic acid into dehydro ascorbic acid in the presence of enzyme ascorbinase over ripen fruits with injured skin. The result corroborates with the findings of Jawadagi *et al.* (2013) in custard apple.

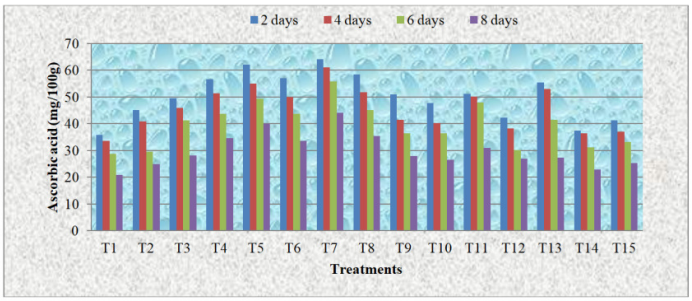

Fig. 6.

F. Acidity (%)

Acidity of sugar apple was decreased with prolonging in storage period, all treatments registering minimum reduction (0.29, 0.26, 0.21 and 0.17%) with paraffin wax (10%) at 2, 4, 6 and 8 days of storage followed by paraffin wax (5%) (0.32, 0.27, 0.24 and 0.20%) respectively (Fig. 7). In the present study, minimum acidity under paraffin wax (10%) could be explained with the fact that organic acid might be utilized slowly in respiration or conversion of acid into sugar from pre climacteric to post-climacteric stage. These results are in close view to that of Gohlani and Bisen (2012) as he stated that the higher acidity content might be due to anaerobic respiration and higher evapo-transpiration rate. Whereas, maximum (0.30%) acidity was observed in untreated fruits up to 8 days of storage (Table 2).

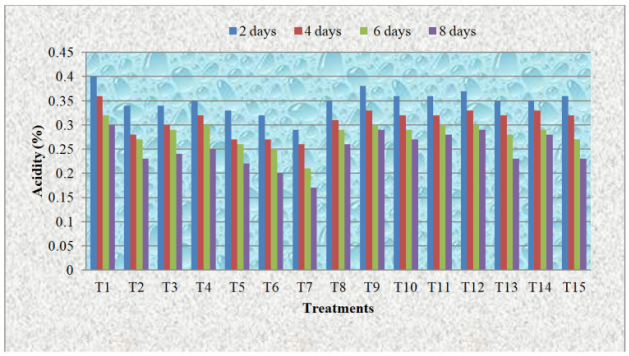

Fig. 7.

This may be due to minimum accumulation of sugars which caused the fewer breaks down of polysaccharides during ripening and contributes to the increase of acidity as a result of decrease in TSS/ acid ratio. The result is supported by the finding of Roy *et al.,* (2000). Similarly, Bhowmick *et al.* (2015) in ber reported that maximum percentage of acidity was found in untreated fruits which may be due to minimum utilization of acidity during metabolism or may be less use of organic acid during respiration.

G. Total sugar (%)

Table 2 indicates that days of storage were significantly effect on total sugar content of sugar apple fruits. It is vivid from the data that total sugar content showed an increasing trend with all the treatments up to 6 day of storage and thereafter declined up to 8 days. Total sugar content was found highly significant between 2 to 8 days of storage. A higher content of total sugar (27.16, 29.50, 30.88 and 25%) was observed in the paraffin wax (10%) followed by (25.26, 26.20, 27.06 and 23.17%) under paraffin wax (5%) after 2, 4, 6 and 8 days of storage respectively. While the minimum (15.44, 17.64, 20.14 and 17.83%) total sugar was found in the control followed by (15.44, 17.64, 20.14 and 17.83%) $KMnO_4$ (0.1%) at same days of storage (Fig. 8).

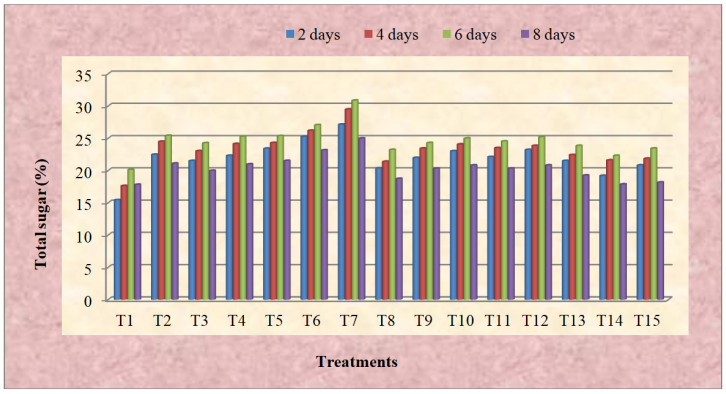

Fig. 8.

