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Improvement of Physio-biochemical and Sensory Attributes of Guava (*Psidium guajava* Linn.) cv. VNR Bihi by using Various Bagging Materials

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ABSTRACT: Fruit bagging is a very congenial approach that prevents fruits from being stressed by multiple biotic and abiotic stresses and provides a microclimate during development. It can also potentially improve the quality and market value of fruits. The investigation was carried out at the Horticulture Research Centre, Pattarchatta and Department of Horticulture, G. B. Pant University of Agriculture & Technology, Pantnagar, Udam Singh Nagar, Uttarakhand, during the years 2018–2019. To evaluate the effect of different pre-harvest bagging materials (Biodegradable bags; purple, yellow, pink, green and red; Polypropylene bags; blue, light green, white, green and red; Polyethylene bags; yellow, white, blue, green, orange and pink) on the maturity and physico-chemical properties of guava cv. VNR Bihi. The experiment was laid out in a randomized complete block design with five replications. Fruit bagging treatments showed significant effects on the different parameters studied. Fruit gained the maximum fruit length: diameter ratio (0.99) under the purple biodegradable bag. The maximum core diameter (4.70 cm) was noted with blue polyethylene bag (T_{14}), followed by green polypropylene bag T_{10} (4.65 cm), white polyethylene bag T_{13} (4.55 cm) and light-yellow polyethylene bag T_{12} (4.50 cm). While treatment with light green polyethylene bag reported a higher sugar: acid ratio (24.64) in bagged fruit, it was found to be significantly higher as compared to other treatments. Sensory attributes (appearance, taste, texture, flavour, and overall acceptability) of fruits were maximally observed in the light pink biodegradable bag, respectively 7.47, 7.29, 7.12 and 7.39, followed by blue polyethylene bag, compared to other bagging materials and control.

Keywords: Guava, fruit bagging, maturity, physiochemical characteristics, sensory attributes.

INTRODUCTION

Guava is a most significant tropical or subtropical fruit crops, sometimes referred to as the "Apple of Tropics" and a member of the Myrtaceae family. The fruit, which has roughly 100 genera and 3000 varieties and is native to Tropical America, is slowly making its way across the globe from Mexico to Peru. According to horticulture statistics, guava has the fifth position in terms of significance among fruits cultivated in India, as determined by factors such as area and production. This ranking places of guava after mango, banana, apple, and citrus fruits. Guava has grown in popularity in our nation as a result of its prolific and early-blooming nature, as well as its wider adaptability under diverse agro-climatic conditions (Dolkar *et al*., 2014). It is rich source of ascorbic acid, lycopene, and various antioxidants, minerals and dietary fibers. Additionally, it contains a substantial quantity of vitamins, including provitamin A (carotene), thiamine, riboflavin, pantothenic acid, and niacin (Singh and Singh 2005; Kherwar and Usha 2016). Furthermore, the sample demonstrates the presence of micro- and macronutrients such as potassium, calcium, phosphorus, iron, sodium, and magnesium. In addition to the guava fruits, many plant components like roots, leaves, and bark possess therapeutic characteristics (Kherwar and Usha 2016). These plant parts are commonly employed in the treatment of gastrointestinal disorders, including gastroenteritis, diarrhoea, and dysentery. The presence of phenolic compounds in guava has been shown to possess potential therapeutic properties against malignant cells and to have preventive effects against skin ageing. Furthermore, the various processed derivatives of guava, including juices, jelly, jam, nectar, and cheese, have gained significant popularity in the global market. To effectively penetrate the global trade market under the World Trade Organisation (WTO) framework, it is imperative to enhance the quality and productivity of guava. Fruits commonly encounter various biotic and abiotic obstacles during their developmental stages, resulting in the formation of undesirable scars on their surfaces. The presence of blemishes and scars on fruits might result in a decrease in their market value. Many researchers have recommended the use of pheromone traps, pesticides, poison food traps, field cleanliness, etc. to reduce the effects of biotic and abiotic variables (Sapkota *et al*., 2010; Wang *et al*., 2022), but such a solution is not cost-effective and has additional drawbacks.

