RESEARCH ARTICLE

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Efficacy of Packaging on the Quality and Shelf Life of Guava (*Psidium Guajava*)

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ABSTRACT

The effectiveness of packaging materials on the quality and shelf life of local and hybrid varieties of guava was evaluated under refrigerated and room temperature. The treatment consisted of packaging with polythene, a perforated polyethylene bag, and control (without packaging. Different quality parameters such as physiological weight loss, decay loss, color and overall acceptability score, percentage of marketability, moisture content, total solid content, ash content, protein content, pH, titratable acidity, and vitamin C content were examined. The results showed that the vitamin C, pH content reduction rate is comparatively lower in the case of hybrid guava stored in perforated polythene packaged at refrigeration temperature compared to other treatments. An increase in titratable acidity content was recorded lowest in the case of deshi variety packaged with polythene stored at refrigeration temperature whereas hybrid variety packaged with perforated polythene stored at room temperature showed a higher rate of increase. Physiological weight loss and decay loss were recorded lowest for the sample packaged with a perforated polythene bag under the refrigerated condition while the control sample stored at normal room temperature showed the highest rate. Marketability of perforated polythene packaged fruits was recorded highest when that of the control one under normal room temperature was recorded the lowest. Performances of perforated polythene packaging system under the refrigerated temperature may be recommended for the longest shelf life and the highest quality of guava.

Keywords: Guava, Packaging, Shelf-Life, Vitamin-C, Weight Loss.

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I. Introduction

Guava (*Psidium guajava* L.) fruit is considered one of the most important fruit crops in Bangladesh, producing 2.36 million tons per year [1]. It is cultivated commercially in Barisal, Sylhet and Chittagong regions.

The consumer demand for guava is a very high due to its good taste and lower price in comparison with other fruits. Guava is one of the finest sources of vitamin C in comparison with any other fruits. It serves vital minerals balance in our body such as calcium, phosphorus, iron etc. Guava fruits contain carbohydrates 14.3 g, protein 2.55 g, calcium 8 mg, vitamin-C 228 mg, vitamin-A 624 IU, lycopene 5204µg, energy 68 Kcal, and anti-oxidant property 496 mg/100 g fruit making it a super food [2]. Various types of value added product, such as jam, jelly, cheese, ketchup, puree, juice, powder, necter etc. are prepared commercially from ripe guava. Guava salad is gaining popularity now a days [3].

However, due to having huge amount of water, it is perishable in nature and difficult to store. Every year, a significant amount of guava fruit is lost after harvesting because of the fruit's thin and sensitive skin, which causes desiccation, blemishes, and quick, irreversible biochemical changes that reduce the flavor and firmness of the flesh and shorten the fruit's shelf life. Bangladesh has a high population density and has had population growth of 1.6% annually in recent years. Comparing the growth rate of population, fruit production is not growing faster. Thus, it is difficult to overstate the importance of preserving the balance between population, food, and nutrition. The majority of Bangladesh's population is malnourished, particularly in terms of vitamins and minerals. Guava is a wonderful source of vitamins and minerals that are easily absorbed. Even without many worries, it is extremely lucrative, prolific, and hairy [3].

