Studies on Effect of Pre-Harvest Fruit Bagging on Yield and Quality of Litchi (*Litchi chinensis*)

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Abstract: ***The present investigation entitled "Studies on Effect of Pre-Harvest fruit Bagging on Yield and Quality of Litchi (Litchi chinensis)" was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat During 2021-2022. The experiment was laid out in Randomized Block Design (RBD) with seven (7) treatments and three (3) replications. The treatments taken under the study were Control (T_1), Non-woven Red (T_2), Non-woven Blue (T_3), Non-woven White (T_4) Non-woven Green (T_5), Non-woven Yellow (T_6) and Polypropylene (T_7). The maximum fruit weight (17.81g), fruit volume (20.00cc), fruit breadth (3.16cm), fruit length (3.56cm), aril weight (14.28g), peel weight (2.31g) and yield (0.44kg/bunch) were recorded in T_4 (Non-woven White). Sun burn (8%) and fruit cracking (5.66%) percentage was observed lowest in T_4. T_4 was found the highest in case of total soluble solids (16.63ºB), total sugar (15.35%) and ascorbic acid (23.65mg/100g) whereas, it recorded lowest in titratable acidity (0.63%). Deep red colour fruits of T_7 (Polypropylene) was due to high amount of anthocyanin content (38.11mg/100g). During storage, highest shelf life was observed in T_4 i.e. 10.50 days. Thus, it can be concluded that all the bags studied in the present experiment were found to be good both in qualitative and quantitative characters and also increased shelf life. But the most superior one among the selected bags was non-woven white bag in terms of morphological, biochemical and shelf life characteristics.***

Keywords: Fruit bagging, litchi, yield, quality

1. Introduction

Litchi (*Litchi chinensis*), popularly known as 'Queen of subtropical fruits' is an origin to Southern China and belongs to the family Sapandaceae and sub-family Nepheleae. Litchi fruit has two species, one is *Litchi philippinensis* and another is *Litchi chinensis*. Litchi is one of the least adaptable of tropical and subtropical fruit crops, which flowers and fruits grow well only in areas which consistently experience cool dry winters (Menzel, 2001). For its enchanting red peel colour, excellent physico-chemical fruit quality, sweet blended with acid, juicy and crispy aril & its characteristics pleasant aroma and flavor, litchi is popular now a days. At present scenario, it has a strong commercial value in domestics and international market. Litchi fruit is rich in nutritional values. It has good amount of sugar, TSS (15.90-20.10ºB) and ascorbic acid (27.8mg/100g). The fruit has also some source of mineral elements such as potassium (170.00mg), phosphorus (30.00-42.00mg), calcium (8.00-10.00mg), iron (0.40mg) and sodium (3.00 mg). The moisture content of the fruits is about 77-83% and acid content of the fruits is 0.2-0.64%. The major problems responsible for low yield of litchi cultivation are poor fruit set and inferior fruit quality well as other factors like irregular flowering, heavy fruit drop, poor fruit retention, alternate bearing, fruit cracking, small fruit size and low yields are reported wherever litchi is grown, hampering its development as a major commercial crop. Among several such alternatives, pre-harvest fruit bagging emerged as an effective approach in different parts of the World. In this technique, individual fruit or fruit bunches are bagged on the tree for a specific period.

2. Materials and Methods

Litchi (*Litchi chinensis*) cv. 'Piyaji' was selected for the study. The seven-treatment comprised of different coloured of non-woven bagging materials (Non-woven Red, Non-woven Blue, Non-woven White, Non-woven Green, Non-woven yellow and Polypropylene) with one un-bagged were selected. Bagging for each treatment was distributed equally in three directions and different height of tree canopy to avoid possible influence on treatment effects. Fruits bagged and non-bagged (control) fruits were harvested at commercial mature stage. Parameters like fruit weight, fruit volume, fruit breadth, fruit length, aril weight, peel weight, yield, shelf life, pericarp sunburn and fruit cracking percentage were evaluated. Quality attributes like TSS, acidity, ascorbic acid, total sugar and anthocyanin content were estimated. Data were analysed statistically by adopting RBD. The level of significance for different variables was tested at 5% value of significance.