Under North Indian conditions, out of the three Bahar of guava, Mrig Bahar is the most preferred crop. Which produced the best quality guava; however, sometimes late rainfall and mechanical brushing left the fruit scared, which fetched a poor market price. Hence, during developmental periods, scars on the fruits can be reduced with improved fruit colour through physical barriers like bagging. However, different bagging materials like newspaper bags, brown paper bags, polyethylene bags, biodegradable bags, polypropylene bags, etc. have different characteristics in vapour permeability, light transmittance, heat conductance and consequently cause differential effects on the microenvironment and subsequently on fruit mass, quality, texture and appearance (Niu *et al*., 2003; Son and Lee 2008; Ali *et al*., 2021; Jat *et al*., 2021). Moreover, the fruiting stage when it was bagged, fruit cultivars, and duration of fruit exposure to natural light after bag removal (before harvesting) also affect the fruit quality.

Therefore, the purpose of this study was to evaluate the numerous physiological and quality attributes changes that occur in fruits as a result of the change in microclimate that occurs in bags made of different materials and how fruit quality improves under different bagging methods. In addition, the results of this experiment allow farmers to select low-cost, effective bagging materials for use in the bagging of guava fruits, allowing them to harvest scar-free, quality fruit.

MATERIALS AND METHODS

The field experiment was conducted at the Horticulture Research Centre, Pattharchatta, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) during winter season crop of 2018-2019 on four-year-old trees of guava cv. VNR Bihi spaced at 5 m × 3 m. The Horticulture Research Centre, Patharchatta is located in the North Western Plains of Tarai region of Uttarakhand adjoining the foothills of Shivalik range of Himalayas at an altitude of 243.83 meters above the mean sea level and at 28º 58′ N latitude and 79º 2′ E longitudes.

The experiment was laid out in randomized block design comprising of 17 treatments with five replications having four fruits per replication. The healthy and uniform sized fruits of guava were wrapped with different biodegradable bags, polypropylene bags and polyethylene bags which were *viz*., T_1 – Control, T_2 – Purple Biodegradable bag, T_3 – Yellow Biodegradable bag, T_4 – Pink Biodegradable bag, T_5 – Green Biodegradable bag, T_6 – Red Biodegradable bag, T_7 – Blue Polypropylene bag, T_8 – Light green Polypropylene bag, T_9 – White Polypropylene bag, T_{10} – Green Polypropylene bag, T_{11} – Red Polypropylene bag, T_{12} – Yellow Polyethylene bag, T_{13} – White Polyethylene bag, T_{14} – Blue Polyethylene bag, T_{15} – Green Polyethylene bag, T_{16} – Orange Polyethylene bag and T_{17} – Pink Polyethylene bag. Each bags having size of 20” × 30” were used as wrapping materials at 65 days after fruit set when guava fruits attained size of 3.5” × 4.0”. Perforations were made at bottom of the bag and both sides on all bags for proper ventilation required for fruit growth and development. The healthy fruits were selected for bagging.

Physical parameters such as fruit length: diameter ratio and core diameter was recorded. The fruit length: diameter ratio was calculated by dividing the fruit length with fruit diameter and sugar: acid was estimated by dividing the total sugars with total titratable acidity. Core diameter was measured with the help of vernier caliper and expressed in cetimeter. A panel of 10 semi trained judges evaluated treated fruits for its appearance, taste, texture, aroma and overall acceptability on 9-point Hedonic scale *i.e.* Like Extremely (9), Like Very Much (8), Like Moderately (7), Like Slightly (6), Neither Like nor Dislike (5), Dislike Slightly (4), Dislike Moderately (3), Dislike Very Much (2) and Dislike Extremely (1).

The data were analyzed to test the significance of differences between the means for various attributes through Analysis of Variance (ANOVA) (Gomez and Gomez 1984). Significant differences among treatments were determined using Duncan’s multiple range tests at $p<0.05$ and all computation and statistical analyses were done using IBM SPSS Statistics 19 statistical software (IBM, NY, USA).

RESULTS AND DISCUSSION

A. Physio-biochemical attributes

The fruit length: diameter ratio, core diameter and sugar: acid ratio of guava fruits are significantly affected by the use of different bagging materials (Table 1).

