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Effect of Fruit Bagging on the Development and Quality of Guava Fruit

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ABSTRACT

Guava (Psidium guajava L.) is highly nutritious, and contains significant minerals, vitamins and dietary fibre, which makes it effective for treating stomach-related issues. Fruit quality is influenced by biotic and abiotic factors, with external appearance being crucial. Agronomic practices can improve the fruit microenvironment, enhancing quality and market value. Thus, producing high-quality, defect-free, and chemical-free fruits is essential. The present experiment studied the effect of bagging on the development and quality of guava variety Lalit. Bagging at marble and egg stages used various materials: control (no bagging), newspaper, butter paper, and different colored non-woven bags. Bagging improved physicochemical parameters compared to unbagged fruits. The egg stage bagging recorded maximum fruit weight (134.79 g), fruit length (6.07 cm), fruit diameter (6.43 cm), fruit volume (133.99 ml), fruit retention (96.11%), number of fruits per tree (28.83), yield per tree (3.95 kg), shelf life (6.73 days), TSS (11.83 °Brix), reducing sugars (6.48%), total sugars (8.32%), ascorbic acid (170.66 mg/100 g pulp), minimum PLW (7.34%), and titratable acidity (0.55%).Among bagging materials, the non-woven red bag yielded the highest fruit weight (137.13 g), fruit length (6.22 cm), fruit diameter (6.53 cm), fruit volume (138.81 ml), fruit retention (97.22%), number of fruits per tree (29.17), yield per tree (4.12 kg), shelf life (7.00 days), TSS (12.07 °Brix), reducing sugars (6.61%), total sugars (8.56%), non-reducing sugars (1.95%), ascorbic acid (173.46 mg/100 g pulp), and minimum days required for harvesting and physiological weight loss (7.04%). Conversely, the newspaper bag showed the lowest titratable acidity (0.52%). Bagged fruits had fewer fruit fly infestations and higher marketability. No significant differences were observed in physical and quality attributes across various stages and bagging materials.

Keywords: *Bagging, Guava, Lalit, Microenvironment, Non-woven bag, Psidium guajava, quality, yield*

INTRODUCTION

Guava (*Psidium guajava* L.), a member of the family Myrtaceae, is one of the most important tropical or subtropical fruit crops popularly known as "Apple of Tropics" as its nutritive value is equivalent to that of apple. In India, guava occupies 2,76,000 ha area and 42,36,000 MT production. Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, and Maharashtra are the primary states in India known for guava cultivation. Uttar Pradesh holds the leading position in both guava cultivation area and production [2]. It has become a popular fruit on account of its high consumption, demand and profit in the market. It is regarded as an exquisite, nutritionally valuable, and highly profitable crop. This climacteric fruit is delicious and nutritious, often referred to as a "super fruit". Guava fruits are consumed fresh and are also used in the production of jams, jellies, pastes, toffees, and candies. Additionally, guava fruits, leaves, and roots have medicinal uses, treating ailments such as diarrhoea and dysentery, and are ingredients in various traditional medicines. In West and South Indian agro-climatic conditions, guava flowers thrice in a year, first in February- March known as *Ambe bahar*, second in June-July which is referred as *Mrig bahar* and then in October- November which is *Hasth bahar*. Generally, fruit yield is higher during the rainy season compared to the winter season [23]. However, the fruits produced in the rainy season tend to be tasteless, of lower quality, and more susceptible to pests and diseases. In contrast, fruits harvested in the winter season are of superior quality and command higher market prices.

Recently, guava fruits are getting good return price because of their high quality. Inferior quality fruits obtained due to climate change such as abnormal rains, sudden fluctuations in the temperature and fog up to a great extent. Fruit bagging is a simple and phytosanitary procedure widely used for improving the visual quality by promoting fruit coloration and also to enhance internal fruit quality. It reduces the incidence of insects, pests, and diseases also. In this method, individual fruits or fruit clusters are bagged on the tree for a specific duration to achieve desired outcomes. Bagging influences fruit size, maturity, peel color, flesh mineral content, and overall fruit quality, depending on the type of bag used and the developmental stage of the fruit at the time of bagging [9][7]. This technique helps eliminate the need for insecticides and fungicides. By altering the micro-environment around the fruit during its development, bagging affects the physico-chemical quality of the produce. It also prevents damage from bruises, wounds, scars, diseases, and pests, resulting in clear fruit skin with attractive coloration [3]. Bagging is widely used in various fruit crops to enhance skin color and reduce issues like splitting, mechanical damage, and sunburn on the fruit skin [21].

