Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 3018-3023
Received: 05-07-2020
Accepted: 11-08-2020

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# Effect of edible coating and packaging on postharvest life and quality of litchi (*Litchi chinensis* Sonn.) fruits during storage

**Shubham, NK Mishra, Ravi Kumar, Ankit Dongariyal, Ratna Rai and Manoj Kumar Arya**

## Abstract
The effect of packaging and edible coating on the storage life and quality of 'Rose Scented' litchi was investigated. The litchi fruits were treated with different coating material including Guar Gum, Xanthan Gum and Methyl cellulose (low viscosity and high viscosity) at different concentration (0.5%, 1.0%, 2.0%, 2.5%) and stored at 4 ± 1 °C under 90 ± 5% RH. During storage, observations on biochemical attributes were recorded at 2 days interval. The experimental results demonstrated that packaging and edible coating had a significant effect in maintaining fruit TSS, pH, acidity, ascorbic acid, total sugar, reducing sugar and non-reducing sugar as compared to non-coated fruits. Fruits coated with guar gum 1.5% and packed in perforated brown paper bags at the end of 12 days of storage at low temperature, a significant increase in fruit TSS (18.45 $^0$B), ascorbic acid (24.78 mg), total sugar (12.62%), reducing sugar (10.32%) and non-reducing sugar (2.19%) was observed, whereas the pH (6.73) and titratable acidity (0.221%) were significantly decreased in guar gum 1.5% coated 'Rose Scented' litchi. Thus, postharvest application of guar gum 1.5% as an edible coating and perforated paper bags as packaging material can effectively maintain the quality and extend the storage life of litchi cv. Rose Scented up to 10 days under low temperature storage condition.

**Keywords:** Litchi, edible coating, packaging, postharvest loses, storage

## Introduction
Litchi (*Litchi chinensis* Sonn.) also known as 'Queen of fruits' is an important subtropical fruit crop of the family Sapindaceae. India is the second largest producer of litchi after China. In India, the litchi is cultivated in an area of about 92 (000 ha), with a total production of 583 (000 MT) with a productivity of 6.3 t/ha (NHB, 2017) [13]. Due to the specific climate requirement, its cultivation is limited to particular pockets. Fruits are borne in the terminal panicles with a development cycle of about 4 months. It possesses pinkish or bright red colored skin and has juicy and sweet edible aril. It is a non-climacteric fruit and does not ripe off the trees after harvest. So, its fruit should be harvested at proper maturity stage to ensure its characteristic quality (Jiang *et al*., 2006) [8]. However, ripe litchi fruit perish rapidly after harvest and lose their attractive color in 1-2 days during ambient conditions due to skin browning (Sivakumar *et al*., 2010) [18, 19]. Browning of litchi fruit reduces visual quality and negatively affects purchase decision of the consumers in the markets eventually leading to significant economic losses (Sivakumar *et al*., 2010) [18, 19]. Sulfur dioxide is one of the most commonly used anti-browning chemical at commercial scale in litchi industry. It primarily inactivates polyphenol oxidase enzyme and reduce browning of litchi fruit (Zhang *et al*., 2018) [22]. However, due to potent allergic reactions in the end users and packaging house workers the use of sulphur is not appropriate for litchi fruit. It imparts negative effects and leads to decreased edible quality because of sulphur-induced enhanced aril acidity (Sivakumar *et al*., 2010) [18, 19]. Thus, environmentally friendly, safe and natural alternative treatment is needed which not only maintains quality of the treated fruit but is also safe for the consumers and packaging house persons. Coating application could be considered highly suitable because litchi fruit are consumed after peeling. The said coatings provide an effective barrier that eventually leads to reduced mass loss, delayed ripening and maintained quality (Mahajan *et al*., 2018) [11]. In particular surface coating is made by applying a thin layer of an edible material on the product surface (Allegra *et al*. 2016) [3]. This coating inhibits the moisture migration and slows down the oxidative processes, improving food quality and handling of food products. Until now, the effects of edible coating in improving the shelf life of processed litchi have been little studied.

Keeping in view above points under consideration, the present study was carried out to evaluate the effects of edible coating and packaging on the fruit quality of litchi during cold storage.