Bagged fruits with a purple biodegradable bag (T_2) showed a higher fruit length: diameter ratio (0.99) and it was found to be significantly higher as compared to the rest of the treatments. While fruits were bagged with white polypropylene bags (T_9), guava exhibited a lower fruit length: diameter ratio (0.85). The significant impact of bagging was observed and maximum core diameter (4.70 cm) was noted with blue polyethylene bag (T_{14}) and it was found at par with green polypropylene bag T_{10} (4.65 cm), white polyethylene bag T_{13} (4.55 cm) and light-yellow polyethylene bag T_{12} (4.50 cm), while minimum core diameter (3.86 cm) was recorded in control (T_1). Fruit length: fruit diameter ratio and core diameter of guava fruit are positively significant with bagged fruit compared to unbagged fruit due to pre-harvest fruit bagging improving the fruit weight and diameter through conducive effects such as increased relative humidity and consequently reduced fruit water loss (Dutta and Majumdar 2012). Similar findings were reported by Kutinyu (2014), who also emphasized that changes in fruit weight caused by the covering of different colours of polyethylene might be due to interactions between light intensity and favourable temperature and moisture regimes inside the bag. Similar results were observed by Debnath and Mitra (2000), as they also observed maximum physical characteristics in blue polythene-covered guava fruits.

However, guava fruits bagged in a light green polyethylene bag reported a higher sugar: acid ratio (24.64) and were found to be significantly higher as compared to other treatments. While minimum sugar: acid ratio (13.50) was observed in control (T_1) during the experimentation.

Table 1: Effect of pre-harvest fruit bagging on fruit length: diameter ratio, core diameter and sugar: acid ratio of guava.

Treatments	Fruit length: diameter ratio	Core Diameter (cm)	Sugar: acid ratio
T_1 (Control)	0.93^{c-g*}	3.86^{h}	13.50^{i}
T_2 (Purple biodegradable bag)	0.99^{a}	4.01^{f-h}	17.04^{h}
T_3 (Light yellow biodegradable bag)	0.89^{g}	4.15^{ef}	20.56^{cd}
T_4 (Light pink biodegradable bag)	0.95^{b-d}	4.61^{ab}	21.86^{b}
T_5 (Light green biodegradable bag)	0.91^{d-g}	4.38^{cd}	18.37^{g}
T_6 (Light red biodegradable bag)	0.90^{fg}	4.00^{f-h}	19.91^{de}
T_7 (Blue polypropylene bag)	0.91^{d-g}	4.25^{de}	21.86^{b}
T_8 (Sky polypropylene)	0.94^{c-e}	4.10^{e-g}	19.33^{ef}
T_9 (White polypropylene bag)	0.85^{h}	4.05^{e-h}	17.27^{h}
T_{10} (Green polypropylene bag)	0.94^{c-e}	4.65^{ab}	18.63^{fg}
T_{11} (Red polypropylene bag)	0.90^{fg}	4.01^{f-h}	16.92^{h}
T_{12} (Light yellow polyethylene bag)	0.95^{b-d}	4.50^{a-c}	18.78^{fg}
T_{13} (White polyethylene bag)	0.96^{a-c}	4.55^{a-c}	17.60^{h}
T_{14} (Blue polyethylene bag)	0.94^{c-e}	4.70^{a}	19.07^{fg}
T_{15} (Light green polyethylene bag)	0.93^{c-g}	3.96^{f-h}	24.64^{a}
T_{16} (Light orange polyethylene bag)	0.92^{c-g}	3.90^{gh}	21.11^{bc}
T_{17} (Pink polyethylene bag)	0.94^{c-e}	4.45^{bc}	19.95^{de}
SEm±	0.01	0.06	0.25
CD @ 5%	0.04	0.17	0.71

*Means with same letter within a column shows non-significant differences (at $p \leq 0.05$) as per Duncan's multiple-range test

B. Sensory evaluation

The perusal of the data of sensory evaluation presented in Table 2 showed that the appearance of fruit bagged with light pink biodegradable bag T_4- (7.47) attract the evaluator and it was found at par with blue polyethylene bag T_{14}- (7.33), as compared to other treatments. While fruit appearance is slightly different when fruits are not bagged. In terms of taste, texture and flavour, fruits bagged with light pink biodegradable bag got significantly higher marks than others, i.e., 7.29, 7.12 and 7.39, respectively and it was found at par with blue polyethylene bags (T_{14}) with the marks 7.50, 6.99 and 7.27, respectively. However, minimum marks got for taste (5.21), texture (4.50) and flavour (4.58) in the T_1 (Control). In case of overall acceptability, the light pink biodegradable bag gathered maximum marks (7.41) as compared to other treatment and minimum marks in control- T_1 (4.71). From the results, it is clear that bagging treatments significantly retained physico-chemical properties, ultimately maintaining the organoleptic characteristics. The possible reason might be the change in the microenvironment caused by the bagging treatments on the tree, which ultimately slowed down the metabolic activities during storage. Degradation of AA proceeds through both aerobic and anaerobic pathways (Huelin, 1953; Johnson *et al*., 1995) and depends upon many factors such as exposure to light (Robertson and Samaniego 1986), storage temperature and storage time (Fellers, 1988; Gordon and Samaniego-Esguerra 1990). The similar findings were reported by Sarmiento *et al*. (2023) in dragon fruit, Amarante *et al.* (2002) in pear.