The stage of bagging in various fruit crops significantly affects fruit quality. Black stain is a major issue in persimmon fruit, and bagging the fruits 35 to 50 days before harvest helps to reduce this problem.

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The choice of bagging material greatly impacts fruit quality. A bag type that works well for one crop or cultivar may not be suitable for another. Each bagging material has its own advantages and disadvantages concerning fruit fly control and the physical and chemical quality of the fruit. Therefore, selecting the appropriate bagging material and timing is crucial for optimal results. This study examined the physiological and physicochemical changes in guava fruits caused by the altered micro-climate within bags made from various materials, and how these changes enhanced fruit quality under different bagging systems at two distinct stages. Additionally, this experiment offers farmers a range of low-cost, effective bagging material options to produce high-quality, blemish-free guava fruits.

Figure 1: Overview of fruit bagging treatments along with stages

MATERIALS AND METHODS

The experiment was carried out during 2021-22 at the Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari in Block-5. About five years old uniform size and canopy guava cv. Lalit trees planted at a spacing of 2 m × 2 m were selected for the experiment. All the experimental trees were given with uniform cultural practices during the period of investigation. The experiment was laid out in a Completely Randomized Design with factorial concept (FCRD). Each tree under the treatment was considered as one unit and every treatment was repeated thrice. The experiment consisted of different types of bagging materials *viz.*, Control- no bagging (B_1), newspaper bag (B_2), butter paper bag (B_3), non-woven red (B_4), non-woven green (B_5) and non-woven white bag (B_6) and they were bagged at two different stages *viz.*, Marble(S_1) and egg stage(S_2).Six to eight perforations of 4 mm diameter were made at the bottom of the newspaper bag for proper ventilation.

The bags were tied along the fruits tightly and marked accordingly. The control fruits were kept uncovered in each replicated plant. The fruits were observed regularly and the selected fruits from each replication were analyzed for morphological parameters like the weight of selected fruits was weighed by using an electronic weighing balance, length and diameter were measured by *Vernier caliper* and volume by water displacement method. A number of days taken for harvesting of fruits were counted after bagging for each treatment. The damaged fruits were subtracted from the total number of fruits. Fruit fly infestation percentage was calculated by subtracting fruit fly infested fruits from total number of fruits harvested. Marketable fruit percentage was calculated by subtracting damaged fruit and fruit fly infested fruit percentage from 100. Physiological loss of weight was calculated by subtracting the final weight of fruit at the end of the eatable stage from the initial weight at the time of harvest divided by final weight. Fruit retention was calculated by subtracting total number of fruits drop from the total number of fruits at the time of bagging which should be divided by the total number of fruits at the time of bagging.

The fruits from each tree were harvested and calculated as the total number of fruits per tree at harvest.The average fruit weight was multiplied by total number of fruits at harvest to get fruit yield in kilograms per tree.

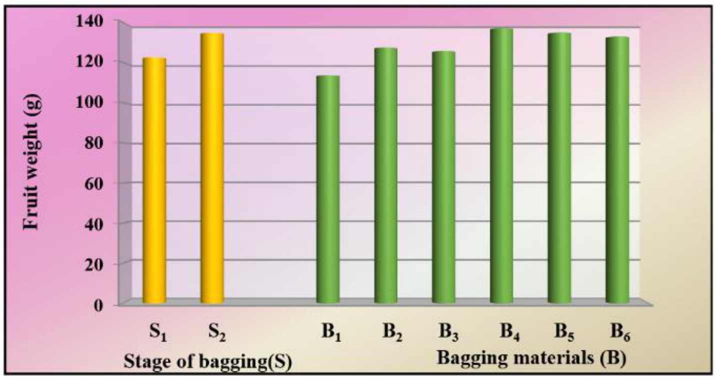
Fruits were analyzed for its TSS, reducing, non-reducing and total sugars, acidity and ascorbic acid at ripe stages. TSS was recorded by using a digital hand refractometer (Range of 0 to 32 °Brix). Reducing sugars, total sugars and non-reducing sugars were determined as described by [22]. Titrable acidity was estimated by titrating a known amount of pulp against 0.1 N NaOH using phenolphthalein as an indicator [22]. Ascorbic acid content of fruits was calculated by Dye method as detailed by [22]. The statistical analysis of data was carried out as per the method prescribed by [18]. The standard error of the mean (S. Em.) was worked out and the critical difference (C. D.) at 5 per cent was calculated whenever the results were found significant.