## Material and Methods

The present experiment was carried out in the Post-graduate Laboratory of Department of Horticulture, GBPU&T Pantnagar, U.S. Nagar, Uttarakhand. There were 17 treatment combinations i.e. without coating + without packaging material **(**$T_0$); Without coating + Perforated brown paper bag ($T_1$); Guar Gum 0.5% ($T_2$); Guar Gum 1.0% ($T_3$); Guar Gum 1.5% ($T_4$); Guar Gum 2.0% ($T_5$); Xanthan Gum 0.5% ($T_6$); Xanthan Gum 1.0% ($T_7$); Xanthan Gum 1.5% ($T_8$); Xanthan Gum 2.0% ($T_9$); Methyl Cellulose (low viscosity) 0.5% ($T_{10}$); Methyl Cellulose (low viscosity) 1.0% ($T_{11}$); Methyl Cellulose (low viscosity) 1.5% ($T_{12}$); Methyl Cellulose (low viscosity) 2.0% ($T_{13}$); Methyl Cellulose (high viscosity) 0.5% ($T_{14}$); Methyl Cellulose (high viscosity) 1.0% ($T_{15}$); Methyl Cellulose (high viscosity) 1.5% ($T_{16}$) and Methyl Cellulose (high viscosity) 2% ($T_{17}$) with 3 replication. Xanthan and guar gum solutions were prepared as per method given by Ruelas-Chacón *et al*. 2017 [16]. The methyl cellulose solution (both low viscosity and high viscosity) was prepared by solubilizing the methyl cellulose powder in a mixture of water and ethyl alcohol (2: 1) at 75 ° C in a high-speed mixer (900 rpm) for 15 minutes. In all the treatments, glycerol (1%) was added as plasticizer and ascorbic acid (1%) as an antioxidant. After uniform application of all the coating materials, fruits were placed in the perforated brown paper bags. There after packed fruits were stored at low temperature (4°C±l°C) and 85-90% related humidity in a refrigerator for further studies. Data were recorded at two days interval (0, 2, 4, 6, 8, 10 and 12$^{th}$ day) from the juice extracted by crushing the fruit pulp. Total Soluble Solids (TSS) of the fruits were recorded at room temperature with the help of digital hand refractometer (0-32) and was expressed in terms of °Brix. The pH value of filtered juice was determined with the help of a digital pH meter. Titratable acidity or total acidity of fruits was assessed by the method outlined by AOAC (1970) [1]. Ascorbic acid content of fruits was determined by the reduction of 2,6, dichlorophenol-indophenol (dye) by ascorbic acid as method described by Ranganna (1986) [14]. The results are expressed as milligram ascorbic acid per 100 gm pulp (mg/100g). Reducing sugar and total sugar estimated by Lane and Eynon method as described by Ranganna (1986) [14]. The amount of non-reducing sugar was calculated by subtracting reducing sugar from total sugars and multiplying the difference by factor 0.95 as suggested by AOAC (1970) [1]. The data were analyzed according to the procedure for analysis of two factorial completely randomized design (Factorial CRD) as given by Snedecor and Cochran (1987) [20].

## Result and Discussion

The Data presented in the table 1 revealed the significant increase in TSS with the advancement of storage duration. The fruits coated with 1.5 per cent guar gum and packed in perforated brown paper bags recorded the maximum TSS (18.45 $^0$B) closely followed by $T_9$ *i.e.* xanthan gum 2% + perforated brown paper bags (18.38 $^0$B). The minimum TSS (17.82 $^0$B) was recorded in control (fruits without coating and packaging). The mean values for storage interval showed that TSS content gradually increased upto 10$^{th}$ day and subsequently decreased on the day 12$^{th}$; whereas in control, TSS started decreasing from 6$^{th}$ day onwards. The interaction between various coating and packaging materials and storage intervals was found to be non-significant. The increase in TSS content in all the treatments with time may be attributed to hydrolysis of starch to simple sugars (soluble) during fruit ripening (Gupta and Mehta, 1987) [7]. The coating material acts as a physical barrier for transpiration loss and creates a modified atmosphere resulting into building of internal $CO_2$ and depletion of $O_2$. This might have led to decrease in the rate of carbohydrate metabolism being reflected in delayed starch depletion. The findings are in confirmation with Bhowmick *et al* (2015) [5], who also revealed that fruits coated with guar gum @1.5% showed the best result in terms of TSS content in ber fruits.

