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Effect of chemicals on shelf-life of jamun (*Syzygium cuminii* (L.) Skeels) fruits

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Abstract
The present experiment was conducted at Department of Fruit Science and Horticulture Technology, Odisha University of Agriculture and Technology, Bhubaneswar during the year 2018-19 to determine effect of post-harvest treatments of chemicals on shelf-life of jamun fruits cv. CISH J 42. Eight treatments were taken with different chemicals and growth regulator concentrations $CaCl_2$ 1%, $CaCl_2$ 1.5%, Ca $(NO_3)_2$ 1%, Ca $(NO_3)_2$ 1.5%, GA_3 50 ppm, GA_3 100 ppm followed by perforated polythene packaging, polythene packaging without any chemical and control. This experiment revealed that fruits treated with 1.5% $CaCl_2$ and kept in perforated polyethylene bag, showed reduced in physiological loss in weight (59.364%), spoilage losses (58.333%), maintained the marketable quality (41.667%) and rendering them acceptable up to period of 6 days as compared to control (2 days) when stored under ambient condition.

Keywords: Jamun, shelf-life, post-harvest treatment, physical parameters

Introduction
The Jamun (*Syzygium cumini* (L.) Skeels) comes under family Myrtaceae. It has great significance due to its multifarious uses and capacity to withstand adverse climatic condition. It is also used as windbreak, avenue plantation, wasteland development and dry land horticulture. Due to its hardiness it can easily be grown in neglected and marshy areas where other fruit plants cannot sustain. It is one of the minor fruit with high medicinal as well as nutritional value. Powdered jamun fruits are used for treating diabetes (Patel *et al*., 2005) [8]. This tropical edible fruit can be a potentially rich source of natural antioxidant (Banerjee *et al.* 2005) [2]. According to Santiago *et al*., 2016 [9] the peel powder of jamun fruits gives intense and attractive colour also proved to be rich in dietary fibres and thus good ingredients for low calories diets as well as having low lipid content. According to Helmstaedter A., 2008 [7], seed kernel of jamun fruits reduce blood sugar level by 30%.

Jamun fruits generally ripen during April-July i.e. from summer to rainy season. These fruits are highly perishable and become inconsumable very soon. As it is a seasonal fruit, in the peak harvest period it cause market glut there by causing reduction in price tending to distress sale. Further, more the perishable nature of fruits cause spoilage loss, which is a great loss to the farmer. On the other hand nowadays, people are aware about the health benefits of jamun but its shelf life is a major hindrance for sufficient supply of jamun fruits throughout the year which also result in price hike. To delay the process of ripening, to reduce the post-harvest losses, various chemical as well as growth regulators have been used in solo or in combination. And also, to improve and maintain colour and quality by slowing down the metabolic activities of fruits, increase shelf-life and maintain the marketable quality for a longer period various chemical and growth regulator are used. Hence the main objective of this experiment to study the effect of chemicals on shilf life extention and quality of jamun fruits.

Materials and methods
This experiment was carried out in Completely Randomized Block Design. It contains eight treatments with three-time repetition. The treatments are T_1- $CaCl_2$ 1% + Perforated polythene bag, T_2- $CaCl_2$ 1.5% + Perforated polythene bag, T_3- Ca $(NO_3)_2$ 1% + Perforated polythene bag, T_4- Ca $(NO_3)_2$ 1.5% + Perforated polythene bag, T_5- GA_3 50 ppm + Perforated polythene

bag, T_6- GA_3 100 ppm + Perforated polythene bag, T_7- Perforated polythene bag and T_8- Without any chemical in open plate (control). The jamun fruits are harvested from an 8-year-old jamun tree cv. CISH J 42 at deep purple to black colour stage. After shorting the fruits are treated with different treatments and kept at room temperature. The reading was taken on 1st, 2nd, 3rd, 4th, 5th, 6th and 7th day of storage in the months of May – July. Day to initiation of shrivelling was calculated by counting the number of days from which day the day of shrivelling initiation starts. Total soluble solids was measure by hand refractometer. The other observations were taken by following formula.

$$\text{Physiological loss in weight (\%)} = \frac{initial\ weight - final\ weight}{initial\ weight} \times 100$$

$$\text{Spoilage loss (\%)} = \frac{number\ of\ rotten\ fruits}{total\ number\ of\ fruits} \times 100$$

$$\text{Marketable fruit (\%)} = \frac{number\ of\ marketable\ fruits}{total\ number\ of\ fruits} \times 100$$

