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Influence of Post-Harvest Treatments on Physiological Loss in Weight (PLW) and Bio-Chemical Changes in Litchi cv. Shahi

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ABSTRACT

A laboratory research work was conducted to measure the physiological loss in weight (PLW) and biochemical changes of litchi cv Shahi as influenced by chemical treatments and storage conditions. The chemical treatments were C_0 (Control), C_1 (Sodium metabisulphite 0.3% + 3% HCl dip), C_2 (Sodium metabisulphite 0.6 % + 3% HCl dip), C_3 (Sodium Nitroprusside @ 0.05 mM), C_4 (Sodium Nitroprusside @ 1.0 mM), C_5 (Salicylic acid @ 0.5 mM), C_6 (Salicylic acid @ 1.0 mM), C_7 (Chitosan @ 1%), C_8 (Chitosan @ 2%) and storage conditions were T1 (room temperature) and T_2 (4°C + perforated LDPE bag). The experiment was laid out in two factors Completely Randomized Design (CRD) with three replications during 2018. All these treatments were examined for fruit morphological changes (physiological loss in weight during storage), total soluble solids and acid contents in fruit during storage. Overall result showed that the minimal physiological loss in weight (4.90%) was found in salicylic acid @ 0.5 mM at 4^{O}C with perforated LDPE bags along with the highest TSS (18.40 ^{0}Brix) and less acid content (0.45%) in fruit even at 6 DAH without decay incidence.

Keywords Litchi, PLW, Temperature, Quality, Storage.

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INTRODUCTION

Litchi (*Litchi chinensis* Sonn.) is one of the most relished sub-tropical fruit belonging to family sapindaceae. Litchi fruits are famous for its excellent quality, pleasant flavor and attractive color. Edible parts are fleshy white aril surrounding the seed. Litchi is a native of South China and Chinese consider this as the most unique gift of nature. Litchi reached India by the end of 17th century through Burma and from there, it spread to many countries. China, India, South Africa, Madagascar, Israel, Mauritius, USA, Indonesia, Philippines, Taiwan, Thailand, Australia, Brazil and Vietnam are the litchi growing countries in the world (Lemmer 2002). The short span of fruit availability coupled with poor shelf life limits the duration of availability of litchi fruits in the domestic as well as international market. The fruits are available

from 15th May to 15th July as location specific and the shelf life can be extended up to 2 to 3 weeks. At present the export of fresh litchi fruit from India is negligible. Demand for litchi fruit is quite high due to its delicious taste, unique aroma and juicy nature but supply is limited due to its highly perishable and non climacteric with little change in soluble solids concentration on titratable acidity after harvesting the fruit deteriorate rapidly unless proper handling techniques are employed. The major factors reducing the storage life and the marketability of litchi fruit are microbial decay and pericarp browning. Moreover, the fruit deteriorate rapidly when removed from cold storage. Cold storage is mostly used to decline respiration rate, ethylene production and extension of post-harvest shelf life of fruit (Fattahi *et al.* 2010). Fruits also get spoiled soon after the harvest due to physiological and microbiological changes. Browning is associated with ascorbic acid oxidation which enhances anthocyanin degradation. Techniques to reduce browning and maintain the red color and prolonged storage life include packaging in perforated plastic bags and storage under cold conditions (Neog and Saikia 2010). Litchi fruits are very susceptible to postharvest decay and degradation of anthocyanin through enzymatic oxidation of phenolics by polyphenol oxidase and/or peroxidase (Sun *et al.* 2010). A wide range of fungal pathogens, bacteria and yeast have shown to cause postharvest disease in litchi fruits. Technique to alleviate the pericarp browning, control of postharvest decay and to extend the storage life of litchi fruit have included sulfur fumigation, fungicide dips, application of plant growth substances, waxes and chitosan coating (Kumar *et al.* 2017 and Shiekh *et al.* 2013), use of microbial antagonist, irradiation and acid treatment. Since most of the chemicals are being restricted to use commercially and have been proved as health hazards. So, alternative methods need to focus in reducing major post-harvest problem in order to produce light colored, chemical- free fruit without disease or insect infestation. Increased post-harvest losses along with high demand of fresh fruits has stricken the development of different storage technologies and handling protocols to enhance and prolong the overall quality during storage (Mangaraj *et al*. 2010). Modified atmospheric packaging, shrink wrap and vacuum packaging have been widely postulated to keep the fruit afresh with good quality for long time. Although India is the second largest producer of litchi, a commercially viable technique is not available here for its shelf life extension. Non-availability of a proper technique is the biggest barrier for ambitious vendors involved in trade of litchi fruits. The development of technology in an integrated manner by using different level of chemicals and stored under modified atmospheric condition with LDPE packaging can offer a practical solution to the difficulties associated with litchi.