The fruit pH was significantly affected by coating and packaging material with the advancement of storage duration (table 2). The highest pH (7.01) content was recorded in fruits without coating and packaging (control), while the fruits coated with $T_4$ recorded the lowest pH (6.73) followed by $T_2$ (6.74). In all the treatments, pH generally increased with the storage interval which might be due to the breakdown of acid as a result of respiration during storage (Baldwin *et al.*, 1999) [4]. The above findings are in accordance with the findings of Adetunji *et al.* (2014) [2], who reported an increase in pH value during the storage period in papaya fruits. The data depicted in table 3 indicates that the coating and packaging materials also had a significant effect on titratable acidity (%) with the advancement of storage period. The minimum acidity (0.221%) was observed in the fruits coated with the 1.5% guar gum and packed in perforated brown paper bags followed by $T_{11}$ *i.e*. Methyl Cellulose (low viscosity) 1.0% + brown paper bags (0.238%) and $T_3$ *i.e.* Guar Gum 1.0% + brown paper bags (0.244%), whereas the maximum titratable acidity was found in control (0.284%). The mean values for storage interval showed that titratable acidity generally decreased with storage duration. The decreasing trends in acid content are due to the fact that acids are used as a source of energy in the fruit and organic acids are converted into sugar (Burton, 1985) [6]. The fruits coated with 1.5 per cent guar gum and packed in perforated brown paper bags ($T_4$) recorded the maximum ascorbic acid (24.78 mg) followed by $T_2$ *i.e.* Guar Gum 0.5% + brown paper bags (24.34 mg) and $T_{12}$ *i.e.* Methyl Cellulose (low viscosity) 2.0% + brown paper bags (24.32 mg), while the minimum ascorbic acid (23.50 mg) content was found in control (fruits without coating and packaging). The mean values for storage interval showed that ascorbic acid content gradually decreased with the advancement of storage duration. The higher retention of ascorbic acid in coated fruits might be due to continued synthesis of L-ascorbic acid from its precursor, glucose-6-phosphate and additive effect of slow rate of oxidation in respiration process during the storage period. Prolongation of higher ascorbic acid content by oxalic acid may due to the inhibitory effect on ascorbic acid oxidation (Tannerrbaum *et al.*, 1985) [21]. The loss in ascorbic acid content during storage has been attributed to its enzymatic oxidation as reported Nagar (1994) [12] in litchi.

The data pertaining to effects of coating and packaging materials and storage intervals was found to be significant for total sugars content of litchi fruits (Table 5). The maximum total sugar (12.62%) was recorded in the fruits coated with the 1.5% guar gum + perforated brown paper bag ($T_4$) followed by $T_{15}$ *i.e.* Methyl Cellulose (high viscosity) 1.0% + perforated brown paper bag (12.44%) and $T_{16}$ *i.e.* Methyl Cellulose (high viscosity) 1.5% + perforated brown paper bag (12.44%). On the other hand, the minimum total sugars

(11.16%) was found in $T_0$ *i.e.* control (fruits without coating and packaging). The mean values for storage interval showed that total sugars content gradually increased upto 10th day and then decreased on day 12th. The increased total sugar might be due to the fact that the maximum breakdown of polysaccharides and starch would have taken place up to this day. The decline in sugar content after peak level might be attributed to complete breakdown of sugar during respiration process and fermentation during prolonged storage. The results are in close conformity with the findings of Rani (2010) [15] in litchi cv. Rose Scented.

The results for reducing sugar revealed that edible coating and storage intervals significant effect on reducing sugar (%) of litchi fruits. The maximum reducing sugar content was recorded in $T_4$ *i.e.* guar gum 1.5% + perforated brown paper bag (10.32%) followed by $T_{15}$ *i.e.* Methyl Cellulose (high viscosity) 1.0% + perforated brown paper bag (10.22%) and $T_{16}$ *i.e.* Methyl Cellulose (high viscosity) 1.5% + perforated brown paper bag (10.20%). On the other hand, the minimum reducing sugar (9.39%) was noted in the fruits without coating and packaging (control). The increase in reducing sugar might be due to maximum breakdown of polysaccharides and starch. The decline in reducing sugar content after peak level *i.e.* after day 10th is attributed to complete breakdown of sugar during respiration process and fermentation during prolonged storage. The effect of coating and packaging materials was significant on non-reducing sugar with advancement of storage period. The maximum non-reducing sugar (2.19%) was recorded in the fruits coated with 1.5% guar gum and packed in perforated brown paper bags ($T_4$) followed by $T_{16}$ *i.e.* Methyl Cellulose (high viscosity) 1.5% + perforated brown paper bag (2.13%) and $T_{15}$ *i.e.* Methyl Cellulose (high viscosity) 1.0% + perforated brown paper bag (2.11%), whereas the minimum non-reducing sugar content was found in $T_0$ *i.e.* control (1.68%). The mean values for storage interval showed that non-reducing sugar content generally increased from zero to day 10th after that it starts to decrease on day 12th whereas in control it was seen that the non-reducing sugar started decreasing from 6th day onwards. The results are in close conformity with the findings of Nagar (1994) [12] and Rani (2010) [15].