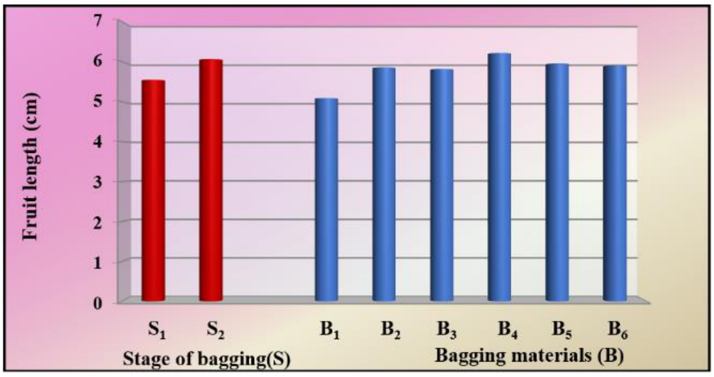
RESULTS AND DISCUSSION

Effect of stage of bagging and type of bagging materials on physical parameters of Guava fruit cv. Lalit

Effect of stage of bagging

The study found that the bagging stage had varying impacts on the measured fruit parameters. Table 1 shows the significant effect of stage of bagging on the physical parameters of guava fruit. Maximum fruit weight (134.79 g), length (6.07 cm), diameter (6.43 cm), volume (133.99 ml), retention (96.07 %), a greater number of fruits per tree (28.83), yield (3.95 kg/tree), shelf life (6.73 days) and minimum PLW (7.34 %) and minimum days for harvesting (figure 1f) was recorded in S_2 (egg stage of bagging). The stage of bagging does not significantly affect the percentage of fruit fly-infested or marketable guava fruits. Increased fruit weight, length and diameter could be imputed to proper bagging stage in regard to the growth and developmental stages of guava fruit and other atmospheric variables like solar radiation, humidity *etc*. [6]. The increase in weight may be attributed to a greater accumulation of food material [14]. Similar findings were reported by [10][8][12][26] in mango. Bagging at the egg stage resulted in the least physiological loss of fruit weight, possibly due to rapid moisture loss from fruits bagged at the marble stage, leading to higher physiological weight loss [1]. Comparable results were observed by [15][26] in mango. Early fruit harvesting might be due to the less exposure of fruits for environmental conditions like sunlight, temperature, *etc*. which have role in fruit development [14]. The highest fruit retention might be due to the protection of fruits during development from temperature fluctuations and disease incidence [14]. Similar results were obtained in mango by [26]. The differences in a number of fruit and yield might be due to bagging at the marble stage would result in the shrivelling of the young fruits and drop due to higher temperature inside the bag when compared to air temperature. The increase in temperature at egg stage of bagging might have led to increased sink strength [6]. Similar results were obtained by [26] in mango. The extended shelf life might be because fruits at the egg stage exhibited greater firmness, resulting in better shelf life [15]. This outcome was also observed by [16][26] in mango.





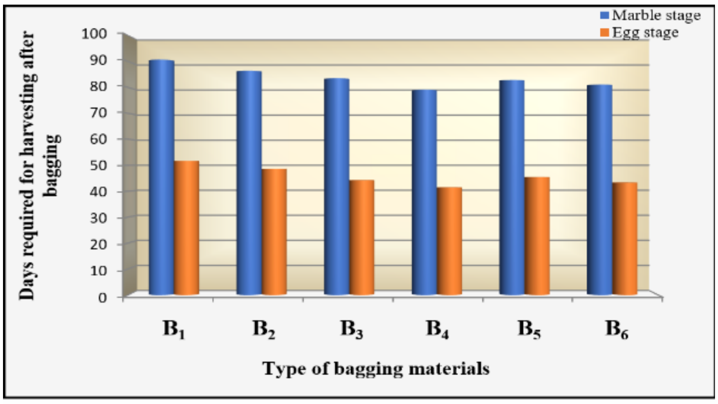


Figure 2: Impact of Bagging Stage and Bagging Materials on Physical Parameters of Guava

