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Influence of post-harvest treatments on quality and shelf life of jamun (*Syzygium cuminii* Skeels.) fruits under ambient storage

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Abstract
An investigation was carried out to know the effectiveness of different post-harvest treatments on storage behaviour, physiological, physico-chemical changes and organoleptic parameters of jamun fruits at ambient storage. The treatments involved post-harvest application of calcium chloride (1.0 and 2.0%), GA_3 (50 and 100ppm) and sachets containing iron powder (1 and 1.5g/kg fruits) and potassium permanganate (5 and 10g/kg of fruits).Minimum respiration rate (32.32 ml CO_2/kg/h), rotting percentage (17.86%), highest retention of titratable acidity (1.39%), Phenols (200.70 mg/100g) and antioxidant activity (87.13%) was recorded in the fruits with sachets containing iron powder (1g/kg of fruits) during the storage period up to 6 days after storage respectively. The fruits with sachets containing iron powder (1g/kg of fruits) extend shelf life up to 6 days at ambient storage and it was superior to all other treatments in maintaining better physiological behaviour, physico-chemical characters and organoleptic qualities under ambient storage conditions.

Keywords: Jamun, $CaCl_2$, GA_3, Iron powder, $KMNO_4$, LDPE and storage

1. Introduction
Jamun (*Syzygium cuminii* Skeels.) is an evergreen tropical tree which belongs to family 'Myrtaceae'. It is commonly known as java plum, jambul, jamun, black plum, faux pistachier, Indian blackberry, doowet, Jamboo and jambolan. Jamun is native to the subtropical Himalayas, India, Sri Lanka, Malaysia and Australia. Its fruits are delicious and have great importance in folk medicine (Ayyanar and Subash, 2012) [2]. India is the second largest producer of the fruits in the world. World production of Jamun is estimated to 13.5 million tones, out of which 15.40 per cent is contributed by India. India ranks second in production of Jamun in the world. Maharashtra state is the largest Jamun producer of the country (Savitha., 2018) [13]. Jamun fruits exhibits non climacteric pattern of respiration hence they have very short shelf life after harvest and that is one of the major drawbacks for long distance transport and marketing. Physiological and biochemical processes such as respiration and transpiration continue after harvesting as the fruits are living entity even after the detachment from mother plant. Post-harvest treatments will help to slow down the physiological processes in fresh fruits such as respiration, transpiration, ripening and senescence. In addition, those treatments also reduce the incidence of pathogen attacks and microbial contamination to increase the shelf life of fresh commodities. Use of gibberallic acid (GA_3) and $CaCl_2$ are effective as a post harvest treatments and used on large scale in a number of fruits. GA_3 acts as antisenescent agent and thereby enhance the shelf-life of fruits. While chemical like, $CaCl_2$ extends the storage life of fruits by maintaining their firmness and minimizing the rate of respiration, protein breakdown and rotting incidence (Scott and Wills, 1975) [14]. The use of active packaging technology appears to be viable alternative for the storage of fruits as it does not require costly equipments and also the stored commodities do not come in direct contact with the chemicals.

2. Material and Methods
Jamun fruits were procured from Horticulture Department, Hidkal Dam, Belgaum district of Karnataka. Fruits were harvested manually and packed in plastic crates and brought to the laboratory immediately for further experimentation.

Fruits of uniform size, shape, free from any visible damage and decay, were manually selected for the experiment to maintain the uniformity. Further the fruits were washed in clean water to remove the dirt and they were air dried under electric fan.

2.1 Scavenger Sachet preparation
The sachets of scavengers of oxygen and ethylene were prepared by enclosing weighed quantities of iron powder and potassium permanganate in small bags (4×2 cm) made of high density woven fabric which was permeable to gases but impermeable to the ingredients.

2.2 Packaging material
Low density polyethylene bags (500 gram capacity) bags of film thickness 150 gauze having 0.5 per cent perforations were used for the experiment.