Total sugar increased up to 6 days of storage might be due to partial hydrolysis of complex carbohydrates and maximum retention of total sugar under paraffin wax coated fruits. It may be due to the ability of coated layer to slow down ripening process. This resulted into delay dehydration and physico-chemical changes as a result of less moisture loss and decrease in acidity, respectively. The increased level of total sugar was probably due to conversion of starch and pectin into glucose and fructose which decline later on during storage might be due to their rate of consumption of sugars in respiration and other energy sources. Such information has been reported by Gohlini and Bisen (2012), Patel *et al.* (2011), Chouksey *et al.* (2013); El-Monem *et al.*, (2003) in custard apple and Pandey *et al.,* (2010) in guava.

CONCLUSION

Sugar apple is a delicious and highly perishable fruit. The fruit is very delicate and requires to be handled with care. Post-harvest shelf life of fully matured sugar apple fruits under tropical conditions is limited to a short period. Sugar apple fruits are seasonable and available during winter season only. During this season large volume of fruits available in the market which cause the producers are faced with low returns due to perishable nature of the commodity, therefore a need to increase shelf life of sugar apple is well recognized. The fruits are normally dispatched to the market immediately after harvesting and these ripen on their way to the destination. Being a perishable fruit, sugar apple cannot be stored for a long period.

Paraffin wax coating reduce the respiration rate and delayed the ripening process of the sugar apple fruits results longer the storability up to 8 days without adversely affecting their physical as well as biochemical attributes. Paraffin wax coating may be effectively useful for enhancing storability of the fruits. Looking the facts, it could be concluded that the results of this laboratory experiment will not only be useful for longer storability, quality retention, shipping, distribution and marketing but also beneficial for both the growers and consumers.

FUTURE SCOPE

Paraffin wax coating may be effectively useful for enhancing storability of the fruits. Extensive research is therefore required to utilize Paraffin wax as a coatings for the preservation of various seasonal fruits and vegetables.

Acknowledgements. The authors acknowledge and extend their gratitude to Dean, Pt. Shiv Kumar Shastry College of Agriculture and Research Station, Rajnandgoan, IGKV (C.G.). Authors also express their acknowledgement to Prof. & Head, Department of Food Science, IGKVV, Raipur for providing the facilities to support the research.

Conflict of Interest. None.

REFERENCES

Bisen, A. and Pandey, S. K. (2008). Effect of gamma irradiation, growth retardant and coatings on storability of lime fruits. *Asian J. Hort., 25*:159–163.

Bhooriya, M. S., Bisen, B. P., Dongre, Rahul and Kumar, Maneesh (2019). Effect of post-harvest treatments on shelf life and physico-chemical changes of Guava

fruits. *International Journal of Chemical Studies, 7*(6): 3096-3099.

Bhowmick, N., Ghosh, A., Dutta, P. and Dey, K. (2015). Efficacy of edible coatings on the shelf life of ber (*Zizyphus mauritiana* Lamk.) fruits at ambient condition. *International J. Agri. Environ. and Biotech., 8*(3): 601-608.

Chouksey, S., Singh, A., Singh, R. and Deshmukh, R. (2013). Influence of gamma irradiation and benzyl adenine on keeping quality of custard apple fruits during storage. *J. Food Sci. And Technol*., *50*(5): 934-941.

El-Monem, Eaaa., Mostafa, A. and El-Maged, M. (2003). Effect of harvest treatments on storage behaviour of guava fruits cv. Sardar. *J Maharashtra Agric. Univ., 26*: 297–300.

Gohlani, S. and Bisen, B. P. (2012). Effect of different coating material on the storage behavior of custard apple (*Annona squamosa* L.). *The Bioscan., 7*(4): 637-640.

Gomez, K. A. and Gomez, A. (1985). Statistical procedure for agriculture research. *A wibey- International Science Publication* John and Sons. Newyork.

Hiwale, S. S. and Singh, S. P. (2003). Prolonging the shelf life of guava (*Psidium guajava* L.). *Indian J. Hort*., *6*(2) : 1-9.

http://apeda.in/agriexchange/India%20Production/India_Productions.aspx?cat=fruit&hscode=1044. 10 December, 2018.

Jain, Charul, Champawat, P. S., Mudgal V.D., Madhu, B. and Jain, S.K. (2019) Post-harvest processing of custard apple (*Annona squamosa* L.): A review. *International Journal of Chemical Studies, 7*(3): 1632-1637.

Haribabu, K., Zaheeruddin, Md. and Prasad, P. K. (1990). Studies on post harvest storage of custard apple fruits (*Annona squamosa* L.). *Acta Hort*., *269*: 299.