Result

Physiological loss in weight

Different treatments significantly reduced the loss in weight as compared to control (T_8). Treatments T_7 (without any chemicals in perforated polythene bag) and T_8 (without any chemicals in open plate) showed the complete loses of fruit on 3rd day and the physiological loss in weight in 2nd day were 46.622% and 50.151% respectively. By comparing all the treatment on day 2 of storage we found that control show the maximum physiological loss in weight (50.151%) whereas the minimum physiological loss in weight showed by T_1 ($CaCl_2$ 1% having perforated polythene bag) (5.212%) which is at par with T_2 ($CaCl_2$ 1.5% with perforated polyethylene bag) (5.228%). T_1 ($CaCl_2$ 1% having perforated polythene bag) and T_6 (GA_3 100 ppm with perforated polythene bag) retained the fruits up to the same days (5 days), but the physiological loss in weight in T_6 is higher (82.778%) then T_1 (49.131%) on 4th day of storage. Chemical treatments at different concentration with packaging material had shown better reduction in physiological loss in weight compared to plant growth regulator at different concentration with packaging material. Three treatments T_2 ($CaCl_2$ 1.5% with perforated polyethylene bag), T_3 ($Ca(NO_3)_2$ 1% with perforated polyethylene bag), and T_4 ($Ca(NO_3)_2$ 1.5% with perforated polyethylene bag) retained the fruit longer period up to day 6 as compared to control. Among these treatments T_2 ($CaCl_2$ 1.5% having perforated polythene bag) recorded the minimum physiological loss in weight (59.364%) followed by T_4 ($Ca(NO_3)_2$ 1.5% with perforated polythene bag) (60.456%) and T_3 ($Ca(NO_3)_2$ 1.0% with perforated polythene bag) (86.534%).

Table 1: Effect of post-harvest treatments on physiological loss in weight (percent) of jamun fruits.

Treatment	Day1	Day2	Day3	Day4	Day5	Day6	Day 7
T_1	0.000	5.212	21.254	49.131	100.000		
T_2	0.000	5.228	12.464	29.439	49.353	59.364	100.000
T_3	0.000	5.784	16.082	31.657	53.174	86.534	100.000
T_4	0.000	7.229	17.569	35.187	53.924	60.456	100.000
T_5	0.000	18.657	86.275	100.000			
T_6	0.000	10.628	44.616	82.778	100.000		
T_7	0.000	46.622	100.000				
T_8	0.000	50.151	100.000				
SE(m)±		1.603	5.431	6.498	3.408	4.897	
CD at 5%		4.848	16.423	19.648	10.306	14.808	
CV (%)		14.859	18.897	17.046	7.194	9.632	

Spoilage of fruits

A perusal of the detail data presented in a tabular manner in table 2 indicate the percentage of jamun fruit spoil under different storage condition coupled with packaging material. It reveals that among all the treatment T_2 ($CaCl_2$ 1.5% with perforated polyethylene bag) exhibited the lowest spoilage loss (58.333%) followed by T_4 ($Ca(NO_3)_2$ 1.5% with perforated polythene bag) (63.889%) and T_3 ($Ca(NO_3)_2$ 1.0% with perforated polythene bag) (97.222%) at 6th day of storage. Other treatments got spoiled 100% before 6th day of storage considering the rate of spoilage in T_7 (without any chemical in perforated polythene bag) (100%) fruits spoil on the 3rd day as well as in T_8 (without any chemicals in open plate). On day 4 the treatments T_6 (GA_3 100 ppm with perforated polythene bag) and T_1 ($CaCl_2$ 1% having perforated polythene bag) and on day 5 the treatment T_5 (GA_3 50 ppm with perforated polythene bag) got spoiled. The minimum spoilage (58.333%) was recorded in T_2 ($CaCl_2$ 1.5% with perforated polyethylene bag), followed by T_4 (Ca (NO3)2 1.5% with perforated polyethylene bag) (63.889%) and T_3 ($Ca(NO_3)_2$ 1% with perforated polyethylene bag) (97.222%), on 6th day of storage which were the lowest than control.

Table 2: Effect of post-harvest treatments on spoilage (percent) of jamun fruits.