MATERIALS AND METHODS

The experiment was conducted at the School of Agricultural Sciences and Rural Development, Department of Horticulture, Medziphema, Nagaland University during the period of May, 2018. The fruit of litchi cv Shahi were collected from a SASRD orchard in Medziphema. Fully matured with flattened tubercles (smooth epical) and bright pinkish-red colored fruit were randomly harvested from all sides of the canopy along with a portion of the branch on second week of May 2018. Immediately after harvest, the fruits were taken to the research laboratory where fruit with a short stalk (2 inches) were detached from the branches with the help of secateurs. Large and uniform sized and colour, free from damage or blemishes were selected and also pre-cooled it by immersing it in ice water for five minutes. It is then immersed in different chemical treatment for two minute and packed using polypropylene bags for control temperature and without polypropylene bag for room control. The experiment was laid out in a completely two factors Randomized Design (CRD) with three numbers of replication and eighteen treatments consisting of 75 fruits in each replication. These eighteen treatment combination were as follows: i) C_0T_1-Control + Room temperature without perforated LDPE bags, ii) C_0T_2–Control and 4°C with perforated LDPE, iii) C_1T_1- Sodium Metabisulphite (0.3%) +3% HCl dip + Room temperature without perforated LDPE bags, iv) C_1T_2-Sodium Metabisulphite (0.3%) +3% HCl dip and 4°C with perforated LDPE, v) C_2T_1-Sodium Metabisulphite (0.6%)+3% HCl dip + Room temperature without perforated LDPE bags, vi) C_2T_2 - Sodium Metabisulphite (0.6%) +3% HCl dip + 4°C with perforated LDPE, vii) C_3T_1-Sodium Nitroprusside (SNP) @ 0. 5 mM + Room temperature without per-

forated LDPE bags, viii) C_3T_2 - Sodium Nitroprusside (SNP) @ 0. 5 mM + 4°C with perforated LDPE, ix) C_4T_1 - Sodium Nitroprusside (SNP) @ 1.0 mM + Room temperature without perforated LDPE bags, x) C_4T_2 - Sodium Nitroprusside (SNP) @ 1.0 mM + 4°C with perforated LDPE, xi) C_5T_1 - Salicylic acid @ 0.5mM + Room temperature without perforated LDPE bags, xii) C_5T_2 - Salicylic acid @ 0.5 mM + 4°C with perforated LDPE, xiii) C_6T_1 - Salicylic acid @ 1.0 mM + Room temperature without perforated LDPE bags, xiv) C_6T_2 - Salicylic acid @ 1.0 mM + 4°C with perforated LDPE, xv) C_7T_1 - Chitosan @ 1% + Room temperature without perforated LDPE bags, xvi) C_7T_2-Chitosan @ 1% + 4°C with perforated LDPE, xvii) C_8T_1 - Chitosan @ 2% + Room temperature without perforated LDPE bags, xviii) C_8T_2-Chitosan @ 2% + 4°C with perforated LDPE.

Physiological loss in weight (PLW)

The fruit weight was measured with the help of top pan balance and the average weight of all the samples kept in LDPE packages as well as control samples were recorded daily using a weighing balance having least count 0.001g. The physiological losses in weight (%) of the samples were noted down at 12 hours interval and continued up to 72 hours on the basis of the produce and computed using the following formula:

$$\text{PLW \%} = \frac{W_1 - W_2}{W_1} \times 100$$

Where W_1 and W_2 are the initial and final weight of the fruits in gram (Mangaraj and Goswami 2011).

Total soluble solids

The total soluble solid (TSS) concentration of litchi fruits was analyzed every two days interval starting from first day of harvesting to sixth day of storage in freeze as well as in room condition and the TSS content of the fruit was determined with the help of ERMA hand refractometer, calibrated at 20°C. The reading was corrected as per international correction table and the result was represented as °Brix (AOAC 1984).