2.3 Treatment imposition details
The fruits were given different post-harvest treatments (as mentioned in treatment details). The washed Jamun fruits were dipped in $CaCl_2$ (1 and 2%) and GA_3 (50 and 100 ppm) for 2 minutes respectively. The treated ($CaCl_2$ and GA_3) fruit samples with sachets (containing iron powder and potassium permanganate) and control were packed in low density polyethylene bags of film thickness 150 gauze having 0.5 per cent perforations. The packaged samples were stored at ambient conditions and observations were recorded at an interval of 2 days.

Treatment details

T_1	Control (Distilled water spray)
T_2	$CaCl_2$ (1%)
T_3	$CaCl_2$ (2%)
T_4	GA_3 (50 ppm)
T_5	GA_3 (100 ppm)
T_6	Iron powder (1g/ kg of fruits)
T_7	Iron powder (1.5g/ kg of fruits)
T_8	$KMNO_4$ (5g /kg of fruits)
T_9	$KMNO_4$ (10g /kg of fruits)

2.4 Rate of respiration (ml CO_2/kg/h)
The rate of respiration was measured by static method using gas analyzer. Known quantities of fruits were sealed hermetically in a 330 ml plastic container having a provision for hole and closed with septum for 1 h at ambient temperature. The syringe was inserted into the head space of the container to estimate the CO_2 release by the fruits.

$$\text{Rate of respiration (ml } CO_2\text{/kg/hr)} = \frac{CO_2 \text{ Concentration X Volume of the container}}{100 \text{ X weight of the fruit (kg) X Time (h)}}$$

2.5 Rotting (%)
The percentage fruits decay was calculated by using the following formula:

$$\text{Rotting Percentage (\%)} = \frac{\text{Weight of the rotted fruits}}{\text{Initial weight of the fruits}} \text{ X } 100$$

2.6 Shelf-life (Days)
Shelf-life of jamun fruits were recorded throughout the experimental period under ambient storage condition. As and when the fruits lost their marketability, the shelf-life was recorded (in days) until the end of the experimental period.

2.7 Total titratable acidity (%)
The acidity was determined by diluting the pulp extracted from five grams of sample and filtered through muslin cloth and made up to known volume with distilled water (100 ml). From this, five ml of aliquot was taken and titrated against standard NaOH (0.1 N) using a phenolphthalein indicator. The appearance of light pink colour was recorded as the end point. The values were expressed in terms of tartaric acid per cent of the fruits (Anon., 1984) [1].

2.8 Total Phenol (mg/100g)
Jamun fruit pulp was preserved in 80 per cent alcohol in refrigerator was used for the estimation of total phenols. Phenols were estimated as per the Folin ciocalteau reagent (FCR) method (Bray and Thrope, 1954) [4] and expressed as mg per 100 gram of pulp.

2.9 Total Antioxidant activity (%)
Antioxidant activity of jamun fruits was determined by free radical activity of the extract was measured in terms of radical scavenging ability using the stable free radical DPPH. 1 mM solution of DPPH in ethanol and 1 mg/1ml juice extract in ethanol was prepared and 1.5 ml of this solution was added to 1.5 ml of DPPH. The absorbance was measured at 517 nm against the corresponding blank solution.

$$\text{DPPH scavenging (\%)} = \frac{A_{(cons)} - A_{(test)}}{A_{(cons)}} \text{ X } 100$$

$A_{(cons)}$ – It is the absorbance of the control reaction
$A_{(test)}$ – It is the absorbance in the presence of the sample of the extract