Treatments	Day 1	Day2	Day 3	Day 4	Day 5	Day6	Day 7
T_1	0	36.111	58.333	77.778	100.000		
T_2	0	11.111	22.222	38.889	47.222	58.333	100.000
T_3	0	30.556	66.667	77.778	86.111	97.222	100.000
T_4	0	13.889	30.556	44.444	50.000	63.889	100.000
T_5	0	44.444	88.889	100.000			
T_6	0	38.889	58.333	83.333	100.000		
T_7	0	55.556	100.000				
T_8	0	66.667	100.000				
SE(m)±		3.106	5.103	4.606	2.196	2.778	
CD at 5%		9.391	15.431	13.929	6.640	8.400	
CV (%)		14.478	13.469	10.258	4.453	5.350	

Days to initiation of shrivelling

The data pertaining to days to shrivelling initiation (days) at 1st, 2nd, 3rd, 4th, 5th, 6th and 7th day after storage presented in table 3 were observed and found significantly influenced by various post-harvest treatments. Treatments T_2 ($CaCl_2$ 1.5% + perforated polythene bag) and T_4 ($Ca(NO_3)_2$ 1.5% + perforated polythene bag) recorded significantly the late shrivelling initiation (1.5 days) after storage compared to rest of the treatments. T_7 (without any chemical in perforated polythene bag) and T_8 (without any chemicals in open plate) recorded early shrivelling initiation (1 day) after storage.

Table 3: Effect of post-harvest treatments on days no shrivelling initiation (days) during storage of jamun fruits.

Treatments	R1	R2	R3	Mean
T_1	1.5	1	1.5	1.333333
T_2	1.5	1.5	1.5	1.5
T_3	1.5	1.5	1	1.333333
T_4	1.5	1.5	1.5	1.5
T_5	1	1.5	1	1.166667
T_6	1	1	1.5	1.166667
T_7	1	1	1	1
T_8	1	1	1	1
SE(m)±				0.118
CD at 5%				0.356
CV (%)				16.33

Marketable fruits

The observations were recorded on percentage marketable fruits as influenced by various post-harvest treatments and noticed significantly influenced at 1st, 2nd, 3rd, 4th, 5th, 6th and 7th day after storage are presented in figure 1. The perusal of the figure reveals that on 2nd day the maximum marketable fruit percentage retained by T_2 ($CaCl_2$ 1.5% with perforated polythene bag) (88.889%) followed by T4 ($Ca(NO_3)_2$ 1.5% with perforated polyethylene bag) (86.111%) and T_3 ($Ca(NO_3)_2$ 1% with perforated polyethylene bag) (69.444%) and the minimum marketable fruit percentage retain by T8 (without any chemical in open plate) (33.333%) followed by T_7 (without any chemical in perforated polythene bag) (44.444%). The treatments T_2 ($CaCl_2$ 1.5% with perforated polythene bag) and T_4 ($Ca(NO_3)_2$ 1.5% with perforated polyethylene bag) retained relatively high percentage of marketable fruit every day and also good percentage of fruits (41.667% and 36.111% respectively) for long storage period that is up to day 6 as compared to others. It also revealed that the chemicals treatment show better result as compared to growth regulators, on the other hand we found that the perforated polythene bag had beneficial effect over open condition.

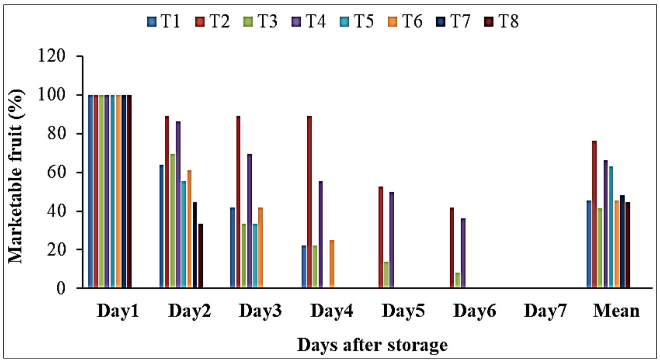

Fig 1: Effect of post-harvest treatments on marketable fruit (percentage) during storage of jamun fruits.

