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Effect of Surface Coating and Wrapping Materials on Extending Shelf-Life of Litchi Fruits (*Litchi chinensis* Sonn.) Cv. Deshi

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Abstract

Shelf-life of litchi fruits is very poor and losses its quality within two days after harvest at room temperature. To extend the shelf-life of litchi fruits the experiment was conducted at the Department of Horticulture, Institute of Agriculture Sciences, BHU, Varanasi to find out the effect of surface coating of different concentrations of calcium nitrate (1 %, 1.5% and 2 %) and hot water treatment for five minutes followed by fruit wrapping in newspaper and perforated polythene on extending shelf-life of litchi (*Litchi chinensis* Sonn.) cv. Deshi. Fruits without treatment were considered as control. The experiment was conducted in completely randomized design with three replications and observations were recorded on alternate day up to 13 days of storage. A significant minimum percentage (19.90 %) of physiological loss in weight was recorded in T_{10} (2.0 percent calcium nitrate + perforated polythene wrapping) and a maximum percentage (29.80%) in control. It was observed that fruits treated with 1% and 2.0% calcium nitrate in combination with perforated polythene bags (T_8 and T_{10}) recorded minimum losses (16.60%) and (1810%) due to spoilage respectively. as compared to control (38.20%) on 11th day of storage. Significantly maximum economic life up to the 11th day of storage were recorded in perforated polythene wrapping with different concentration of calcium nitrate. Significantly maximum TSS (23.00%) was recorded in T_{10} and minimum (19.00%) in T_{11}treatments. Total Sugar Content was recorded as significantly highest (16.60%) in polythene wrapping along with 1.5 and 2.0% calcium nitrate and hot water (T_9, T_{10} and T_7) and minimum (14.20%) in control. On the 11th day of storage the most effective treatments were T_7, T_9, and T_{10} showed the trace intensity of infestation for rotting as compared to control (T_{11}) and newspaper wrapping alone (T_1). Based on the above observations, it could be suggested that fruit dipping in calcium nitrate at 2.0 per cent concentration with polythene wrapping (20% vent) gives better results for extending the shelf- life of litchi fruit at room temperature.

Key words : *Litchi, post-harvest treatments, calcium nitrate, storage life, economic life.*

Introduction

Litchi (*Litchi chinensis* Sonn.) fruit is one of the finest and fascinating gifts of the nature. It is one of the most important evergreen sub-tropical fruit crops of family Sapindaceae believed to have originated in the area near southern China, possibly northern Vietnam (1). It is called queen-of-fruits having excellent fruit quality, bright red peel colour, pleasant flavour, juicy flesh (aril) and attractive appearance which is closely related to fruits like longan and rambutan. It is also an excellent source of vitamins and minerals (2). Since its fruits are very delicate and it lose their bright red colour and turns brown within 24-36 hours after harvest at ambient temperatures (3). The major factors reducing the storage life and marketability of litchi fruit are microbial decay and pericarp browning. Pericarp browning is the first visual sign of fruit of deterioration, rapid desiccation (4) and increased polyphenol oxidase activity (5), which has been reported to be proportional to temperature, humidity and storage time (6) and attack of pathogens. Low temperature storage at 1-5 degrees C is used to reduce pathological decay. Under refrigeration, litchi fruit has a storage life of approximately 30 days (7). Wrapping materials are supposed to become barriers for the direct effect on the environment. Hot water treatment creates a disturbance in the normal physiological functions of the fruits. Keeping the above facts in view the objective of the present study was the effect of calcium coating and different wrapping materials for extending the shelf-life of litchi.