3. Results and Discussion

The data presented in Table 1 fruit length was significantly influenced by the bagging treatments. The fruit length under different treatments were control (3.10cm), Non-woven Red (3.36cm), Non-woven Blue (3.40cm), Non-woven White (3.56cm), Non-woven Green (3.30cm), Non-woven yellow (3.43cm) and Polypropylene (3.53cm). Highest fruit length of 3.56cm was recorded in white non-woven bagged fruits followed by polypropylene bagged fruits (3.53cm) whereas, the lowest fruit length of 3.10cm was observed in un-bagged fruits. Increased fruit length in bagged fruits might be due to

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rapid cell division and expansion under favourable micro-climate. The results obtained are endorsed with the findings of Debnath and Mitra (2008) and Senanan *et al*. (2011) in litchi.

Fruit breadth under different treatments were (Control) 2.70cm, (Non-woven Red) 2.86cm, (Non-woven Blue) 2.80cm, (Non-woven White) 3.16cm, (Non- woven Green) 3.06cm, (Non-woven Yellow) 3.03cm and (Polypropylene) 3.13cm. The highest fruit breadth of 3.16cm was found in Non-woven White which was statistically at par with Polypropylene 3.13cm and Non-woven Green 3.06cm and lowest was found in Control *i.e.* 2.70cm. Earlier studies made by several workers also have similar findings like Debnath and Mitra (2008) and Senanan *et al*. (2011) in litchi , Ghalib *et al*. (1988), El- Kassas *et al*. (1995), Harhash and Al-Obeed (2010), Kassem *et al*. (2011) and Mostafa *et al*. (2014) in datepalm.

The maximum fruit weight (17.81g) was recorded when fruits were bagged with white non-woven bags whereas the minimum fruit weight (14.09g) was noticed when fruits were not bagged. Similar findings were observed by Fumuro and Gamo (2001) in persimmon and Debnath and Mitra (2008) in litchi fruits. This trend in fruit weight might be attributed due to the favourable microclimate created inside the bags which increased accumulation of assimilates leading to maximum fruit weight.

The data presented in Table 1, shows that fruits bagged with white non-woven bags had higher fruit volume (20.00 cc) while it was found lowest (14.33 cc) in unbagged fruits. Similar results have been obtained by Daniells and Farell (1992) who reported that the higher fruit volume in banana fruits might be due to higher humidity and appropriate microclimate inside the bags, which results in proper growth and development of fruits.

Maximum value (14.28g) of fruit aril weight was obtained when fruits were bagged with white non-woven bags while the minimum fruit aril weight (9.73g) was observed in unbagged fruits. Similar results were obtained by Zhou et al. (2012) in Canarium album, El-Kassas et al. (1995), El-Shazly (1999) in date palm fruits.

Table 1: Fruit length, Fruit breadth, Fruit volume and Fruit Weight

Treatment	Fruit length (cm)	Fruit breadth (cm)	Fruit volume (cc)	Fruit weight (g)
T1 (Control)	3.1	2.7	14.33	14.09
T2 (Non-woven Red)	3.36	2.86	15.66	15.11
T3 (Non-woven Blue)	3.4	2.8	17.33	15.02
T4 (Non-woven White)	3.56	3.16	20	17.81
T5 (Non- woven Green)	3.3	3.06	16	14.9
T6 (Non-woven Yellow)	3.43	3.03	16.67	14.76
T7 (Polypropylene)	3.53	3.13	18.67	16.39
S.Ed (±)	0.05	0.04	1.12	0.14
CD (P=0.05)	0.01	0.13	2.45	0.32

Maximum peel weight was observed in Non-woven White *i.e.* 2.31g which was statistically at par with Non-woven Red (2.23g), Polypropylene (2.12g), Non-woven Yellow (2.08g), Non-Woven Blue (2.06g), Non-woven Green (1.98g). Minimum peel weight was recorded in T_1 (Control) *i.e.* 1.37g. Harhash & Al-Obeed (2010) reported that bagging treatment could lead to modifying nutrients and phytochrome metabolism in fruits during development which lead to the thicker skin in bagged fruits.