3 Results and Discussion
3.1 Rate of respiration (ml CO_2/kg/h)
The results regarding to effects of different post-harvest treatments on respiration rate of Jamun fruits under ambient storage is presented in Table 1. The initial respiration rate of jamun was 31.65 (2019) and 29.50 (2020) ml CO_2/kg/h. After two days of storage, the minimum respiration rate was recorded in T_6 (30.68, 29.68 and 30.18 ml CO_2/kg/h) and maximum was noticed in T_1 (55.77, 54.77 and 55.27 ml CO_2/kg/h) during 2019, 2020 and pooled data, respectively. Whereas, minimum respiration rate (T_6) was significantly on par with with T_7 during 2019 and 2020 respectively.
After 4 DAS, the minimum respiration rate was recorded in T_6 (30.82, 29.82 and 30.32 ml CO_2/kg/h) and maximum was recorded in T_1 (56.06, 55.06 and 55.56 ml CO_2/kg/h) during 2019, 2020 and pooled data, respectively. However, after 6 DAS, the minimum respiration rate was recorded in T_6 (32.82, 31.82 and 32.32 ml CO_2/Kg/h) and maximum was recorded in treatment T_1 (59.60, 58.60 and 59.10 ml CO_2/kg/h).
The respiration rate of Jamun fruit was found to increase with increase in storage period under ambient condition (Table-1). Minimum respiration rate was noticed in the treatment in T_6 (Iron powder 1g /Kg of fruits) followed by T_7 (Iron powder 1.5g/Kg of fruits) when compared to all other treatments. Polyethylene film liners along with scavengers of oxygen (Iron powder) might have resulted in a modified atmosphere

with lower O_2 and higher CO_2 concentrations thereby, reducing the respiration rate of fruits inside such packages thereby prolonging its storage life (Cruz *et al*., 2013) [7]. The ability of modified atmosphere to reduce respiratory activity inside the packages represents not only a way to control the respiration rate of the fruit but also a way to decrease of the intensity of catabolic activity and degradation processes (Sandhya, 2010) [12].

Similar findings have reported by Mohamed and Goukh (2010) [9] in guava, Superlan and Itoh (2003) [19] in tomato.

Table 1: Effect of post harvest treatments on respiration rate (ml CO_2/kg/h) of jamun fruits stored under ambient storage

Treatments	Days after storage								
	2			4			6		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	55.77	54.77	55.27	56.63	55.63	56.13	59.60	58.60	59.10
T_2	43.41	41.70	42.91	43.59	42.18	43.09	43.64	43.46	43.14
T_3	42.70	41.59	42.60	43.18	42.41	42.79	44.46	42.64	43.55
T_4	44.80	42.98	44.30	44.83	43.83	44.33	44.98	43.90	44.44
T_5	49.75	48.75	49.25	56.06	55.06	55.56	56.15	55.15	55.65
T_6	30.68	29.68	30.18	30.82	29.82	30.32	32.82	31.82	32.32
T_7	30.75	29.82	30.28	30.95	29.95	30.45	36.44	35.44	35.94
T_8	42.94	41.94	42.44	42.94	41.95	42.44	44.67	43.67	44.17
T_9	43.86	42.86	43.36	44.49	43.49	43.99	46.49	45.49	45.99
Mean	42.74	41.56	42.28	43.72	42.70	43.23	45.47	44.45	44.96
S. Em±	0.25	0.25	0.25	0.31	0.31	0.31	0.31	0.31	0.31
C.D. @ 1%	1.04	1.04	1.04	1.29	1.29	1.29	1.29	1.29	1.29

Initial value of respiration rate was 31.65 (2019) and 29.50 ml CO_2/kg/h (2020)

T_1- Control (Distilled water spray)
T_2 -$CaCl_2$ (1%)
T_3 - $CaCl_2$ (2%)
T_4 - GA_3 (50 ppm)
T_5 - GA_3 (100 ppm)
T_6- Iron powder (1g/kg of fruits)
T_7 - Iron powder (1.5g /kg of fruits)
T_8 - $KMNO_4$ (5g/kg of fruits)
T_9 - $KMNO_4$ (10g/kg of fruits)