Materials and Methods

The experiment was conducted in the Department of Horticulture, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Fresh, uniform size and maturity and free from pests and diseases fruits of cv. Deshi was selected for the experiment. The experiment was carried out in a completely randomized design (CRD) with three replications at room temperature. 200 fruits per treatment per replication were taken. These post-harvest

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treatments are T_1 – Newspaper wrapping, T_2 – Newspaper wrapping + hot water treatments 50 ± 2°C for 5 minutes, T_3 – Newspaper wrapping + calcium nitrate 1.0 %, T_4 – Newspaper wrapping + calcium nitrate 1.5 %, T_5 – Newspaper wrapping + calcium nitrate 2.0 % , T_6 – Polythene wrapping (20% vent), T_7 – Polythene wrapping + hot water treatments 50 ± 2°C for 5 minutes, T_8 – Polythene wrapping + calcium nitrate 1.0 %, T_9 – Polythene wrapping + calcium nitrate 1.5 %, T_{10} – Polythene wrapping + calcium nitrate 2.0 % and T_{11} – Control. Newspaper in size 60 30 cms and 50-gauge thickness of 45 cm x 30 cm in size perforated polythene bag were used as wrapping materials. Different concentrations of calcium nitrate (1.0, 1.5, and 2.0 percent) were used for dip treatments of fruits for 5 minutes. The hot water treatment of litchi fruits was given in an electrically operated bath of 40-gallon capacity and required temperature 50 ± 2°C for 5 minutes then fruits were taken out and dried under the electric fan. Such treated fruits, either wrapped with newspaper or polythene were kept in bamboo baskets at room temperature. Observation to be recorded were physiological loss in weight (P.L.W. %), spoilage and economic life of fruits (%), total soluble solid, total sugar and loss in volume (%), change in size (%), economic life of fruits, total sugar (%) and intensity of rotting due to pathogen.

Physiological loss in weight (P.L.W.) : The cumulative physiological loss in weight (P. L. W.) of the fruits in percent was calculated at alternate day on the original weight basis using the following formula :

$$\text{Physiological loss in weight (P.L.W.) per cent} = \frac{\text{Original weight} - \text{Final weight}}{\text{Original weight}} \times 100$$

Loss due to spoilage of fruits : The spoiled fruits was collected each day on replication wise from all the treatments. The fruits so obtained were counted and the percentage of spoiled fruits on each day was calculated by using the following formula :

$$\text{Percentage of spoilage} = \frac{\text{No. of spoiled fruits}}{\text{Original number of fruits}} \times 100$$

Economic life of fruits : The economic life of fruits was recorded by observing the day on which cumulative number of fruits due to spoilage subjected to a particular treatment exceeded 15 percent.

Total soluble solids (T.S.S.) : The T. S.S. of fruits (°Brix) was recorded with the help of hand refractometer on alternate day and values corrected to 20°C.

Total sugar : 10 ml of juice was hydrolysed by adding 3 ml of conc. HCl. It was left for 24 hours. After that it was neutralised by adding sodium hydroxide 4N solution. For complete neutralization blue and red litmus papers were used. This solution was then titrated against Fehling A and B as in the case of reducing sugar and the percentage of total sugar were worked out.

Isolation and identification of the pathogen : The rotten fruits of each replications were collected from all the treatments to day of observation were used for isolation and identification of the organism. The isolation and purification of the organisms were done according to the methods suggested by (8). The organisms from the diseased parts of the fruits were sub- cultured and were allowed to grow in petri dishes for sporulation. Thereafter, the cultures were examined under the microscope for their identification, potato Dextrose Agar (PDA) medium autoclaved at 15 pounds pressure for 20 minutes was used for maintaining the isolated organisms. To test the pathogenicity of the organisms so isolated fresh fruits were surface sterilized with 70 percent alcohol. The culture kept in Petri dishes in agar media were inoculated on fresh fruits by pricking the skin of the fruit (9). Later on, the pathogens were re-isolated from diseased spots of fresh fruits and the organisms so isolated were compared with those found in original culture. After that morphological characters of the organisms were studied under a microscope. General symptoms and taxonomical aspect of the pathogen was also studied.