Fruit, vegetables, and root crops have very large postharvest losses because they are far less hardy and perishable than other crops, and if proper care is not taken during harvest, processing, and transportation, they quickly rot and become unfit for human consumption [4]. In Bangladesh, handling, storage, and ripening of fruit after harvest results in 30 to 50 percent of fruit being wasted [5]. Due to the guava's extreme perishability, this post-harvest loss is very noticeable. There are no accurate statistical data available, particularly in Bangladesh, to show the extent of post-harvest guava loss. A crucial topic of investigation would therefore be how to lessen these post-harvest losses in guava and other fresh fruits and to improve Bangladesh's population-food balance. Individual packaging of fresh goods has been increasingly popular in recent years as a way to increase their shelf life. Individual packaging has significant advantages over traditional packing techniques, including the potential to reduce weight loss and deformation, maintain firmness, reduce cold injury, prevent secondary infection degradation, and delay color development and senescence [6]. By storing and protecting the food, "cling film," a plastic packaging film, has transformed the food sector. Cling film is a very thin polyethylene film that sticks to the fruit's surface and provides an additional layer of protection. By delaying respiration and transpirational losses, the film improved the physicochemical features of the guava, including appearance, weight loss, total soluble solids, titrable acidity, ascorbic acid concentration, and total sugars [7]. Additionally, Mung bean sprouts' shelf life was increased with cling film by up to 5 days [8]. Common uses for perforated polyethylene sheets include minimizing weight loss, reducing abrasion, preventing damage, and delaying fruit ripening [1]. Compared to LDPE and HDPE films, shrink film significantly reduced weight loss, total soluble solids, required hardness, and prolonged storage life up to 3 weeks, maintaining the exceptional quality of pears [9]. The physicochemical features of apples packaged in CFB boxes with polyethylene liners and shrink-wrapped trays under storage temperatures of 2 ± 1 °C and 85–90% RH have the desired impact and have been kept for a longer period of time [10]. The goal of the current project work was to evaluate how individual film packaging of guava fruits affected its shelf life. This was done in consideration of the significant impact that individual wrapping has on fruit shelf lives, as well as how the characteristics and thickness of the film used, the wrapping methods, and the storage temperatures affect the outcome of wrapping. To assess the impact of various post-harvest treatments on the shelf life of guava, the storage life of 2 (two) guava types has been included in the current study under the aforementioned conditions. The specific objectives of this research were as i) to compare the varietal difference between two varieties of guava ii) to extend shelf life of guava by using different packaging materials iii) to evaluate quality of guava under room and refrigeration temperature.

II. Materials and Methods

The fresh and matured Guava of Deshi and Hybrid varieties were collected from the local market. Chemicals and solvents used in the study were of analytical grade.

A. Experimental Design

Guava fruits were selected according to uniform color, shape, and size and were free from defects. The experiment consisted of three postharvest treatments such as i) control (without packaging) ii) packed with polyethylene and iii) packed with a perforated polyethylene bag. The experiment was carried out under room and refrigeration temperature in a complete randomized design with 3 replications.

B. Sample Preparation

The guava was washed with sodium hypochlorite (NaOCl) solution (@100 ppm) at 20°C for 5 min for surface disinfection. After surface drying, all fruits were weighted by balance. The weighed guava fruits were packed in different packaging treatments with three replications at ambient conditions (35°C).

C. Parameters Studied

Physiological weight loss, decay percentage, percentage marketability, moisture content, ash, protein, pH, titrable acidity, and vitamin C of fresh and preserved guava were analyzed.

1) Percent weight loss (PWL)

The weight loss percentage was determined using the methods described by Amin *et al.* [1]. The equation (1) was used to calculate successive weight loss expressed as percentage for the respective treatments.

$$\%\text{ weight loss} = \frac{\text{weight of initial} - \text{weight of final}}{\text{weight of initial}} \times 100 \quad (1)$$

2) Decay loss

The percentage of decayed fruits was determined by dividing a number of decayed fruits to number of unmarketable fruits. The disease type was also identified by the help of colored photographs [11].

3) Percentage of marketability

A small modification to the method of Hailu *et al.* [11] was used to subjectively evaluate the marketability of fruits. The extent of the obvious mold growth, decay, shriveling, smoothness, and shininess of the fruits was used to subjectively determine these descriptive qualitative criteria. Fruit quality was rated on a scale of 1 to 5, where 1 was considered unusable, 2 acceptable, 3 fair, 4 good, and 5 exceptional. Marketable fruit was defined as earning a rating of 3 or higher. The number of marketable fruits was measured in order to determine the percentage of marketable fruits that were present during storage. The product was evaluated subjectively, and then Equation (2) was used to calculate it:

$$\text{Percentage marketability} = \frac{\text{Number of marketable guava fruit}}{\text{Total number of guava fruit}} \times 100 \quad (2)$$

4) Chemical composition determination

Moisture, ash, protein, and acidity content of the samples were determined according to the methods of AOAC [12]. Vitamin C (ascorbic acid) was determined by the method of Ranganna [13]. The pH of the guava pulp was measured by using a PERKINFLMER Merion-V pH meter at ambient temperature.

D. Statistical Analysis

Statistical analysis was performed in Completely Randomized Design (CRD) by using Analysis of Variance (ANOVA).

III. Results and Discussion

A. Chemical Composition of Guava

This chemical composition of locally available deshi and hybrid guava experiment was performed and given in table I.