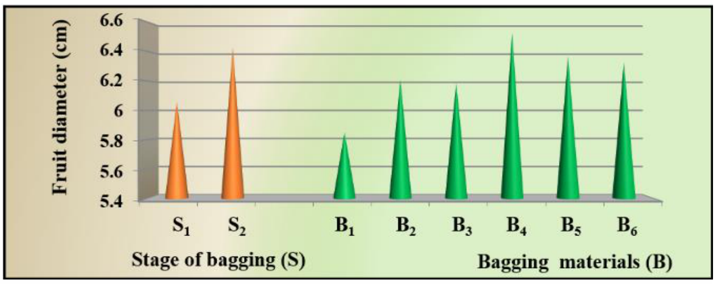
Effect of type of bagging materials

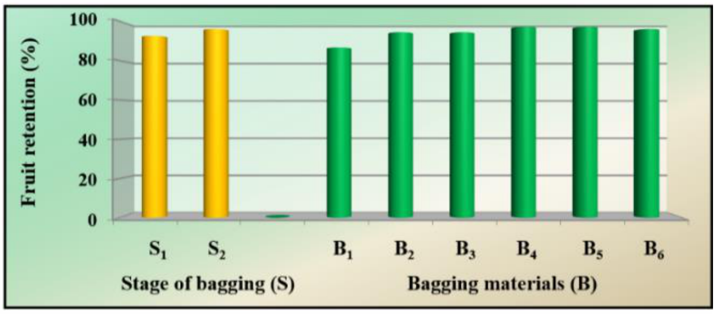
The study found that different bagging materials had varying impacts on the measured fruit parameters. All types of bagging materials enhanced the fruit physical parameters. Table 1 showed the significant effect of type of bagging materials on the physical parameters of guava fruit. Highest fruit weight (137.13 g), length (6.22 cm), diameter (6.53 cm), volume (138.81 ml), retention (97.22 %), a greater number of fruits per tree (29.17), yield (4.12 kg/tree), shelf life (7.00 days) and minimum PLW (7.04 %) (Table 1) and Minimum days required for harvesting (figure 1f) found in non-woven red bags. The lowest fruit fly infestation (0.53 %) and maximum marketable fruits percentage *i.e.*, 89.43 % was recorded with the treatments B_4, B_5 and B_6 *i.e.*, non-woven red, green and white bags. The increase in the weight of bagged guava fruits with non-woven bags might be due to the protection of fruit from ultra-violet rays; as a result, the cell division in the fruits increased and proper availability of photosynthates to the fruits on the plant was ensured [20]. Similar results were observed by [5][13] in guava, [11] in grapes, and [29] in pomegranate. The increase in fruit volume may be due to the lower temperature inside the bag, which reduces chlorophyll degradation and inhibits the activity of the GA3 degrading enzyme.

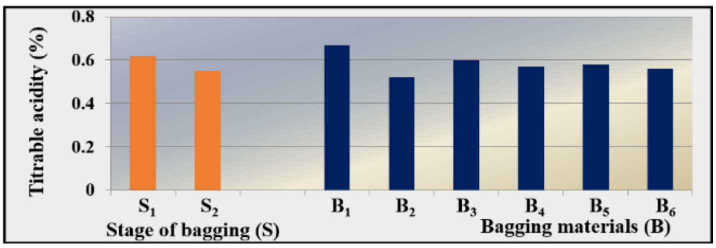
Consequently, the increase in fruit size and volume can be attributed to GA3-stimulated elongation of the mesocarp tissues [11].

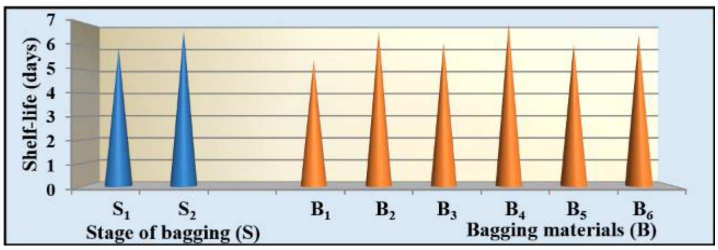
Among the different bags used, non-woven bags were most effective in managing the fruit fly incidence and also maximum marketable fruits were found, possibly due to the direct damage by puncturing the fruit skin to lay eggs inside the fruit is prevented. A physical barrier created between the fruit flies and the fruits resulted in minimizing the attack of pest [5]. The results are in line with the findings of [13][17] in guava. Bagging of fruits also reduce the mechanical damage by protecting from damage due to scratching of branches, rats and rodents and also by birds.