Results and Discussion

Physiological loss in weight (P.L.W.) : The perusal of data in Table-1 indicated that there was a gradual increase in physiological loss in weight but the rate of increase differed amongst the treatments. Generally, the the maximum rate of increase in physiological loss in weight was observed in untreated fruits (T_{11}) and minimum loss was recorded in fruits treated with different concentrations of calcium nitrate and kept in perforated polythene bags which was closely followed by perforated polythene (20% vent) bags alone or in combination with hot water treatments. Significant minimum physiological loss in weight (19.90 percent) was observed in treatments T_{10} (2.0 per cent calcium nitrate with perforated polythene) each day followed by T_8 (1.0 per cent calcium nitrate with perforated polythene), T_9 (1.5 per cent calcium nitrate with perforated polythene), T_7 (hot water treatment with perforated polythene) and T_6 (perforated polythene alone) finally showing the values 19.92, 20.90, 21.10 and 21.30 per cent respectively on the 13th of storage when the experiment was terminated. Significantly maximum loss (33.00 per cent) in P.L.W. was observed in each day of storage in fruits of control (T_{11}) followed by paper wrapping (31.80 percent) on similar days of observation. Similar findings were reported by (10). The maximum loss of weight in these fruits might be due to the maximum loss of moisture caused by a higher rate of transpiration and respiration through uninterrupted an atmosphere. The

Table-1 : Cumulative physiological loss in weight (P.L.W. %) of litchi cv. Deshi fruits during storage.

Treatment	1st day	3rd day	5th day	7th day	9th day	11th day	13th day
	23/5	25/5	27/5	29/5	31/5	2/6	4/6
T_1	0.00	6.00	10.50	16.50	23.10	28.90	31.80
T_2	0.00	5.80	10.40	15.90	22.60	28.40	31.60
T_3	0.00	5.70	10.40	16.00	22.50	28.40	31.50
T_4	0.00	5.60	10.30	15.90	22.00	28.30	31.50
T_5	0.00	5.50	10.20	15.47	22.20	28.30	30.73
T_6	0.00	1.50	5.10	10.20	14.40	18.10	21.30
T_7	0.00	1.50	4.90	10.00	15.30	18.60	21.10
T_8	0.00	1.40	4.90	10.20	15.00	18.60	19.92
T_9	0.00	1.50	4.80	10.00	15.00	18.60	20.90
T_{10}	0.00	1.40	4.80	10.10	14.90	18.60	19.90
T_{11}	0.00	6.80	11.80	18.50	24.40	29.80	33.00
SE(m)±	0.00	0.40	0.24	0.29	0.19	0.16	0.16
CD at 5%	0.00	1.15	0.69	0.84	0.54	0.46	0.44
CV %	0.00	6.51	2.58	2.39	1.26	0.96	0.87

Table-2 : Spoilage per centage and economic life (days) of litchi cv. Deshi fruits during storage.

Treatment	1st day	3rd day	5th day	7th day	9th day	11th day	13th day	Economic life in days
	23/5	25/5	27/5	29/5	31/5	2/6	4/6	
T_1	0.00	0.00	5.50	13.00	18.00	27.10	31.90	7
T_2	0.00	0.00	4.60	12.70	18.00	26.20	30.70	7
T_3	0.00	0.00	3.70	9.10	16.90	21.70	27.10	9
T_4	0.00	0.00	4.60	9.70	16.30	22.60	27.10	7
T_5	0.00	0.00	4.30	9.10	12.70	19.90	26.50	9
T_6	0.00	0.00	4.90	11.80	19.00	25.60	29.00	7
T_7	0.00	0.00	0.00	4.60	7.80	15.70	23.50	9
T_8	0.00	0.00	0.00	0.00	5.50	11.20	16.60	11
T_9	0.00	0.00	0.00	0.000	4.20	11.80	19.00	11
T_{10}	0.00	0.00	0.00	0.00	3.70	11.80	18.10	11
T_{11}	0.00	0.00	8.20	14.20	25.30	32.20	38.20	5
SE(m)±	0.00	0.00	0.49	0.30	4.06	0.24	0.18	
CD at 5%	0.00	0.00	1.39	0.87	NS	0.68	0.52	
CV%	0.00	0.00	10.24	3.86	34.02	1.55	1.04	

Table-3 : Total soluble solids (°Brix) of litchi cv. Deshi fruits during storage.