**Table 1:** Effect of different treatments and storage intervals on the TSS (0brix) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 17.48 | 17.83 | 18.09 | 18.24 | 18.02 | 17.61 | 17.49 | 17.82 |
| $T_1$ | 17.48 | 17.91 | 18.25 | 18.46 | 18.67 | 18.12 | 17.64 | 18.08 |
| $T_2$ | 17.48 | 17.85 | 17.92 | 18.01 | 18.11 | 18.72 | 18.02 | 18.07 |
| $T_3$ | 17.48 | 18.26 | 18.31 | 18.37 | 18.42 | 18.49 | 18.40 | 18.25 |
| $T_4$ | 17.48 | 18.52 | 18.56 | 18.62 | 18.67 | 18.85 | 18.62 | 18.45 |
| $T_5$ | 17.48 | 18.04 | 18.21 | 18.36 | 18.48 | 18.56 | 18.36 | 18.22 |
| $T_6$ | 17.48 | 18.17 | 18.25 | 18.41 | 18.48 | 18.52 | 18.45 | 18.25 |
| $T_7$ | 17.48 | 18.18 | 18.24 | 18.29 | 18.32 | 18.37 | 18.28 | 18.17 |
| $T_8$ | 17.48 | 18.11 | 18.19 | 18.28 | 18.37 | 18.45 | 18.38 | 18.18 |
| $T_9$ | 17.48 | 18.42 | 18.47 | 18.52 | 18.58 | 18.65 | 18.53 | 18.38 |
| $T_{10}$ | 17.48 | 18.31 | 18.36 | 18.42 | 18.46 | 18.51 | 18.42 | 18.28 |
| $T_{11}$ | 17.48 | 18.29 | 18.34 | 18.37 | 18.41 | 18.45 | 18.36 | 18.24 |
| $T_{12}$ | 17.48 | 18.31 | 18.37 | 18.42 | 18.46 | 18.53 | 18.44 | 18.29 |
| $T_{13}$ | 17.48 | 18.16 | 18.19 | 18.23 | 18.28 | 18.31 | 18.26 | 18.13 |
| $T_{14}$ | 17.48 | 18.21 | 18.27 | 18.32 | 18.37 | 18.41 | 18.32 | 18.20 |
| $T_{15}$ | 17.48 | 18.05 | 18.25 | 18.37 | 18.48 | 18.61 | 18.41 | 18.24 |
| $T_{16}$ | 17.48 | 17.58 | 18.05 | 18.26 | 18.47 | 18.58 | 18.44 | 18.12 |
| $T_{17}$ | 17.48 | 17.80 | 17.93 | 18.09 | 18.21 | 18.33 | 18.17 | 18.00 |
| Mean B | 17.48 | 18.11 | 18.24 | 18.34 | 18.40 | 18.46 | 18.28 | |

| Factors | C.D. | SE(m) |
|---|---|---|
| Factor(A) | 0.24 | 0.09 |
| Factor(B) | 0.15 | 0.05 |
| Factor (A X B) | N/A | 0.23 |