Table 2: Effect of pre-harvest fruit bagging on sensory attributes of guava fruits.

Treatments	Appearance	Taste	Texture	Flavour	Overall acceptability
T_1	4.56^{g*}	5.21^{l}	4.50^{n}	4.58^{l}	4.71^{p}
T_2	5.10^{f}	5.42^{kl}	4.89^{lm}	4.95^{jk}	5.09^{n}
T_3	7.06^{b}	7.29^{bc}	6.79^{bc}	7.10^{b}	7.06^{c}
T_4	7.47^{a}	7.67^{a}	7.12^{a}	7.39^{a}	7.41^{a}
T_5	5.86^{e}	6.33^{gh}	5.67^{hi}	5.83^{f}	5.92^{i}
T_6	6.57^{c}	6.94^{de}	6.43^{de}	6.55^{d}	6.62^{e}
T_7	6.39^{cd}	6.83^{e}	6.24^{ef}	6.42^{d}	6.47^{f}
T_8	5.29^{f}	5.88^{i}	5.27^{jk}	5.30^{g-i}	5.44^{kl}
T_9	6.15^{d}	6.45^{fg}	5.89^{gh}	6.10^{e}	6.15^{h}
T_{10}	5.17^{f}	5.54^{jk}	5.08^{kl}	5.14^{ij}	5.23^{m}
T_{11}	5.33^{f}	6.15^{h}	5.30^{jk}	5.41^{gh}	5.55^{k}
T_{12}	5.67^{e}	6.28^{gh}	5.46^{ij}	5.55^{g}	5.74^{j}
T_{13}	5.21^{f}	5.67^{ij}	5.15^{j-l}	5.26^{hi}	5.32^{lm}
T_{14}	7.33^{a}	7.50^{ab}	6.99^{ab}	7.27^{ab}	7.27^{b}
T_{15}	6.83^{b}	7.10^{cd}	6.67^{cd}	6.81^{c}	6.85^{d}
T_{16}	4.79^{g}	5.33^{kl}	4.67^{mn}	4.79^{kl}	4.90^{o}
T_{17}	6.27^{d}	6.57^{f}	6.04^{fg}	6.30^{de}	6.30^{g}
SEm±	0.09	0.08	0.10	0.09	0.04
CD @ 5%	0.26	0.23	0.29	0.26	0.13

*Means with same letter within a column shows non-significant differences (at $p \leq 0.05$) as per Duncan's multiple-range test

CONCLUSIONS

Based on the results, it can be said that there was a significant difference between the various pre-harvest fruit bagging treatments in terms of fruit length: fruit diameter ratio, core diameter, total sugar: acidity ratio, and sensory attributes (appearance, taste, texture, flavour, and overall acceptability).From the experimental findings, it might be concluded that, among the seventeen bagging materials, Purple biodegradable bag showed the best result of fruit length: fruit diameter ratio compared to other. Green polypropylene bag showed the best finding for core diameter of fruits compare to other treatments. Light green polyethylene was best for total sugar: acidity ratio light pink biodegradable bag best for sensory attributes compare to other treatments. Given the results mentioned above, it is advised to do more research to explore the impact of other potential non-chemical botanical pesticides at various concentrations on the quality of guava fruits. In order to provide a comprehensive recommendation for the technology, it is essential to incorporate both nutritional and taste evaluations.

FUTURE SCOPE

Future of bagging in fruit crops promises eco-friendly pest management and improved fruit quality. Smart materials and technology will maximize protection and reduce chemical consumption. Adoption might boost yields, food security and sustainability.

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Conflict of interest. None.

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