Treatment	1st day	3rd day	5th day	7th day	9th day	11th day	13th day
	23/5	25/5	27/5	29/5	31/5	2/6	4/6
T_1	17.70	20.20	21.70	22.80	21.60	20.20	19.30
T_2	17.60	19.80	21.40	22.60	22.80	21.20	20.40
T_3	17.70	19.80	21.20	22.50	22.90	21.20	20.60
T_4	17.70	19.70	21.20	22.60	23.00	21.50	20.70
T_5	17.40	19.70	21.30	22.50	23.00	21.40	20.70
T_6	17.70	19.20	20.20	21.40	22.20	22.40	22.20
T_7	17.60	19.80	19.90	21.20	22.40	23.00	22.50
T_8	17.40	18.70	20.00	21.00	22.70	23.00	22.60
T_9	17.40	18.70	19.90	21.00	22.80	22.90	22.60
T_{10}	17.60	18.80	19.80	20.90	22.80	23.00	22.70
T_{11}	17.70	20.70	22.70	20.20	19.70	19.00	18.40
SE(m) ±	0.00	0.36	0.40	0.23	0.29	0.33	0.30
CD at 5%	0.00	1.06	1.16	0.67	0.85	0.97	0.88
CV %	0.00	3.20	3.30	1.81	2.25	2.63	2.46

Table-4 : Total sugar (per cent) of litchi cv. Deshi fruits during storage.

Treatment	1st day	3rd day	5th day	7th day	9th day	11th day	13th day
	23/5	25/5	27/6	29/5	31/5	2/6	4/6
T_1	12.80	14.10	15.10	16.10	15.50	14.80	13.90
T_2	12.70	14.00	14.90	15.50	16.10	15.40	14.20
T_3	12.80	13.80	14.40	15.40	16.00	15.50	14.60
T_4	12.60	13.80	14.40	15.40	16.20	15.50	14.70
T_5	12.80	13.70	14.20	15.30	16.10	15.40	14.80
T_6	12.70	13.70	14.20	15.20	15.90	16.00	15.00
T_7	12.70	13.50	14.10	15.10	15.70	16.50	15.50
T_8	12.60	13.30	14.00	14.90	15.60	16.40	15.50
T_9	12.60	13.30	14.00	14.80	15.50	16.60	15.60
T_{10}	12.80	13.30	13.90	14.80	15.40	16.60	15.60
T_{11}	12.70	14.70	16.30	15.50	14.40	14.20	13.80
SE (m) ±	0.07	0.11	0.07	0.13	0.29	0.21	0.24
CD at 5%	NS	0.31	0.19	0.37	0.86	0.62	0.71
CV %	0.09	1.35	0.78	1.45	3.22	2.33	2.84

Table-5 : Intensity of fruit rot of litchi cv. Deshi during storage.

Treatments	5th day	7th day	9th day	11th day	13th day	Microorganism associated
T_1	+	++	+++	++++	++++	*Aspergillus sp., Colletotrichum sp.*
T_2	+	++	++	+++	++++	*Aspergillus sp.*
T_3	+	++	++	++	+++	*Aspergillus sp., Alternaria*
T_4	+	+	++	+++	++++	*Aspergillus Sp., Penicillium sp.*
T_5	+	+	++	+++	++++	*Aspergillus Sp., Alternaria Sp.*
T_6	+	++	+++	+++	++++	*Aspergillus Sp., Penicillium Sp, Alternaria.*
T_7	-	-	+	+	++	*Aspergillus Sp.,*
T_8	-	-	+	++	++	*Aspergillus sp., Fusarium sp.*
T_9	-	-	+	+	++	*Aspergillus sp., Rhizopus sp.*
T_{10}	-	-	+	+	++	*Aspergillus sp., Botryodiplodia sp.*
T_{11}	+	++	+++	++++	+++++	*Aspergillus sp., Collectotrichum sp, Alternaria sp., Penicillium sp.*