3.2 Rotting (%)

The percent rotting of jamun fruits as influenced by postharvest treatments during the storage is presented in Table 2. After second day of storage, the minimum rotting was recorded in T_6 (16.03, 17.03 and 16.53%) it was on par with T_3. The treatment T_1 showed significantly higher per cent of rotting (27.35, 28.35 and 27.85%) was recorded in 2019, 2020 and pooled data, respectively. After fourth day of storage, the treatment T_6 (17.41, 16.41 and 16.91%) showed significantly minimum rotting. The maximum rotting per cent was observed in T_1 (32.20, 31.20 and 31.70%) in 2019, 2020 and pooled data, respectively and it was significant over rest of the treatments. After sixth day of storage, the treatment T_6 (18.36, 16.41 and 17.86%) showed significantly minimum per cent of rotting followed by T_7 during 2019, 2020 and pooled data, respectively. The maximum rotting per cent was observed in T_1 (36.94, 35.94 and 36.44%) in 2019, 2020 and pooled data, respectively

Spoilage of Jamun fruits was observed on 2 days after storage (DAS). It is evident from the data presented in Table-2 that rotting of Jamun fruits was directly proportional to the increase in storage temperature. There was a progressive increase in the spoilage with the advancement of storage under all treatments. Minimum mean spoilage (17.86%) was noticed in the treatment in T_6 (Iron powder 1g/Kg of fruits). However, the control fruits (T_1) exhibited maximum spoilage throughout storage and therefore resulted in maximum mean spoilage (36.44%). The lower spoilage incidences under MAP with active components, as observed during the present study, could be attributed to delayed senescence as a result of reduced respiration activity, as senescence makes the fruit more susceptible to attack by decay causing organisms.

3.3 Shelf-life (Days)

In general, shelf life of Jamun fruits differed significantly during both the seasons and even after pooling the two years data (Table 2). The treatments T_6 recorded significantly the highest shelf life in 2019 (5.83 days each), 2020 (6.00 days) as well as in pooled analysis (5.91 days) when compared to all other treatments, respectively. The lowest shelf life was in the control (T_1) fruits (4.08, 4.16 and 4.12 days) for 2019, 2020 and pooled data, respectively.

Table 2: Effect of post harvest treatments on rotting percentage and shelf life of jamun fruits stored under ambient storage

Treatments	Days after storage									Shelf life (Days)		
	2			4			6					
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	27.35	28.35	27.85	32.20	31.20	31.70	36.94	35.94	36.44	4.08	4.16	4.12
T_2	17.75	18.74	18.25	19.74	18.75	19.24	21.38	20.38	20.88	5.16	5.33	5.25
T_3	16.50	17.20	17.00	18.20	17.50	17.70	19.69	18.69	19.19	5.33	5.41	5.37
T_4	18.07	18.90	18.57	19.90	19.07	19.40	21.83	19.33	21.33	4.58	4.66	4.62
T_5	18.67	19.01	19.17	20.01	19.17	19.51	20.17	19.67	19.67	4.5	4.5	4.54
T_6	16.03	16.41	16.53	17.41	17.03	16.91	18.36	16.41	17.86	5.83	6.00	5.91
T_7	17.35	17.16	17.40	18.16	17.90	17.66	18.42	18.17	17.92	5.16	5.33	5.25
T_8	16.90	17.88	17.85	18.88	18.35	18.38	19.17	17.42	18.67	4.66	4.33	4.50
T_9	18.14	18.35	18.64	19.35	19.14	18.85	20.16	19.16	19.66	4.83	4.50	4.66
Mean	18.52	19.52	19.02	20.42	19.42	19.92	21.79	20.51	21.29	4.90	4.91	4.90

S. Em±	0.15	0.15	0.15	0.12	0.12	0.12	0.17	0.14	0.169	0.23	0.23	0.21
C.D. @ 1%	0.64	0.64	0.64	0.49	0.49	0.49	0.69	0.58	0.691	0.97	0.94	0.87

T_1 - Control (Distilled water spray) T_6- Iron powder (1g/kg of fruits)
T_2 - $CaCl_2$ (1%) T_7 - Iron powder (1.5g/kg of fruits)
T_3 - $CaCl_2$ (2%) T_8 - $KMNO_4$ (5g/kg of fruits)
T_4 - GA_3 (50 ppm) T_9 - $KMNO_4$ (10g/kg of fruits)
T_5 - GA_3 (100 ppm)