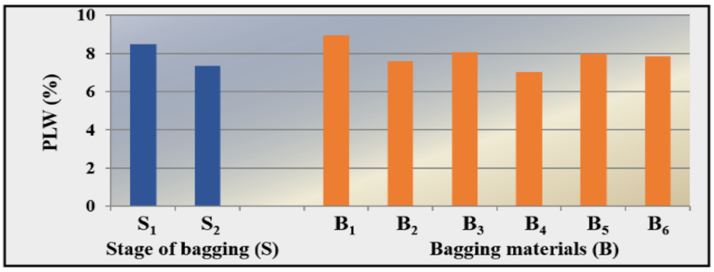
The minimum PLW could be attributed to bagging, which increases relative humidity and consequently reduces fruit water loss [27]. Early harvesting of fruits might be due to the trapping of solar heat in the non-woven bags. The maximum fruit retention may be due to the micro-climate created by bagging around the fruit, which is favourable for its growth [27]. This might be due to less fruit drop, increased fruit weight, less infested fruits with fruit fly [14]. Bagging of fruits with these coloured bagging materials might lead to increased sink strength and yield increased due to an increase in size and weight of the fruit. Due to favourable microclimate created by the bagging, plant remain physiologically more active to build up sufficient food stock for development, which ultimately leads to an increase in yield [30]. Results are in conformity with [26] in mango.

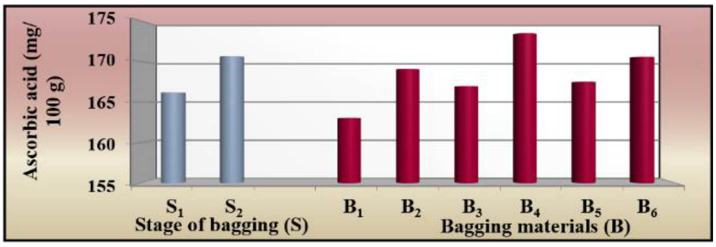












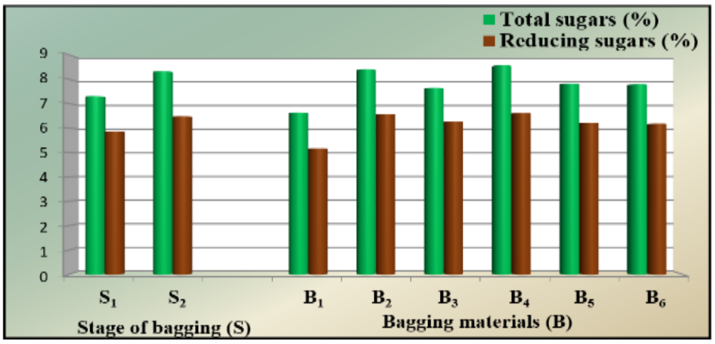


Figure 3: Effect of stage of bagging and type of bagging material on a) Titrable acidity (%), b) Total sugars and Reducing sugars (%), c) Ascorbic acid (mg/100g) and d) Shelf life (days) of guava

Effect of stage of bagging and type of bagging materials on quality parameters of Guava fruit cv. Lalit

Effect of stage of bagging

TSS content of fruit (11.83 ºBrix), Reducing sugars (6.48 %), total sugars (8.32 %), non-reducing sugars (1.84 %) and ascorbic acid (170.66 mg 100 g^{-1} pulp) was found maximum while, minimum titrable acidity content of fruit (0.55 %) was found in egg stage of bagging (S_2). Highest ascorbic acid content might be attributed to bagging at this stage providing humid environment that promotes the accumulation of ascorbic acid. Similar results were obtained by [6].

Effect of type of bagging materials

The highest TSS content of fruit (12.07 ºBrix), reducing sugars (6.61 %), total sugars (8.56 %), non-reducing sugars (1.95 %), and ascorbic acid content of fruit (173.46 mg 100 g^{-1} pulp) were noted in non-woven red bag (B_4). Minimum titrable acidity (0.52 %) was recorded in fruits bagged with newspaper bag (B_2).

The increased TSS content in guava fruits bagged with non-woven red bags may be attributed to the rapid degradation of accumulated polysaccharides during the climacteric stage, with most being converted into soluble sugars, which constitute a significant portion of TSS [19].