Intensity of rotting	0	Free from rotting-	(Free)
(on the basis of surface area)	1-5 per cent	Fruit area infected	+ (Trace)
	6-10 per cent	Fruit area infected	++ (Light)
	11-15 per cent	Fruit area infected	+++ (Moderate)
	16-20 per cent	Fruit area infected	++++ (Severe)
	> 20 per cent	Fruit area infected	+++++ (Very severe)

minimum loss of weight during storage of litchi under different concentrations of calcium nitrate with perforated polythene wrapping might be due to the dual action of calcium nitrate coating and polythene wrapping. These results are in agreement with findings of (11). The best results obtained using perforated polyethylene wrapping were earlier reported also in grape fruits (12) and mandarin (13).

Spoilage and economic life of fruits : The spoilage percentage and economic storage life of fruits under different treatments are presented in Table-2. The economic life of fruits in days was calculated by identifying the data on which the fruits experienced more than 15 per cent of loss due to spoilage. The economic storage life of the fruits during storage of untreated fruits (T_{11}) was 5 days only whereas the maximum economic life of 11 days was observed in fruits of treatments T_{10} T_8 and T_9 which were followed by T_7 (Hot water with perforated polythene), T_5 and T_3 (2.0 and 1.0 per cent calcium nitrate with newspaper wrapping) showing economic life up to 9 days. On 13th day of storage all treatments expressed the spoilage percentage above 15 per cent showing uneconomic viability for storage when the experiment was terminated. Significant minimum spoilage percentage (16.60 per cent) was found in the fruits of treatment T_8 (1.0 per cent calcium nitrate with perforated polythene) it was closely followed by T_{10} and T_9 (2.0 per cent 1.5 per cent calcium nitrate with perforated polythene) showing spoilage percentage 18.10 and 19.00 respectively. The significant maximum spoilage percentage of 38.20 was

recorded in untreated fruits of control (T_{11}). These results were in agreement with the findings of (14).

Less spoilage under newspaper wrapping might be due to a barrier from room atmosphere for fungal growth. Calcium nitrate under different concentrations might have played an effective role in maintaining the vigour and resistance capacity to fight against the pathogens resulting less spoilage of fruits under these treatments. Less spoilage or delay the quality deterioration during storage may be due to spraying with different concentrations of calcium that could inhibit the activities of polygalactonase enzyme (PG) and peroxidase (POD) slow the accumulation of membranaceous peroxide (NDA) in cells (15). (10) reported that polyvinyl chloride (PVC) film wrapping might be more effective than polyethylene film for extending the shelf life of litchi fruits. (13) concluded that the fruits stored in 200 gauged perforated polypropylene bags recorded the best results.

Total soluble solids : Data indicated significant maximum T.S.S. (23.00 ^{0}Brix) was found in the stored fruits of treatment $T_{10,}$ T_7 and T_8 treatments followed by T_9 (22.90) and T_6 (22.40) treatments on the eleventh day of storage. On same day minimum T.S.S. (19.00 ^{0}Birix) found in fruits of control (T_{11}). On the basis of the above results it could be inferred that application of different concentrations of calcium nitrate in combination with perforated polythene bags was most effective in increasing and retaining the T.S.S. of stored fruits Perforated polythene wrapping alone was also effective in this regard. The total soluble solids content of the fruits increased gradually under storage up to 5th day of storage afterward it decreased except perforated polythene wrapped fruits treated with different concentrations of calcium nitrate which expressed maximum T.S.S. on the 13th day when storage was terminated. The minimum T.S.S. was recorded in untreated fruits (T_{11}) on the 13th day when storage was terminated. The results aree in agreement with the findings of (16) in litchi, (12) in grapes, (17) in peach, (18) in guava, (18) in mango fruits. This might be due to the conversion of cell wall material such as pectin and hemicelluloses in reducing substances during storage was responsible for increasing T.S.S. The increase in T.S.S. (^{0}Brix) might be associated with the transformation of pectic substances, starch, or other polysaccharides into soluble sugar. Declined T.S.S. in some treatments might be due to the degradation of total soluble substances due to the prolonged period of storage. A slow but gradual rise in T.S.S. of fruits treated with calcium nitrate and wrapped in perforated polythene bags might be due to restricted ripening and senescence.