Total titratable acidity

It was determined every two days interval by titrating the extracted juice against N/10 NaOH using phenolphthalein as indicator and expressed in percentage (AOAC 1984).

$$\text{\% Acid} = \frac{\text{Titrate x normality of alkali x meq wt. of acid x 100}}{\text{volume of sample}}$$

Note: mille equivalent (meq) weight of citric acid is 0.064.

RESULTS AND DISCUSSION

Physiological loss in weight (%)

Data presented in Table 1 depicts the significant difference in the physiological loss in weight (PLW) of fruits as influenced by the chemical treatments, temperature and their interactions. The results indicated that refrigerated condition with LDPE bag have marked influence on the PLW of the fruit during storage. It was noted that the fruit stored at 4°C + perforated LDPE bag (T_2) storage condition followed a slower rate weight loss in fruits indicating by 9.30% at 72 hours after harvesting while the fruits kept under room temperature without perforated LDPE bag (T_1) showed 12.00% loss in weight at end of 72 hours. The possible reason to reduce weight loss might be due to evaporation and transpiration processes. The fruits treated with different chemical concentrations had a significant influence during storage of fruits. However, in general, the fruits treated with salicylic acid at 0.5 mM (C_5) had a slight edge over other treatment during observation having the least fruit weight loss up to 72 hours after harvested (7.60%) followed by sodium metabisulphite @ 0.6% + 3% HCl (C2) with 8.80 % and Sodium Nitroprusside (SNP) @ 1.0 mM (C_4) with 8.90% whereas, the highest weight loss was observed in C_8 (Chitosan @ 2%) with 13.50% at 72 hours after harvest. The lowest level of PLW (4.90%) was recorded when the fruits was treated with salicylic acid @ 0.5 mM and stored at 4°C with perforated LDPE bag (C5T2). Kazemi *et al*. (2011) also found the lowest PLW loss in apple fruits during storage treated with salicylic acid and stored in the control temperature. Salicylic acid is well known as a

Table 1. Effect of temperature, chemicals and their interaction on physiological weight loss (%) in litchi cv Shahi.

Treatments	12 hrs	24 hrs	36 hrs	48 hrs	60 hrs	72 hrs
Temperature (T)						
T_1 (Room temperature	0.70	2.20	4.00	6.10	9.00	12.00
T_2 (4°C + perforated LDPE bag)	0.30	1.30	2.70	5.10	6.60	9.30
SEm±	0.02	0.04	0.06	0.04	0.06	0.06
CD at 5%	0.07	0.11	0.17	0.13	0.17	0.17
Chemicals (C)						
C_0	0.70	2.20	4.00	6.10	9.00	12.00
C_1	0.30	2.60	3.50	5.20	6.20	9.80
C_2	0.40	0.40	1.70	4.30	3.40	8.80
C_3	0.50	0.70	3.80	7.00	8.60	13.40
C_4	0.60	0.60	2.50	5.10	6.10	8.90
C_5	0.30	1.50	1.90	3.40	4.20	7.60
C_6	1.00	2.90	4.40	7.30	9.10	12.00
C_7	0.40	2.60	4.90	8.30	9.90	13.30
C_8	0.80	3.30	6.10	6.50	7.90	13.50
SEm±	0.05	0.08	0.12	0.09	0.13	0.10
CD at 5%	0.15	0.24	0.35	0.27	0.37	0.30
Interactions (C × T)						
C_0T_1	0.70	2.20	4.00	6.10	9.00	12.00
C_0T_2	0.30	1.30	2.70	5.10	6.60	9.30
C_1T_1	0.40	3.60	4.30	5.90	11.00	11.00
C_1T_2	0.30	1.60	2.60	4.60	6.20	8.40
C_2T_1	0.50	0.40	2.30	5.10	5.00	11.00
C_2T_2	0.30	0.30	1.10	3.40	3.40	6.50
C_3T_1	0.90	1.10	4.50	8.00	11.00	14.00
C_3T_2	0.20	0.20	3.00	6.10	8.60	13.90
C_4T_1	0.80	0.80	2.70	5.20	7.10	10.00
C_4T_2	0.40	0.40	2.30	5.00	6.10	7.90
C_5T_1	0.40	1.90	2.20	4.30	8.20	10.00
C_5T_2	0.20	1.20	1.40	2.60	4.20	4.90
C_6T_1	1.10	2.70	4.50	7.50	9.10	13.00
C_6T_2	0.90	3.10	4.20	7.10	9.10	11.40
C_7T_1	0.50	3.40	5.00	8.60	10.50	13.00
C_7T_2	0.20	1.70	4.80	8.00	9.90	13.20
C_8T_1	0.50	1.70	2.40	3.60	7.00	10.00
C_8T_2	0.20	1.90	3.50	6.60	7.90	12.40
SEm±	0.07	0.12	0.17	0.13	0.18	0.15
CD at 5%	0.21	0.34	0.50	0.38	0.52	0.42