Table 1: Impact of Bagging Stage and Type of Bagging Materials on Physical Parameters of Guava (cv. Lalit)

Treatments	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (ml)	Fruit fly infested fruits (%)	Marketable fruits (%)	PLW (%)	Fruit retention (%)	Shelf life (Days)	Number of fruits per tree	Yield (kg/tree)
	Stage of bagging (S)										
S_1: Marble stage	122.54	5.55	6.06	122.26	11.66	77.65	8.49	92.59	5.94	27.78	3.47
S_2: Egg stage	134.79	6.07	6.43	133.99	11.51	77.74	7.34	96.07	6.73	28.83	3.95
S.Em.±	1.94	0.06	0.06	1.95	0.75	0.64	0.07	0.69	0.08	0.20	0.06
C.D. at 5%	5.52	0.18	0.17	5.54	NS	NS	0.21	1.95	0.23	0.58	0.17
	Bagging materials (B)										
B_1: Control (No bagging)	113.67	5.09	5.85	109.53	28.20	57.42	8.96	86.67	5.43	26.00	3.06
B_2: Newspaper bag	127.47	5.86	6.21	127.89	21.23	68.74	7.61	94.45	6.70	28.35	3.67
B_3: Butter paper bag	125.77	5.82	6.19	125.55	18.24	72.62	8.07	94.44	6.20	28.35	3.60
B_4: Non-woven red bag	137.13	6.22	6.53	138.81	0.53	89.43	7.04	97.22	7.00	29.17	4.12
B_5: Non-woven green bag	135.00	5.96	6.37	134.22	0.53	89.43	7.98	97.11	6.17	29.17	3.96
B_6: Non-woven white bag	132.97	5.91	6.33	132.75	0.53	89.43	7.85	96.11	6.53	28.83	3.86
S.Em.±	3.36	0.11	0.10	3.37	1.25	1.12	0.13	1.19	0.14	0.35	0.10
C.D. at 5%	9.56	0.32	0.29	9.60	3.47	3.36	0.36	3.38	0.39	1.01	0.29
	Interaction effect (SxB)										
S.Em.±	4.75	0.16	0.15	4.70	1.64	1.66	0.18	1.68	0.20	0.50	0.14
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	6.40	4.67	4.04	6.45	24.57	3.52	3.97	3.09	5.34	3.06	6.68

The positive outcomes observed with non-woven bags in this study align with the findings of [13][17] in guava, and [24][25] in banana. The increase in reducing sugars may be attributed to the conversion of sucrose into glucose within the bags, possibly due to enhanced activity of sucrose synthesis and sucrose phosphate synthesis inside the bags [13]. Covered fruits exhibited higher total sugars, likely due to elevated temperatures inside the bags, which favor the conversion of starch into sugar [19]. Ascorbic acid, being a heat-labile phytonutrient [4], may have been influenced by the penetration of photosynthetically active radiation (PAR) inside the bags, as higher PAR transmission was recorded. Higher levels of these phytonutrients with sunlight permeability in red-colored bags [6]. Changes in titrable acidity in fruits may be attributed to alterations in metabolic activities due to the modified atmosphere created by fruit bagging, potentially involving the utilization of organic acids in metabolic processes such as respiration and other bio-degradable reactions [28].

Table 1: Effect of stage of bagging and type of bagging materials on quality parameters of Guava fruit cv. Lalit

Treatments	TSS (ºBrix)	Reducing sugars (%)	Total sugars (%)	Non-reducing sugars (%)	Ascorbic acid (mg 100 g^{-1} pulp)	Titrable acidity (%)
	Stage of bagging (S)					
S_1: Marble stage	10.57	5.85	7.30	1.44	166.18	0.62
S_2: Egg stage	11.83	6.48	8.32	1.84	170.66	0.55
S.Em.±	0.13	0.09	0.10	0.15	1.19	0.01
C.D. at 5%	0.37	0.26	0.29	NS	3.39	0.02
	Bagging materials (B)					
B_1: Control (No bagging)	9.83	5.17	6.63	1.46	162.98	0.67
B_2: Newspaper bag	11.70	6.57	8.40	1.83	169.08	0.52
B_3: Butter paper bag	11.15	6.26	7.64	1.38	166.95	0.60
B_4: Non-woven red bag	12.07	6.61	8.56	1.95	173.46	0.57
B_5:Non-woven green bag	11.23	6.21	7.82	1.61	167.50	0.58
B_6: Non-woven white bag	11.23	6.18	7.79	1.62	170.56	0.56
S.Em.±	0.23	0.16	0.17	0.27	2.06	0.02
C.D. at 5%	0.65	0.44	0.50	NS	5.88	0.04
	Interaction effect (SxB)					
S.Em.±	0.32	0.22	0.25	0.38	2.92	0.02
C.D. at 5%	NS	NS	NS	NS	NS	NS
C.V. %	4.98	6.18	5.49	39.80	3.00	6.38

Interaction effect

There was no significant outcome of the interaction between the stage of bagging and the type of bagging materials of guava fruit for any physical and quality parameters. Fruits bagged at egg stage with non-woven red bag (S_2B_4) recorded a maximum net realization of ₹192931/ha.