Total sugar : The total sugar percentage during storage is presented in Table-4. The perusal of data revealed that the total sugar content of fruits gradually increased up to the 5th day in all the treatments, showing maximum value in fruits of control (T_{11}). From the 7th day started a decline in total sugar per cent in the fruits of control (T_{11}) whereas there was increasing trend in other treatments showing the maximum value in T_1 (newspaper wrapping). Significant maximum percentage of total sugar was recorded from 16.40 per cent to 16.60 per cent in T_7 (hot water + perforated polythene wrapping), T_9 (1.5 per cent calcium nitrate + per forted polythene wrapping) and T_{10} (2.0 per cent calcium nitrate + perforated polythene wrapping) which were statistically at par. Significantly minimum total sugar 14.20 percent was recorded in fruits of T_{11} (control) in same day for storage. Based on above results, it can safely be inferred that perforated polythene combined with hot water and all concentrations of calcium nitrate dip treatments were most effective in increasing and maintaining the total sugar up to the 11th day of storage whereas the fruits under control could exhibit the maximum total sugar up to 5th day of storage. The results are in close agreement with the findings of (19, 20). This might be due to a slower rate of conversion of starch and polysaccharides into sugar in treated fruits in comparison to untreated ones. After the storage due to senescence the reduction in sugar content might have followed.

Intensity of rotting due to pathogen : Rotting of fruits is a common phenomenon which appeared during storage. Pathogens are responsible for the rotting and ultimate spoilage and deterioration in quality of the fruit. The intensity of rotting of litchi fruit as a result of different treatments during storage was estimated on the basis of surface area of the fruits and pathogens responsible for spoilage were identified and presented in Table-5.

The critical perusal of table-5 indicated that there was no infestation of the micro-organism up to the 7th day in fruits treated with hot water and wrapped in perforated polythene (T_7) and all concentrations of calcium nitrate with perforated polythene wrapping (T_8, T_9, T_{10}). Rest of the treatments including control (T_{11}) showed a a trace to light intensity of the infestation of micro- organism for rotting like *Aspergillus* sp*., Collototrichum* sp*., Alternaria, and Penicillium.. On 9*th day of storage rotting infestation was noticed with trace intensity in fruits treated with hot water and wrapped in perforated polythene (T_7) and all concentrations of calcium nitrate with perforate polythene wrapping (T_8, T_9, T_{10}). In rest of the treatments light to moderate intensity of infestation was noticed. On 11th day of storage the most effective treatments were T_7 (Hot water with perforated polythene), T_9 (1.5 per cent calcium nitrate + perforated polythene wrapping), T_{10} (2.0 per cent calcium nitrate + perforated polythene wrapping), showing the trace intensity of infestation for rotting but severe intensity of infestation was observed in fruits of

control (T_{11}), T_1 (news paper wrapping alone) and rest of the treatment showed light to moderate intensity of infestation. Besides above-mentioned micro-organisms *Fusarium, Rhizopus, and Botryodipodia* were also responsible for the rotting.

The polythene bags might have provided the congenial temperature evolved due to respiration of fruits and humidity by arresting the transpired moisture for the fungal growth. Calcium nitrate and perforated polythene might have inhibited the fungal growth. The results of above findings are found to be in by view of (18). Similar results were found by (21) who reported that the young litchi fruits were latently infected by the Pathogen (*Colletotrichum glocosporioides*) at 20 days after initial fruit setting. (22) also reported similar results in guava, litchi and apples.

Conclusions

It can safely be concluded that all concentrations of calcium nitrate (1.0, 1.5 and 2.0 percent) dip with perforated polythene (20% vent) treatments were equally most effective in enhancing the shelf-life of fruits up to the 11th day whereas, at normal room temperature it was 5 days only and were found to maintain the desirable shelf-life and physico-chemical properties of litchi fruit cv. Deshi.

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