3.4 Total titratable acidity (%)

The initial titratable acidity of jamun fruits was 1.20 (2019) and 1.80 (2020) per cent (Table 3).The treatment T_6 retained higher titratable acidity (1.95, 0.95, 1.45%) and lower was recorded in T_1 (1.75, 0.75 and 1.25%) at 2 DAS during 2019, 2020 and pooled data, respectively. After 4 DAS, the maximum titratable acidity was found in the treatments T_6 (1.92, 0.92 and 1.42%) whereas lower was recorded in T_1 (1.72, 0.72 and 1.22%) at 4 DAS during 2019, 2020 and pooled data, respectively. After 6 days of storage, the significantly maximum titratable acidity was observed in T_6 (1.89, 0.89 and 1.39%) whereas, minimum was found in T_1 (1.69, 0.69 and 1.19%) during 2019, 2020 and pooled data, respectively. In general, declining trend in titratable acidity was noticed in jamun in all the treatments with advancement in storage period (Table-3). Titratable acidity is directly related to the concentration of organic acids present in the fruit, which are important parameter in maintaining the quality of fruits. Ball (1997) [3] suggested that acidity decreases due to utilization of organic acids to sugars in fruits during storage. The reduction in titratable acidity during storage might also be due to the conversion of organic acids into sugars. In the control fruits the lower titratable acidity levels were recorded. Conversely, interventions to delay the senescence during storage can also delay the utilization of organic acids and hence such fruits should logically retain higher titratable acidity levels. The maximum titratable acidity was retained in T_6 (iron powder 1g/kg of fruits) up to six days of storage. The use of iron powder sachets within LDPE bags may have created conditions which delayed fruit senescence and therefore might have enabled the fruits to retain higher acidity levels. The slower decline in titratable acidity content of fruits packed with sachets containing iron powder is indicative of delaying senescence. The lowest mean titratable acidity was recorded in the control fruits, which could be described to the unhindered high metabolic activities occurring in them, resulting in the utilization of organic acids as respiratory substrates during storage. The present findings are in accordance with the findings of Collum *et al*. (1992) [6] in mango, Illeperuma and Jayasuriya (2002) [8] in mango, Sharma and Singh (2010) [16] in apple, Bron and Jacomino (2006) [5] in papaya, Silva *et al*. (2012) [17] in custard apple, Sood *et al*. (2012) [18] in strawberry and Teka (2013) [20] in tomato fruit.

Table 3: Effect of post harvest treatments on titratable acidity (%) of jamun fruits stored under ambient storage

Treatments	Days after storage								
	2			4			6		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	1.75	0.75	1.25	1.72	0.72	1.22	1.69	0.69	1.19
T_2	1.84	0.84	1.34	1.81	0.81	1.31	1.77	0.77	1.27
T_3	1.90	0.90	1.40	1.87	0.87	1.37	1.84	0.84	1.34
T_4	1.81	0.81	1.31	1.78	0.78	1.28	1.75	0.75	1.25
T_5	1.80	0.80	1.30	1.77	0.77	1.27	1.74	0.74	1.24
T_6	1.95	0.95	1.45	1.92	0.92	1.42	1.89	0.89	1.39
T_7	1.91	0.91	1.41	1.87	0.87	1.37	1.74	0.74	1.24
T_8	1.87	0.87	1.37	1.84	0.84	1.34	1.81	0.81	1.31
T_9	1.82	0.82	1.32	1.79	0.79	1.29	1.77	0.77	1.27
Mean	1.85	0.85	1.35	1.81	0.81	1.31	1.77	0.77	1.27
S. Em±	0.003	0.003	0.003	0.004	0.004	0.004	0.059	0.059	0.059
C.D. @ 1%	0.015	0.015	0.015	0.017	0.017	0.017	0.024	0.024	0.024