Table 2: Peel weight, Aril weight and Yield

Treatment	Peel weight (g)	Aril weight (g)	Yield (Kg/Bagging)
T1 (Control)	1.37	9.73	0.35
T2 (Non-woven Red)	2.23	11.08	0.38
T3 (Non-woven Blue)	2.06	11.88	0.37
T4 (Non-woven White)	2.31	14.28	0.44
T5 (Non- woven Green)	1.98	13.19	0.37
T6 (Non-woven Yellow)	2.08	12.7	0.37
T7 (Polypropylene)	2.12	12.09	0.41
S.Ed (±)	0.17	0.69	0.09
CD (P=0.05)	0.38	1.53	0.01

The maximum fruit yield of 0.44kg was found in non-woven white bagged fruits followed by polypropylene (0.41kg), whereas minimum yield of 0.35kg was found in control *i.e.* un-bagged fruits. Earlier studies made by several workers also have similar findings like Harhash & Al-Obeed (2010) and Kassem *et al*. (2011) in date palm, Abdel Gawad-Nehad *et al*. (2017) in mango and Senanan *et al*. (2011) in litchi.

Minimum fruit cracking (5.66%) was observed in fruits with white non-woven bags and maximum observed in control group (11%). The declining trend in fruit cracking may have resulted due to reduced moisture stress inside the bags (Sanyal *et al*., 1990). Similar finding had been reported by Son and Kim (2010) and Li Juan *et al*. (2003) in grape, Yang *et al*. (2009) in longan fruit, Ma *et al*. (2009) in peach and Abd El- Rhaman (2010) in pomegranate.

The least sunburn percentage of 8% was observed in fruits bagged with white non-woven bags and maximum sunburn percentage (14%) was found in un-bagged fruits. The reduction in pericarp sunburn inside the bagged fruits might be due to protection of fruits from direct sunlight during hot and scorching summer. These results are in conformity with the findings of Hong and Zhengming (2001) as they found bagging protected the navel orange from sunburn.

Table 3: Sunburn, Fruit Cracking and Shelf life

Treatment	Sun burn %	Fruit cracking %	Shelf life (Days)
T1 (Control)	14	11	8.06
T2 (Non-woven Red)	11	9	9.03
T3 (Non-woven Blue)	10	7	9.5
T4 (Non-woven White)	8	5.66	10.5
T5 (Non- woven Green)	12	9	9.17
T6 (Non-woven Yellow)	11.66	7.33	9.03
T7 (Polypropylene)	12	7.66	9.83
S.Ed (±)	1.05	1.21	0.27
CD (P=0.05)	2.32	2.66	0.6

Bagging also influence the shelf life of litchi fruit. The fruits harvested from the non-woven white bags had highest shelf life of 10.50 days as the fruits from the bags were always dry, healthy and had no insect and disease infestation, less susceptible to decay %. Modified microenvironment around the fruits delayed the ripening in bagged fruits as compared to un-bagged ones resulting in the improvement in shelf life of litchi fruit. Similar results were also reported by Akter *et al*. (2020) in mango.

Highest TSS content of litchi fruits was found in fruits bagged with non-woven white bags *i.e.* 16.63ºB and lowest in un-bagged or control group *i.e.*14.53ºB. Difference observed in TSS content amongst all the treatments might be due to high temperature inside the bags which helped in conservation of starch and other polysaccharides into sugar. This result is in conformity with Debnath and Mitra (2008) in litchi fruits, Harhash and Al-obeed (2010) in datepalm.