signal molecule in the induction defense mechanisms in plants and decrease respiration through inhibition of biosynthesis and prevent ACO activity that is the direct precursor of ethylene and decrease Reactive Oxygene Species (ROS) with increase enzyme antioxidant activity and inhibit ethylene production in kiwifruit (Fattahi *et al.* 2010). The chemical treatments and storage condition have great significant effects on the PLW (%) in progress of storage. The fruits stored at T_2 (4°C + perforated LDPE bag) was found to show less PLW than those stored in T_1 (room temperature without perforated LDPE bag). Fruit treated with salicylic acid @ 0.5mM 4°C + perforated LDPE bag showed less PLW on all days of observation. Similar findings were concurrent with Kumari *et al.* (2015) who showed that PLW loss was significantly higher in untreated fruit than in the fruits subjected to salicylic acid and packed in perforated LDPE package. Shugaev *et al.* (2014) found the effects of salicylic acid (0.5 mM) on mitochondrial respiration and it reduced the respiratory control ratio by 25% in the taproots and 35% in cotyledons. Barman and Asrey

(2014) also mentioned that the loss of mango fruit weight with the advancement of storage period could be controlled with salicylic acid and it was assumed due to the fact that salicylic acid suppressed the transpiration rate of mango fruit by closing the stomata of the treated fruit.

Changes in TSS (°B)

The data pertaining to the TSS content as influenced by storage conditions and different chemical treatments and their interaction are shown in Table 2. The results indicated that storage conditions have marked influence on the TSS content of the fruit during storage. A general increasing trend in TSS content of fruit under different storage condition and chemically treated fruits was found to be vary significantly from 0 DAH to 6 DAH (p=4.0777E-09). It is suspected that an increase in TSS might be due to ripening changes in fruit right after harvesting (Aklimuzzaman *et al.*

Table 2. Effect of temperature, chemicals and their interaction on TSS and acidity of litchi cv Shahi.