Initial value of titratable acidity was 1.20 (2019) and 1.80 (2020) %
T_1 - Control (Distilled water spray) T_6- Iron powder (1g/kg of fruits)
T_2 - $CaCl_2$ (1%) T_7 - Iron powder (1.5g/kg of fruits)
T_3 - $CaCl_2$ (2%) T_8 - $KMNO_4$ (5g/kg of fruits)
T_4 - GA_3 (50 ppm) T_9 - $KMNO_4$ (10g/kg of fruits)
T_5 - GA_3 (100 ppm)

3.5 Total Phenol (mg/100g)

The data pertaining to the influence of postharvest treatments of chemicals on phenols of jamun fruits is presented in Table 4. After second day of storage, the maximum phenols content was recorded in T_6 (204.51, 203.51 and 204.01 mg/100g) it was on par with T_2, T_3, T_7, T_8 and T9. The treatment T_1 (201.80, 200.80 and 201.30mg/100g) showed minimum anthocyanin content. After fourth day of storage, the highest phenols content was recorded in T_6 (204.02, 203.02 and 203.52 mg/100g). The treatment T_1 (194.00, 193.00 and 193.50 mg/100g) showed lowest phenols content. After sixth day of storage, the maximum phenols content was recorded in T_6 (201.20, 200.20 and 205.70mg/100g) it was on par with T_2, T_3, and T_9 during 2019 and Pooled data respectively and T_2, T_3, and T_7 during 2020. The treatment T_1 (186.76, 185.76 and 186.26 mg/100g) showed minimum phenols content during 2019, 2020 and pooled data, respectively

Phenolic compounds are widely distributed in fruits and are regarded as effective antioxidants (Rice *et al*., 1996) [11]. Generally, levels of phenols decrease during the storage of fruits thereby reducing the astringency. Phenols in the Jamun fruits recorded a decreasing trend during the storage (Table-4). Jamun fruits packed with iron powder (1g/kg of fruits) sachets retained maximum phenols during the storage period up to 6 DAS. Decrease in phenols during storage might be due to hydrolysis of phenols into sugar, acid and other compounds or it may be due to their transformation from soluble into insoluble form.

Table 4: Effect of post harvest treatments on total phenols (mg/100g) of jamun fruits stored under ambient storage

Treatments	Days after storage								
	2			4			6		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	201.80	200.80	201.30	194.00	193.00	193.50	186.76	185.76	186.26
T_2	203.59	202.59	203.09	201.59	200.59	201.09	200.84	199.84	200.34
T_3	203.71	202.71	203.21	202.02	201.02	201.52	200.92	199.92	200.42
T_4	201.25	200.25	200.75	197.59	196.59	197.09	197.24	196.24	196.74
T_5	201.41	200.41	200.91	198.74	197.74	198.24	196.01	195.01	195.51
T_6	204.51	203.51	204.01	204.02	203.02	203.52	201.20	200.20	200.70
T_7	203.66	202.77	203.16	198.20	202.15	197.70	196.17	199.18	195.67
T_8	204.08	203.08	203.58	195.94	194.94	195.44	199.39	198.39	198.89
T_9	203.77	202.66	203.27	203.15	197.20	202.65	200.18	195.17	199.68
Mean	203.08	202.08	202.58	199.47	198.47	198.97	197.63	196.63	197.13
S. Em±	0.32	0.32	0.32	0.29	0.29	0.29	0.40	0.40	0.40
C.D. @ 1%	1.31	1.31	1.31	1.19	1.19	1.19	1.64	1.64	1.64

Initial value of total phenols was 205 (2019) and 208.00 mg/100g

T_1 - Control (Distilled water spray)
T_2 - $CaCl_2$ (1%)
T_3 - $CaCl_2$ (2%)
T_4 - GA_3 (50 ppm)
T_5 - GA_3 (100 ppm)
T_6- Iron powder (1g/kg of fruits)
T_7 - Iron powder (1.5g/kg of fruits)
T_8 - $KMNO_4$ (5g/kg of fruits)
T_9 - $KMNO_4$ (10g/kg of fruits)