CONCLUSION

Based on the analysis and discussion provided above, it can be concluded that better fruits concerning physical and quality parameters were found in egg stage of fruit bagging and when bagged with a non-woven red bag. Utilizing different materials for fruit bagging positively influences physio-chemical characteristics. The process of pre-harvest fruit bagging significantly impacts fruit development, leading to increased fruit size and weight, by altering the microclimatic conditions within the bags surrounding the fruits. Therefore, pre-harvest fruit bagging represents a simple and cost-effective technique, which is farmer-friendly and ensures the production of high-quality guava fruits, consequently fetching better market prices. Moreover, a key advantage of pre-harvest fruit bagging is its potential to reduce the need for plant protection measures, as it eliminates the requirement for chemical sprays to control disease and insect pests. As a result, fruits are devoid of harmful chemical residues, providing consumers with a safer product. Therefore, pre-harvest fruit bagging presents a mutually beneficial scenario for both growers and consumers.

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FUTURE SCOPE

Future research on the effect of bagging on guava development and quality can explore the optimization of bagging materials for enhanced physico-chemical properties and pest resistance. Additionally, investigating the environmental impact of various bagging materials and developing biodegradable options could further improve sustainable guava production. Molecular and biochemical analyses can elucidate the mechanisms behind improved fruit quality and shelf life.

CONFLICT OF INTEREST

Authors have declared that no competing interests exist.

References

1. Abbasi, N. A.; Amjad, M.; Chaudhary, M.; Ikram, A.; Hussain, A. and Ali, I. (2014). Influence of fruit bagging on quality of guava harvested at different maturity stages during summer. *Int. J. Agric.* Biol., 16: 543-549.

2. Anonymous (2019). National Horticulture Board, Ministry of Agriculture and Farmers Welfare, Govt. of India.

3. Bayogan, E. R. V.; Campeon, R. T. and Esguerra, E. B. (2006). Carabao mango harvest quality and production practices and problems of growers in Davao Oriental, Philippines. *Acta Horticulturae*, 699: 103-109.

4. Borochov-Neori, H.; Judeinstein, S.; Harari, M.; Bar-Ya'Akov, I.; Patil, B. S.; Lurie, S. and Holland, D. (2011). Climate effects on anthocyanin accumulation and composition in the pomegranate (*Punica granatum* L.) fruit arils. *J. Agric. Food Chem*., 59: 5325–5334.

5. Brar, J. S.; Arora, N. K.; Kaur, G.; Gill, K. S. and Gill, M. I. S. (2019). Fruit bagging for improving quality of rainy season guava under Punjab conditions. *Agric. Res. J.*,56(3): 475-479.

6. Chonhenchob, V.; Kamhangwong, D.; Kruenate, J.; Khongrat, K.; Tangchantra, N.; Wichai, U. and Singh, S. P. (2011). Preharvest bagging with wavelength selective materials enhances development and quality of mango (*Mangifera* indica L.) cv. Nam Dok Mai. *J. Sci. Food Agric*., 91(4): 664-671.

7. Fan, X. and Mattheis, J. P. (1998). Bagging 'Fuji' apples during fruit development affects color development and storage quality. *Hort. Sci*., 33(7): 1235-1238.

8. Haldankar, P. M.; Parulekar, Y. R.; Kireeti, A.; Kad, M. S.; Shinde, S. M. and Lawande, K. E. (2015). Studies on influence of bagging of fruits at marble stage on quality of mango cv. 'Alphonso'. *J. Plant Stud*., 4: 12-20.

9. Hofman, P. J.; Smith, L. G.; Joyce, D. C.; Johnson, G. L. and Meiburg, G. F. (1997). Bagging of mango influences fruit quality and mineral composition. *Postharvest Biol. Tech*., 12: 83-91.

10. Islam, M. T.; Rahman, M. S.; Shamsuzzoha, M; Bari, M. A.; Akter, M. M. and Uddin, M. S. (2019). Effect of bagging time on fruit quality and shelf life of mango cv. Langra in Bangladesh. *Int. J. Agric. Environ. and Biores*., 4(4): 279- 289.

11. Kiran, A. S.; Kavitha, C.; Soorianathasundaram, K. and Sritharan, N. (2020). Impact of fruit bagging with different coloured non-woven polypropylene bags on yield attributes in grapes. *Asian J. Diary Food Res*., 39: 359-362.