Discussion

Physiological loss in weight

It is evident from the present study that the loss in weight was significantly reduced (59.364%) when the jamun fruits were post-harvestly treated with $CaCl_2$ 1.5% and stored in perforated polythene bag under ambient temperature condition up to 6th days. Whereas the control treatment were completely damaged on 3rd day of storage. Jamun is a perishable fruit owing to its thin and soft pericarp which is very feeble to protect its inner content. To add it has a higher moisture percentage of 79.21%. The membranous epicarp coupled with semisolid inner contents tend to its low keeping quality and high physiological loss in weight. However treatment with $CaCl_2$ minimise the rate of respiration, the breakdown of protein, the rotting incidence by maintaining fruit firmness. The reduction in physiological loss in weight by calcium chloride treatment may be due to the role of calcium on limiting respiration, which was attributed to an altered membrane permeability. Calcium could have reduced the endogenous substrate catabolism during respiration by limiting the diffusion of substrate from the vacuole to the cytoplasm and favoured the uptake of sorbitol, thus, disallowing its involvement in reactions related to internal breakdown. This type of experimental findings was also reported by Bangerth *et al.* (1972) [3] Haribabu and Shantakrishnamurthy (1993) [6], Singh *et al.* (2010) [13], Ayar *et al.* (2011) [1], Butani *et al.* (2016) [4], Dalvadi *et al.* 2018) [5].

Spoilage of fruits

The spoilage of fruits is the resultant effect of different causes. It may be by external agency or by internal causes. In aseptic condition when we prevent the external spoilage causing organism, the internal factor comes main factor of spoilage. In the present experiment the minimum spoilage was increased with the fruit treated with $CaCl_2$ 1.5% and package in perforated polythene bag 58.333% on 6th day of storage. But the fruit packed in perforated polythene bag after treating with $Ca(NO_3)_2$ 1.5% has a spoilage percentage of 63.889% on 6th day of storage. All the untreated control either inside the perforated polythene or outside spoiled with in 3rd day. This may be due to the internal breakdown of the carbohydrate material and formation of intermediary products which emits foul smell. The reduction in fruit rot with the application of calcium may possibly be due to its effect on firmness of fruit tissue by retarding rate of respiration and preventing cellular disintegration by maintaining synthesis, which leads to delayed senescence (Singh *et al.* 1993) [12]. This type results were also reported by Singh *et al.* (2010) [13], Butani *et al.* (2016) [4], Dalvadi *et al.* (2018) [5].

Marketable fruits

In general marketable fruits percentage were reduced with the advancement of storage period. The higher percentage of marketable fruits was obtained only when there had been reduction loss in weight, spoilage loss and maintaining desirable quality of the fruits with respect to chemical constituents. In the present investigation, the maximum percentage of marketable fruit was recorded with $CaCl_2$ 1.5% and package in perforated polythene bag everyday followed by ($Ca(NO_3)_2$ 1.5% with perforated polyethylene bag) and also maintained the satisfactory marketable fruit percentage for a long storage period of 6 days as compared to others. $CaCl_2$ 1.5% and package in perforated polythene bag had marketable percentage 41.667% followed by ($Ca(NO_3)_2$ 1.5% with perforated polyethylene bag) (36.111%). This may be due to the fact that calcium chloride extend the storage life of fruits by minimizing the rate of respiration, protein breakdown, rotting incidence and physiological disorder. This corroborates the finding of Bangerth *et al.* (1972) [3], Scott and Wills (1975) [10], Sharma *et al.* (1996) [11], Butani *et al.* (2016) [4] and Dalvadi *et al.* (2018) [5].

Day to initiation of shrivelling

A perusal of the detailed data presented in the preceding chapter relating to the character concerned reveals that, the treatments combination of $CaCl_2$ 1.5% with perforated polythene bag and Ca $(NO_3)_2$ 1.5% with perforated polythene bag resulted late initiation of shrivelling by 1.5 days followed by treatments combination of $CaCl_2$ 1% with perforated polythene bag and Ca $(NO_3)_2$ 1% with perforated polythene bag which was in 1.3 days. However, the shrivelling started in the control treatment irrespective of inside polybag or outside in the 2nd day i.e. next day of storage. This may be due to the effect of Ca treatment on fruit firmness by retarding the rate of respiration and preventing cellular disintegration. So, the integrity is maintained in treated fruits as the cell wall is made up of calcium pectate. This agrees with the findings of Butani *et al.* (2016) [4].

Conclusions

On the basis of the above findings, it may be concluded that jamun fruits should be treated with $CaCl_2$ 1.5% and packed in perforated polyethylene bag. This treatment proved to be the best post-harvest treatment for reduction in physiological loss in weight, as well as spoilage loss. Thus it is recommended that fruits should be treated with $CaCl_2$ 1.5% just after harvest and packed in perforated polyethylene bags can be kept at ambient temperature conditions with an extended shelf life from two days to six days. However it needs a further verification after continuing the research for another season.

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