3.6 Total Antioxidant activity (%)

The data pertaining to the influence of postharvest treatments of chemicals on antioxidant activity of jamun fruits is presented in Table 5**.** After second day of storage, the maximum antioxidant activity was recorded in T_6 (91.54, 90.54 and 91.04%) which was on par with T_2 and T_7. The treatment T_1 (91.01, 90.01 and 90.51%) showed minimum antioxidant activity. After fourth day of storage, the maximum antioxidant activity was recorded in T_6 (90.66, 89.66 and 90.16%). The treatment T_1 (89.01, 88.01 and 88.51%) showed minimum antioxidant activity.After sixth day of storage, the maximum antioxidant activity was recorded in T_6 (87.63, 86.63 and 87.13%). The treatment T_1 (86.03, 85.03 and 85.53%) showed minimum antioxidant activity during 2019, 2020 and pooled data, respectively. Several phytochemicals, such as flavonoids, phenolic acids, amino acids, ascorbic acid, tocopherols and pigments might contribute to the total antioxidant activity of fruits (Cardner *et al*., 2000). In the present investigation, antioxidant activity decreased progressively during storage and the decrease in antioxidant activity was at lower magnitude in fruits under active packaging (Table-5). Decrease in phenol content and ascorbic acid also been observed with increase in storage period, thus the decrease in antioxidant activity could be attributed to phenol content and ascorbic acid. Jamun fruits packed with iron powder (1g/kg of fruits) sachets retained maximum antioxidant activity during the storage period up to 6 DAS. Serrano *et al*., (2010) [15] reported that antioxidant activity of strawberry stored under low O_2 or passive atmosphere was significantly higher than those packaged under high O_2 atmosphere. Similarly, Montero *et al*., (2010) [10] found higher retention of antioxidant activity of pineapple stored under low O_2 atmosphere.

Table 5: Effect of post-harvest treatments on total antioxidant activity (%) of jamun fruits stored under ambient storage

Treatments	Days after storage								
	2			4			6		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
T_1	91.01	90.01	90.51	89.01	88.01	88.51	86.03	85.03	85.53
T_2	91.51	90.51	91.01	90.23	89.23	89.73	87.53	86.53	87.03
T_3	91.43	90.43	90.93	90.45	89.45	89.95	87.43	86.43	86.93
T_4	91.24	90.24	90.74	89.31	88.31	88.81	86.30	85.30	85.80
T_5	91.31	90.31	90.81	89.34	88.34	88.84	86.30	85.30	85.80
T_6	91.54	90.54	91.04	90.66	89.66	90.16	87.63	86.63	87.13
T_7	91.53	90.53	91.03	89.39	88.39	88.89	86.43	85.43	85.93
T_8	91.32	90.32	90.82	89.27	88.27	88.77	86.21	85.21	85.71
T_9	91.30	90.30	90.80	89.20	88.20	88.70	86.13	85.13	85.63
Mean	91.35	90.35	90.85	89.65	88.65	89.15	86.66	85.66	86.16
S. Em±	0.01	0.01	0.01	0.11	0.11	0.11	0.01	0.01	0.01
C.D. @ 1%	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04

Initial value of total antioxidant activity was 92.50(2019) and 93.88 (2020) %

T_1 - Control (Distilled water spray)
T_2 - $CaCl_2$ (1%)
T_3 - $CaCl_2$ (2%)
T_4 - GA_3 (50 ppm)
T_5 - GA_3 (100 ppm)
T_6- Iron powder (1g/kg of fruits)
T_7 - Iron powder (1.5g/kg of fruits)
T_8 - $KMNO_4$ (5g/kg of fruits)
T_9 - $KMNO_4$ (10g/kg of fruits)

4. Conclusion

The fruits with sachets containing iron powder (1g/kg of fruits) extend shelf life up to 6 days at ambient storage and it was superior to all other treatments in maintaining better physiological behaviour, physico-chemical characters and organoleptic qualities under ambient storage conditions.

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