**Table 2:** Effect of different treatments and storage intervals on the pH value of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 6.55 | 6.83 | 6.92 | 7.08 | 7.16 | 7.22 | 7.32 | 7.01 |
| $T_1$ | 6.55 | 6.82 | 6.88 | 6.96 | 7.04 | 7.10 | 7.13 | 6.93 |
| $T_2$ | 6.55 | 6.59 | 6.66 | 6.75 | 6.83 | 6.89 | 6.94 | 6.74 |
| $T_3$ | 6.55 | 6.72 | 6.79 | 6.88 | 6.96 | 7.02 | 7.07 | 6.86 |
| $T_4$ | 6.55 | 6.62 | 6.68 | 6.73 | 6.77 | 6.83 | 6.89 | 6.73 |
| $T_5$ | 6.55 | 6.73 | 6.80 | 6.89 | 6.97 | 7.03 | 7.10 | 6.87 |
| $T_6$ | 6.55 | 6.66 | 6.73 | 6.82 | 6.90 | 6.96 | 7.02 | 6.81 |
| $T_7$ | 6.55 | 6.71 | 6.75 | 6.81 | 6.87 | 6.92 | 6.96 | 6.80 |
| $T_8$ | 6.55 | 6.71 | 6.78 | 6.87 | 6.95 | 7.01 | 7.06 | 6.85 |
| $T_9$ | 6.55 | 6.62 | 6.69 | 6.77 | 6.85 | 6.91 | 6.94 | 6.76 |
| $T_{10}$ | 6.55 | 6.79 | 6.86 | 6.95 | 7.03 | 7.09 | 7.14 | 6.92 |
| $T_{11}$ | 6.55 | 6.74 | 6.81 | 6.90 | 6.98 | 7.04 | 7.09 | 6.87 |
| $T_{12}$ | 6.55 | 6.66 | 6.73 | 6.82 | 6.89 | 6.95 | 6.99 | 6.80 |
| $T_{13}$ | 6.55 | 6.83 | 6.90 | 6.99 | 7.07 | 7.13 | 7.19 | 6.95 |
| $T_{14}$ | 6.55 | 6.76 | 6.83 | 6.92 | 7.00 | 7.06 | 7.11 | 6.89 |
| $T_{15}$ | 6.55 | 6.81 | 6.88 | 6.97 | 7.05 | 7.11 | 7.16 | 6.93 |
| $T_{16}$ | 6.55 | 6.70 | 6.77 | 6.86 | 6.94 | 7.00 | 7.05 | 6.84 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $T_{17}$ | 6.55 | 6.62 | 6.69 | 6.78 | 6.86 | 6.92 | 6.97 | 6.77 |
| Mean B | 6.55 | 6.72 | 6.79 | 6.88 | 6.95 | 7.01 | 7.06 | |
| Factors | | | C.D. | | | SE(m) | | |
| Factor(A) | | | 0.11 | | | 0.04 | | |
| Factor(B) | | | 0.07 | | | 0.03 | | |
| Factor (A X B) | | | N/A | | | 0.11 | | |

**Table 3:** Effect of different treatments and storage intervals on the titratable acidity (%) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 0.39 | 0.36 | 0.31 | 0.27 | 0.25 | 0.22 | 0.18 | 0.284 |
| $T_1$ | 0.39 | 0.33 | 0.29 | 0.27 | 0.25 | 0.23 | 0.21 | 0.281 |
| $T_2$ | 0.39 | 0.32 | 0.27 | 0.25 | 0.21 | 0.19 | 0.15 | 0.253 |
| $T_3$ | 0.39 | 0.31 | 0.26 | 0.23 | 0.20 | 0.18 | 0.14 | 0.244 |
| $T_4$ | 0.39 | 0.31 | 0.24 | 0.22 | 0.18 | 0.13 | 0.08 | 0.221 |
| $T_5$ | 0.39 | 0.31 | 0.26 | 0.24 | 0.21 | 0.19 | 0.15 | 0.248 |
| $T_6$ | 0.39 | 0.34 | 0.29 | 0.27 | 0.24 | 0.21 | 0.17 | 0.272 |
| $T_7$ | 0.39 | 0.33 | 0.28 | 0.26 | 0.23 | 0.20 | 0.16 | 0.263 |
| $T_8$ | 0.39 | 0.35 | 0.30 | 0.28 | 0.25 | 0.22 | 0.18 | 0.281 |
| $T_9$ | 0.39 | 0.32 | 0.28 | 0.26 | 0.24 | 0.21 | 0.19 | 0.271 |
| $T_{10}$ | 0.39 | 0.31 | 0.29 | 0.25 | 0.22 | 0.20 | 0.14 | 0.257 |
| $T_{11}$ | 0.39 | 0.30 | 0.25 | 0.23 | 0.20 | 0.17 | 0.13 | 0.238 |
| $T_{12}$ | 0.39 | 0.35 | 0.30 | 0.27 | 0.24 | 0.22 | 0.19 | 0.279 |
| $T_{13}$ | 0.39 | 0.32 | 0.27 | 0.25 | 0.22 | 0.20 | 0.16 | 0.257 |
| $T_{14}$ | 0.39 | 0.33 | 0.28 | 0.26 | 0.23 | 0.21 | 0.17 | 0.265 |
| $T_{15}$ | 0.39 | 0.34 | 0.29 | 0.26 | 0.23 | 0.21 | 0.18 | 0.271 |
| $T_{16}$ | 0.39 | 0.31 | 0.26 | 0.24 | 0.21 | 0.19 | 0.15 | 0.248 |
| $T_{17}$ | 0.39 | 0.33 | 0.28 | 0.26 | 0.23 | 0.20 | 0.16 | 0.264 |
| Mean B | 0.39 | 0.33 | 0.28 | 0.25 | 0.22 | 0.20 | 0.16 | |
| Factors | | | C.D. | | | SE(m) | | |
| Factor(A) | | | 0.01 | | | 0.00 | | |
| Factor(B) | | | 0.01 | | | 0.00 | | |
| Factor (A X B) | | | 0.02 | | | 0.01 | | |