Treatments	TSS^{0}B				Acidity (%)			
	0 DAH	2 DAH	4 DAH	6 DAH	0 DAH	2 DAH	4 DAH	6 DAH
Temperature (T)								
T_1 (Room temperature)	15.10	15.60	15.63	15.64	0.63	0.61	0.58	0.56
T_2 (4°C + perforated LDPE bag)	15.40	16.13	16.46	16.80	0.60	0.58	0.56	0.52
SEm±	0.12	0.05	0.03	0.04	0.006	0.004	0.003	0.005
CD at 5%	NS	0.51	0.09	0.12	0.01	0.01	0.01	0.01
Chemicals (C)								
C_0	15.35	15.85	15.87	16.12	0.63	0.60	0.58	0.56
C_1	15.50	15.73	15.95	16.12	0.63	0.61	0.59	0.55
C_2	14.88	15.45	15.8	16.05	0.59	0.59	0.57	0.49
C_3	15.05	15.70	15.83	16.26	0.62	0.61	0.61	0.49
C_4	15.83	15.78	15.93	16.02	0.63	0.57	0.56	0.57
C_5	15.67	16.27	16.25	16.15	0.58	0.51	0.50	0.49
C_6	15.10	16.47	16.48	16.47	0.63	0.61	0.60	0.61
C_7	15.15	16.00	16.12	16.33	0.59	0.56	0.55	0.53
C_8	14.97	15.52	16.17	16.52	0.64	0.61	0.57	0.51
SEm±	0.25	0.11	0.07	0.09	0.01	0.007	0.01	0.01
CD at 5%	NS	1.08	0.19	0.25	0.03	0.02	0.02	0.03
Interactions (C × T)								
C_0T_1	14.83	15.33	15.33	15.50	0.63	0.61	0.58	0.56
C_0T_2	15.87	16.37	16.40	16.77	0.60	0.58	0.56	0.52
C_1T_1	15.33	15.40	15.50	15.60	0.65	0.63	0.60	0.55
C_1T_2	15.67	16.07	16.40	16.80	0.61	0.58	0.58	0.55
C_2T_1	14.83	15.33	15.70	15.77	0.54	0.54	0.53	0.51
C_2T_2	14.93	15.57	15.90	17.03	0.63	0.59	0.56	0.47
C_3T_1	15.33	15.40	15.50	15.40	0.60	0.56	0.56	0.50
C_3T_2	14.77	16.00	16.17	16.90	0.63	0.60	0.56	0.49
C_4T_1	16.00	15.40	15.30	15.37	0.67	0.60	0.60	0.56
C_4T_2	15.67	16.17	16.57	16.67	0.60	0.60	0.59	0.59
C_5T_1	15.33	15.67	15.13	15.55	0.63	0.62	0.59	0.56
C_5T_2	16.00	16.87	17.37	18.40	0.53	0.52	0.47	0.45
C_6T_1	14.67	16.17	16.23	16.03	0.64	0.68	0.66	0.64
C_6T_2	15.53	16.77	16.73	16.90	0.62	0.57	0.58	0.58
C_7T_1	15.10	16.10	16.00	16.10	0.63	0.61	0.60	0.57
C_7T_2	15.20	15.90	16.23	16.57	0.54	0.52	0.50	0.50
C_8T_1	14.80	15.27	16.00	16.10	0.63	0.59	0.53	0.53
C_8T_2	15.13	15.77	16.33	16.67	0.65	0.63	0.58	0.50
SEm±	0.35	0.16	0.09	0.12	0.01	0.01	0.01	0.01
CD at 5%	NS	1.53	0.27	0.36	0.04	0.03	0.03	0.04

2011). The fruits stored at 4°C under perforated LDPE bag (T_2) had higher TSS content with 16.80°B while the lowest TSS content under room temperature without perforated LDPE bag (T_1) with 15.64°B at end of storage period (6 DAH). The present finding of increase in TSS were in close conformity with the finding of Kazemi *et al.* (2011) who reported that total soluble solids content of fruit during storage was considered an index of fruit ripening during storage and increased in TSS corresponds to a conversion of starch to soluble sugars. The fruits treated with different chemicals also showed the significant influence on changes of TSS content in fruits with progress of storage period. The fruits treated with chitosan @ 2% (C_8) showed the highest TSS (16.52°B) while the lowest in sodium metabisulphite @ 0.6% + 3% HCl (C_2) with 16.05^{0}B at end of storage (6 DAH). Chemicals, storage condition and their interactions have depicted significant influence on the TSS content of fruits on most of observation. The highest level of TSS (18.40^{0}B) was observed by salicylic acid @ 0.5 mM stored at 4°C with perforated LDPE bag (C_5T_2) which was followed by Sodium Metabisulphite (0.6%) +3% HCl dip + 4°C with perforated LDPE (C_2T_2) with 17.03^{0}B while the lowest was noticed in control (C_0T_1) with 15.50°B. Bal and Celik (2010) showed the highest TSS content of kiwifruit treated with salicylic acid @ 0.5mM over other postharvest treatments. Total soluble solids increased steadily among the samples treated with higher level of salicylic acid (Ali *et al.* 2013) also found to decrease titratable acidity initially in all treatments with a rapid decline in control followed by salicylic acid (2mM) up to 12 days at ambient storage condition in apricot fruit. Aklimuzzaman et al. (2011) also noted to decrease the acidity with progress in storage period in litchi.

CONCLUSION

Post-harvest treatments with chemicals and different storage condition along with packaging materials results in the alteration of morphological attributes on post-harvest quality of litchi fruits. The litchi fruits treated with salicylic acid @ 0.5mM and stored at 4 0C with perforated LDPE bags is considered the best treatment and can be potentially used as pre-storage components to control physiological weight loss and decay as well as to maintain a steady TSS and acid content in fruits.

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