Jagadeesh, S. L, Rokhade, A. K. and Lingaraju, S. (2001). Influence of post harvest treatments on storage behaviour of guava fruits, cv. Sardar. *J. Maharashtra Sci*., *26*: 297–300.

Jawadagi, R. S., Patil, D. R., Peerajade, D. A., Shreedhar, D. and Achari, R. (2013). Studies on effect of post harvest treatments on quality and shelf life of custard apple (*Annona squamosa*L) cv. balanagar. *Asian J. Hort*., *8*(2): 494-497.

Jholgiker, P. and Reddy, B. S. (2007). Effect of different surface coating material on post harvest physiology of (*Annona squamosa* L.) fruits under ambient and zero energy cool chamber storage. *Indian J. Hort*., *64*(1): 41-44.

Karanjalker, G. R., and Kumar, P. (2015). Comparative physico-chemical and sensory evaluation of fruits of guava (*Psidium guajava* L.) cultivars. *Progressive Horticulture*, *47*(1): 170-172.

Krishna. K., Rama and Sudhakar, Rao (2014) "Effect of chitosan coating on the physiochemical characteristics of guava (*Psidium guajava* L.) fruits during storage at room temperature. *Indian Journal of Science and Technology*. *7*(5):554.

Mahajan, B. V. C., Dhatt, A. S. and Sandhu, K. S. (2005). Effect of different post-harvest treatments on the storage life of kinnow. *J. Food Sci. and Technol*., *42*(4) : 296-299.

Mahajan, B. V. C., Singh, K., and Dhillon, W. S. (2010). Effect of 1-methylcyclopropene (1-MCP) on storage life and quality of pear fruits. *J. food Sci. and Technol.*, *47*(3): 351-354.

Mitra, A., Selvam, S. P., Shehabudheen, S., Anitha, P. M. and Kumar, M. M. (2020). Efficiency Evaluation of Cinnamon Essential Oil Loaded Nanoliposomal Coating for the Post-Harvest Management of Apple (*Malus domestica*). *International Journal on Emerging Technologies*, *11*(2): 554–559.

Nelson, N. (1944). A photometric adaptation of the Somogyi method for the determination of glucose. *J. biol. Chem*, *153*(2): 375-380.

Pandey N, Barve D. (2011). Phytochemical and pharmacological review on Annona squamosa Linn. *International Journal of Research in Pharmaceutical and Biomedical Sciences, 2*(4):1404-1412.

Pandey, S. K., Joshua, J. E. and Bisen, A. (2010). Influence of gamma-irradiation, growth retardants and coatings on the shelf life of winter guava fruits (*Psidium guajava* L.). *J. food sci. and Technol., 47*(1): 124-127.

Patel, K., Patil, S. J., Patel, C. R. and Patel, F. (2017). Effect of organic coating on shelf life and quality of organically grown mango cv. Kesar, *Int. J. Pure App. Biosci., 5*(5): 190-195.

Patel, N., Naik, A. G. and Arbat S. S. (2011). Response of post harvest chemical treatments on shelf life and quality of custard apple cv. Balanagar. *Indian J. Hort.*, *68*(4):547- 550.

Ranganna, S. (1986). Handbook of analysis and quality control for fruit and vegetable products. *Tata McGraw Hills Pub*., New Delhi.

Roy, M. K. Chatterjee, S. R., Bahukhandi, D., Sharma, R. and Philips, A. S. (2000). Gamma radiation in increasing productivity of *Agaricus bisporus* and *pleurotus sajarcaju* and enhancing storage life of P. sajorcaju. *J. Food Sci. and Technol*., *37*(1):83–86.

Shaifali and Manish Bakshi (2021). Shelf life enhancement of Guava (*Psidium guajava* L.) fruit using novel coating materials. *The Pharma Innovation Journal 2021, 10* (8): 792-797.

Thomas, S. A., E. Bosques- Melina, S. S. and. Sanchez, F. (2005). *J. de physique ivfrance 125:* 889-892.

Tuwar, J. M., Ughreja, P. P. and Patel, A. B. (1997). Studies on post-harvest storage of custard apple *(Annona squamosa* L.*)* fruit cv. Sindhan. *Indian Food Pack*., *51*(2): 16-20.

How to cite this article: Bisen, A.; Pardhi, S. and Dongre, R. (2021). Post Harvest effect of Chemicals, Hormones along with Organic Coatings on Prolonging Storability and Biochemical Constituents of Sugar Apple (*Annona squamosa* L.). *Biological Forum – An International Journal*, *13*(4): 857-865.