**Table 4:** Effect of different treatments and storage intervals on the ascorbic acid (mg/100g) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 27.61 | 26.32 | 25.28 | 23.85 | 22.95 | 20.55 | 17.96 | 23.50 |
| $T_1$ | 27.61 | 26.07 | 24.97 | 23.61 | 22.71 | 21.45 | 18.44 | 23.55 |
| $T_2$ | 27.61 | 26.29 | 25.26 | 24.93 | 23.81 | 22.75 | 19.73 | 24.34 |
| $T_3$ | 27.61 | 26.02 | 24.99 | 24.62 | 22.97 | 21.90 | 18.88 | 23.86 |
| $T_4$ | 27.61 | 26.77 | 25.91 | 24.99 | 24.12 | 23.24 | 20.78 | 24.78 |
| $T_5$ | 27.61 | 26.22 | 25.21 | 24.87 | 23.94 | 20.67 | 17.56 | 23.73 |
| $T_6$ | 27.61 | 26.25 | 25.21 | 24.85 | 23.95 | 22.13 | 19.11 | 24.16 |
| $T_7$ | 27.61 | 26.27 | 24.87 | 24.51 | 23.61 | 21.77 | 18.75 | 23.91 |
| $T_8$ | 27.61 | 26.04 | 25.14 | 24.09 | 23.12 | 21.94 | 18.91 | 23.84 |
| $T_9$ | 27.61 | 26.30 | 25.27 | 23.93 | 23.03 | 21.97 | 18.94 | 23.87 |
| $T_{10}$ | 27.61 | 26.43 | 25.06 | 24.73 | 23.00 | 21.93 | 19.02 | 23.97 |
| $T_{11}$ | 27.61 | 26.07 | 24.75 | 24.50 | 23.37 | 21.97 | 18.95 | 23.89 |
| $T_{12}$ | 27.61 | 26.07 | 25.04 | 24.85 | 23.95 | 22.88 | 19.86 | 24.32 |
| $T_{13}$ | 27.61 | 26.61 | 25.24 | 24.87 | 23.97 | 22.14 | 19.19 | 24.23 |
| $T_{14}$ | 27.61 | 26.28 | 25.25 | 24.88 | 23.98 | 22.51 | 19.49 | 24.29 |
| $T_{15}$ | 27.61 | 26.29 | 25.26 | 24.89 | 23.99 | 20.71 | 17.69 | 23.78 |
| $T_{16}$ | 27.61 | 26.29 | 25.26 | 24.89 | 23.99 | 21.69 | 18.62 | 24.05 |
| $T_{17}$ | 27.61 | 26.27 | 25.24 | 24.87 | 23.97 | 21.49 | 18.47 | 23.99 |
| Mean B | 27.61 | 26.27 | 25.18 | 24.60 | 23.58 | 21.87 | 18.91 | |
| Factors | | | C.D. | | | SE(m) | | |
| Factor(A) | | | 0.37 | | | 0.13 | | |
| Factor(B) | | | 0.23 | | | 0.08 | | |
| Factor (A X B) | | | N/A | | | 0.35 | | |