12. Kireeti, A.; Haldankar, P. M. and Parulekar, Y. R. (2018). Studies on effect of types of bags on mango fruit cv. Kesar at egg stage. American Eurasian. *J. Agric. Environ. Sci*., 6: 01-04.

13. Kumar, S. (2020). Effect of fruit bagging on yield and quality of guava (*Psidium guajava* L.) cv. 'Allahabad Safeda'. *Thesis M. Sc. (Agri.)*, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India. 24 p.

14. Malshe, K. V. and Parulekar, Y. R. (2014). Studies on fruit bagging in Alphonso mango with PP non-woven fabrics on yield and quality. *Ann. Plant Physiol*., 28(2): 70- 72.

15. Malshe, K. V. and Parulekar, Y. R. (2017). Studies on fruit bagging in Alphonso mango with PP non-woven fabrics on yield and quality. *J. Plant Physiol*., 28: 70-72.

16. Mathooko, F. M.; Kahangi, E. M.; Runkuab, J. M.; Onyangob, C. A. and Owinob, W. O. (2011). Pre-harvest bagging of mango (*Mangifera indica* L.) cv. "Apple." *Acta Horticulturae*, 906: 55-62.

17. Mishra, K. K.; Pathak, S. and Chaudhary, M. (2017). Effect of pre harvest spraying of nutrients and bagging with different colours of polythene on physico-chemical quality of rainy season guava (*Psidium guajava* L.) fruits cv. 'L-49'. *Int. J. Curr. Microbiol. Appl. Sci*., 6: 3797-3807.

18. Panse, V. G. and Sukhatme, P. V. (1985). "Statistical Method for Agricultural Workers", ICAR., New Delhi.

19. Paradava, D. R.; Patel, M. J. and Kacha, H. L. (2021). Effect of post shooting spray and covering material on banana bunch on its yield attributes and yield. *J. Agri. Search*, 8(4): 364-369.

20. Rahman, H.; Akter, A.; Rahman, J.; Riad, M. I. and Rahman, M. M. (2017). Effect of fruit thinning and bagging on the yield and quality of guava. *J. Agric. Sci. Technol*., 6: 2349-368.

21. Ram, R. S.; Krishna, P. R.; Ram, A.; Ram, S. V.; Ram, R. D. and Rana, M. R. (2013). Pre-harvest fruit bagging influences fruit color and quality of guava. J. Agric. Sci., 4: 443-448.

22. Rangana, S. (1986). "Manual of Analysis of Fruit and Vegetable Products". Tata Mc. Grew Hill Publishing Company Ltd., New Delhi, pp. 7-12.

23. Rathore, D. S. and Singh, R. N. (2006). Flowering and fruiting in three cropping patterns of guava. *Indian J. Hort*., 3: 331-336.

24. Santosh, D.T.; Tiwari, K.N. and Reddy, R.G. (2017). Banana bunch covers for quality banana production – a review. *J. Curr. Microbiol. App. Sci*. 6 (7): 1275–1291.

25. Sarkar S. (2014). Shooting-harvest interval and physico-chemical properties of banana cv. Grand Naine in relation to micro climate inside the bunch cover. *Asian J. Hort*., 9(1):40-42.

26. Shailaja, H. K. (2020). Effect of pre-harvest bagging on fruit quality of mango var. Sonpari. *Thesis M. Sc. (Horti.)*, Navsari Agricultural University, Navsari, Gujarat, India; 2 p.

27. Sharma, R. R.; Reddy, S. V. R. and Jhalegar, M. J. (2014). Pre - harvest fruit bagging: a useful approach for plant protection and improved post-harvest fruit qualitya review. *J. Hort. Sci. Biotech*., 89(2): 101-113.

28. Singh, R. K.; Shah, N. I. and Solanki. P. D. (2017). Influence of fruit bagging on chemical quality of mango (*Mangifera indica* L.) varieties. *Int. J. Plant Soil Sci*., 18(3): 1-7.

29. Singh, A.; Meena, H. M.; Santra, P.; Meghwal, P. R. and Kumar, P. (2021). Influence of pre-harvest fruit bagging and plant cover on peel colour, physical appearance and quality traits of pomegranate fruits in arid conditions. *J. Environ. Biol*., (42): 1560-1566.

30. Vyas, H. A. (2021). Effect of foliar application of multi-micronutrients grade IV and pre harvest bagging on yield and quality of guava (*Psidium guajava* L.) cv. L- 49. *Thesis M. Sc. (Horti)*, Junagadh Agricultural University, Junagadh, Gujarat, India; 2 p.