Amongst the different treatments used, lowest titratable acidity percentage of 0.63% was noticed in fruits bagged with non-woven white bags which was closely followed by fruits bagged with polypropylene (0.64%) whereas, highest (0.99%) acidity was noted in un-bagged fruits. Reduced content of acidity in bagged fruits might be due to an improved microclimate created around the bagged fruits, which helped in increase translocation of carbohydrates and metabolic conversion of acid into sugars resulting in reduction of titratable acidity content as compare to un-bagged fruits.

Highest (15.35%) total sugar content was recorded in fruits bagged with white non-woven bags and minimum (10.47%) in un-bagged fruits. The increase in level of total sugars inside the bagged fruits might be due to creation of modified atmospheric climate/micro climate around bagged fruit which help in increased enzymatic activity of sucrose synthase (SS) and sucrose-phosphate synthase (SPS). Sucrose synthase is an enzyme that plays an important role in sucrose decomposition.

In the present study maximum ascorbic acid (23.65mg/100g) was recorded in fruits bagged with white non-woven bags followed by polypropylene bags (23.45mg/100g) whereas, minimum ascorbic acid (20.91mg/100g) was found in un-bagged fruits. Similar findings were also achieved by Changqing *et al.* (2006) and Yang *et al*, (2006) in longan. Hongxia *et al.* (2009) concluded in Zill mango that single white layer type of bags tended to produce fruits with increased content of ascorbic acid over control.

Table 4: TSS, Total sugar and Titratable acidity

Treatment	TSS (ºBrix)	Total sugar (%)	Titratable acidity (%)
T1 (Control)	14.53	10.47	0.99
T2 (Non-woven Red)	15.26	12.43	0.73
T3 (Non-woven Blue)	15.23	12.64	0.72
T4 (Non-woven White)	16.63	15.35	0.63
T5 (Non- woven Green)	15.33	13.08	0.78
T6 (Non-woven Yellow)	15.43	12.58	0.79
T7 (Polypropylene)	16.03	15.01	0.64
S. Ed (±)	0.35	0.56	0.06
CD (P=0.05)	0.78	1.22	0.13

Maximum anthocyanin content (38.11mg/100g) in the peel was found in the fruits bagged with polypropylene bags which was followed by fruits bagged with white non-woven bags (38.06mg/100g) whereas, the minimum (35.15mg/100g) recorded in un-bagged fruits. It is reported that bagging increases the light sensitivity of fruit which stimulates the anthocyanin synthesis and due to increase temperature inside the bags the anthocyanin synthesis was hastened at harvesting time when the fruits mature and hence accumulation of anthocyanin increases. The above results are in accordance with the findings of Tyas *et al.* (1998) and Debnath and Mitra (2008) in litchi, Ju (1998) in apple, Wu *et al.* (2013) in mango.

Table 5: Ascorbic acid and Anthocyanin

Treatment	Ascorbic acid (mg/100g)	Anthocyanin (mg/100g)
T1 (Control)	20.91	35.15
T2 (Non-woven Red)	22.03	35.9
T3 (Non-woven Blue)	21.79	37.44
T4 (Non-woven White)	23.65	38.06
T5 (Non- woven Green)	21.63	36.76
T6 (Non-woven Yellow)	21.84	35.89
T7 (Polypropylene)	23.45	38.11
S.Ed(±)	0.56	0.48
CD (P=0.05)	1.23	0.92

4. Conclusion

From the above discussion, it can be concluded that both the qualitative and quantitative parameters of litchi fruits were enhanced at the time of harvest and also during the storage period by pre-harvest fruit bagging using various bagging materials. However, bagging of litchi fruits with white non-woven bags may be recommended to enhance the physical, physiological and biochemical parameters of litchi fruits which can fetch high remuneration to the growers of litchi.

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