**Table 5:** Effect of different treatments and storage intervals on the total sugars (%) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 10.89 | 11.07 | 11.24 | 11.45 | 11.35 | 11.19 | 10.94 | 11.16 |
| $T_1$ | 10.89 | 11.20 | 11.61 | 11.96 | 12.27 | 12.08 | 11.86 | 11.70 |
| $T_2$ | 10.89 | 11.13 | 11.76 | 12.14 | 12.56 | 13.02 | 12.65 | 12.02 |
| $T_3$ | 10.89 | 11.25 | 11.83 | 12.38 | 12.83 | 13.29 | 12.91 | 12.20 |
| $T_4$ | 10.89 | 11.50 | 12.24 | 12.88 | 13.42 | 13.92 | 13.51 | 12.62 |
| $T_5$ | 10.89 | 11.16 | 11.80 | 12.39 | 12.84 | 13.30 | 12.90 | 12.18 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $T_6$ | 10.89 | 11.29 | 11.96 | 12.55 | 13.00 | 13.46 | 13.09 | 12.32 |
| $T_7$ | 10.89 | 11.29 | 11.96 | 12.55 | 13.00 | 13.46 | 13.09 | 12.32 |
| $T_8$ | 10.89 | 11.26 | 11.89 | 12.48 | 12.93 | 13.39 | 13.00 | 12.26 |
| $T_9$ | 10.89 | 11.26 | 11.83 | 12.35 | 12.78 | 13.24 | 12.91 | 12.18 |
| $T_{10}$ | 10.89 | 11.33 | 12.00 | 12.59 | 13.04 | 13.50 | 13.10 | 12.35 |
| $T_{11}$ | 10.89 | 11.18 | 11.85 | 12.44 | 12.89 | 13.35 | 12.96 | 12.22 |
| $T_{12}$ | 10.89 | 11.12 | 11.72 | 12.27 | 12.72 | 13.18 | 12.78 | 12.10 |
| $T_{13}$ | 10.89 | 11.25 | 11.92 | 12.51 | 12.96 | 13.42 | 13.04 | 12.28 |
| $T_{14}$ | 10.89 | 11.22 | 11.89 | 12.47 | 12.92 | 13.38 | 13.01 | 12.25 |
| $T_{15}$ | 10.89 | 11.44 | 12.11 | 12.70 | 13.15 | 13.61 | 13.18 | 12.44 |
| $T_{16}$ | 10.89 | 11.44 | 12.11 | 12.70 | 13.15 | 13.61 | 13.20 | 12.44 |
| $T_{17}$ | 10.89 | 11.30 | 11.97 | 12.56 | 13.01 | 13.47 | 13.06 | 12.32 |
| Mean B | 10.89 | 11.26 | 11.87 | 12.41 | 12.82 | 13.22 | 12.84 | |

| Factors | C.D. | SE(m) |
|---|---|---|
| Factor(A) | 0.18 | 0.07 |
| Factor(B) | 0.11 | 0.04 |
| Factor (A X B) | 0.48 | 0.17 |

**Table 6:** Effect of different treatments and storage intervals on the reducing sugars (%) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 9.27 | 9.32 | 9.41 | 9.54 | 9.48 | 9.40 | 9.31 | 9.39 |
| $T_1$ | 9.27 | 9.41 | 9.72 | 9.94 | 10.08 | 9.97 | 9.83 | 9.75 |
| $T_2$ | 9.27 | 9.38 | 9.82 | 10.02 | 10.27 | 10.58 | 10.36 | 9.96 |
| $T_3$ | 9.27 | 9.43 | 9.85 | 10.23 | 10.51 | 10.82 | 10.61 | 10.10 |
| $T_4$ | 9.27 | 9.54 | 10.02 | 10.45 | 10.82 | 11.17 | 10.93 | 10.32 |
| $T_5$ | 9.27 | 9.39 | 9.84 | 10.22 | 10.50 | 10.81 | 10.57 | 10.09 |
| $T_6$ | 9.27 | 9.44 | 9.92 | 10.30 | 10.58 | 10.89 | 10.69 | 10.16 |
| $T_7$ | 9.27 | 9.46 | 9.94 | 10.32 | 10.60 | 10.91 | 10.71 | 10.17 |
| $T_8$ | 9.27 | 9.48 | 9.92 | 10.30 | 10.58 | 10.89 | 10.67 | 10.16 |
| $T_9$ | 9.27 | 9.37 | 9.81 | 10.14 | 10.40 | 10.71 | 10.51 | 10.03 |
| $T_{10}$ | 9.27 | 9.47 | 9.95 | 10.33 | 10.61 | 10.92 | 10.69 | 10.18 |
| $T_{11}$ | 9.27 | 9.42 | 9.90 | 10.28 | 10.56 | 10.87 | 10.65 | 10.14 |
| $T_{12}$ | 9.27 | 9.40 | 9.84 | 10.18 | 10.46 | 10.77 | 10.54 | 10.07 |
| $T_{13}$ | 9.27 | 9.45 | 9.93 | 10.31 | 10.59 | 10.90 | 10.69 | 10.16 |
| $T_{14}$ | 9.27 | 9.34 | 9.82 | 10.19 | 10.47 | 10.78 | 10.58 | 10.06 |
| $T_{15}$ | 9.27 | 9.52 | 10.00 | 10.38 | 10.66 | 10.97 | 10.71 | 10.22 |
| $T_{16}$ | 9.27 | 9.50 | 9.98 | 10.36 | 10.64 | 10.95 | 10.71 | 10.20 |
| $T_{17}$ | 9.27 | 9.46 | 9.94 | 10.32 | 10.60 | 10.91 | 10.67 | 10.17 |
| Mean B | 9.27 | 9.43 | 9.87 | 10.21 | 10.47 | 10.73 | 10.52 | |

| Factors | C.D. | SE(m) |
|---|---|---|
| Factor(A) | 0.15 | 0.05 |
| Factor(B) | 0.09 | 0.03 |
| Factor (A X B) | 0.39 | 0.14 |

**Table 7:** Effect of different treatments and storage intervals on the non- reducing sugars (%) of litchi fruits

| Treatments | Day-0 | Day-2 | Day-4 | Day-6 | Day-8 | Day-10 | Day-12 | Mean A |
|---|---|---|---|---|---|---|---|---|
| $T_0$ | 1.54 | 1.66 | 1.74 | 1.81 | 1.78 | 1.70 | 1.55 | 1.68 |
| $T_1$ | 1.54 | 1.70 | 1.79 | 1.92 | 2.08 | 2.01 | 1.93 | 1.85 |
| $T_2$ | 1.54 | 1.66 | 1.85 | 2.01 | 2.17 | 2.32 | 2.17 | 1.96 |
| $T_3$ | 1.54 | 1.73 | 1.88 | 2.04 | 2.20 | 2.34 | 2.18 | 1.99 |
| $T_4$ | 1.54 | 1.86 | 2.11 | 2.31 | 2.47 | 2.61 | 2.45 | 2.19 |
| $T_5$ | 1.54 | 1.68 | 1.86 | 2.06 | 2.22 | 2.36 | 2.21 | 1.99 |
| $T_6$ | 1.54 | 1.76 | 1.94 | 2.14 | 2.30 | 2.44 | 2.28 | 2.06 |
| $T_7$ | 1.54 | 1.74 | 1.92 | 2.12 | 2.28 | 2.42 | 2.26 | 2.04 |
| $T_8$ | 1.54 | 1.69 | 1.87 | 2.07 | 2.23 | 2.38 | 2.21 | 2.00 |
| $T_9$ | 1.54 | 1.79 | 1.92 | 2.10 | 2.26 | 2.40 | 2.28 | 2.04 |
| $T_{10}$ | 1.54 | 1.77 | 1.95 | 2.14 | 2.31 | 2.45 | 2.29 | 2.06 |
| $T_{11}$ | 1.54 | 1.67 | 1.85 | 2.05 | 2.21 | 2.35 | 2.20 | 1.98 |
| $T_{12}$ | 1.54 | 1.63 | 1.79 | 1.99 | 2.15 | 2.29 | 2.13 | 1.93 |
| $T_{13}$ | 1.54 | 1.71 | 1.89 | 2.09 | 2.25 | 2.40 | 2.23 | 2.02 |
| $T_{14}$ | 1.54 | 1.79 | 1.97 | 2.17 | 2.33 | 2.47 | 2.31 | 2.08 |
| $T_{15}$ | 1.54 | 1.82 | 2.00 | 2.20 | 2.37 | 2.51 | 2.35 | 2.11 |
| $T_{16}$ | 1.54 | 1.84 | 2.02 | 2.22 | 2.38 | 2.53 | 2.37 | 2.13 |
| $T_{17}$ | 1.54 | 1.75 | 1.93 | 2.13 | 2.29 | 2.43 | 2.27 | 2.05 |
| Mean B | 1.54 | 1.74 | 1.90 | 2.09 | 2.24 | 2.36 | 2.20 | |

| Factors | C.D. | SE(m) |
|---|---|---|
| Factor(A) | 0.03 | 0.01 |
| Factor(B) | 0.02 | 0.01 |
| Factor (A X B) | 0.09 | 0.03 |

## Conclusion
The edible coating and packaging can effectively prolong the shelf life of 'Rose Scented' litchi. The guar gum coating is capable of forming a protective barrier on the surface of litchi to maintain fruit TSS, pH, acidity, ascorbic acid, total sugar, reducing sugar and non-reducing sugar. Therefore, the application of guar gum 1.5% as coating material and packed in perforated brown paper could be favorable in prolonging the self-life and maintaining quality of litchi cv. Rose Scented during storage.

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