TABLE I: Chemical Composition of Two Varieties of Guava

Chemical composition	Deshi Guava	Hybrid Guava
Moisture (%)	75.1 ± 0.249	77.6 ± 0.417
Protein (%)	3.09 ± 0.134	4.5 ± 0.144
Ash (%)	0.50 ± 0.010	0.8 ± 0.028
pH	4.8 ± 0.037	4.2 ± 0.0.037
Acidity (%)	0.35 ± 0.008	0.38 ± 0.009
Vitamin C (mg/100g)	150 ± 0.654	228.3 ± 0.737

Data presented in Table I reveal deshi fresh guava fruit as recording 75.1±0.249% moisture, 3.09±0.134% protein, 0.50±0.010% ash, 4.8±0.037 pH, 0.35±0.008% titrable acidity, and 150±0.654 mg/100g ascorbic acid; whereas, hybrid guava recorded 77.6±0.417% moisture, 4.5±0.144% protein, 0.8±0.028% ash, 4.2±0.0.037 pH, 0.38±0.009% titrable acidity, and 228.3±0.737 mg/100g ascorbic acid Results on total acidity, pH, and ascorbic acid content in guava are in agreement with earlier findings of Tiwari [14].

From the table, it is seen that guava is a rich source of vitamin C, and levels are subject to wide variation (150 to 228 mg/ 100 g fruit) according to variety. Hybrid guava contains more ascorbic acid than deshi guava. From the illustrated data, it can be compared that the deshi guava had lower moisture, protein, ash, acidity, and vitamin C than the hybrid one. The fat content (gm) of deshi and hybrid guava being negligible, it was not determined.

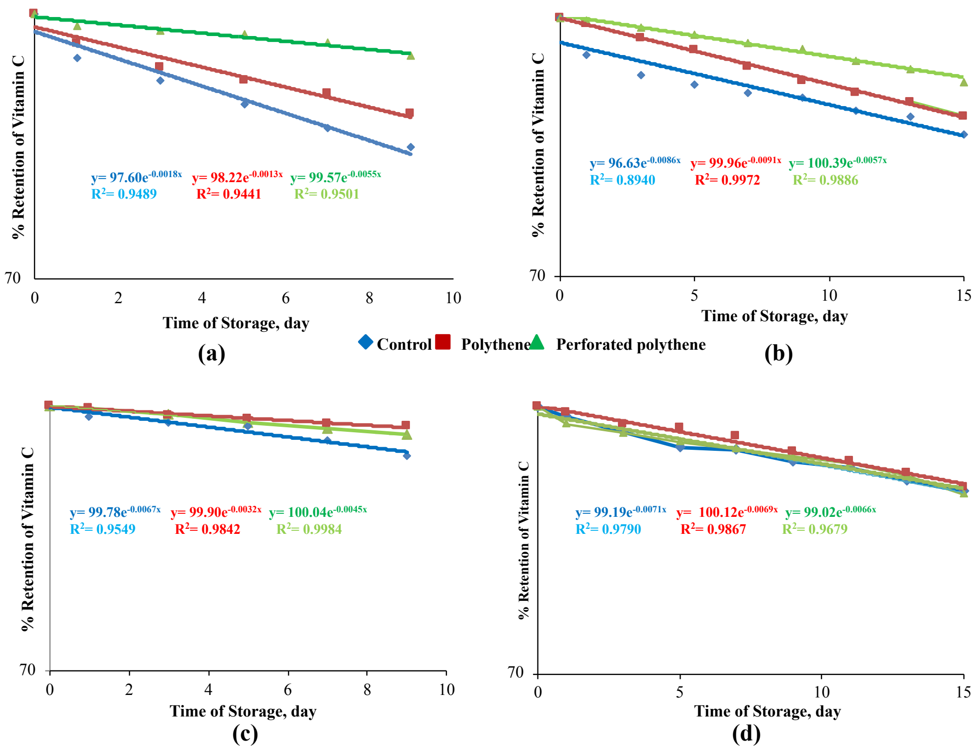

Fig. 1. Changes of vitamin C with time for (a) Deshi guava at RT; (b) Deshi guava at RFT; (c) Hybrid guava at RT; (d) Hybrid guava at RFT under different packaging materials.

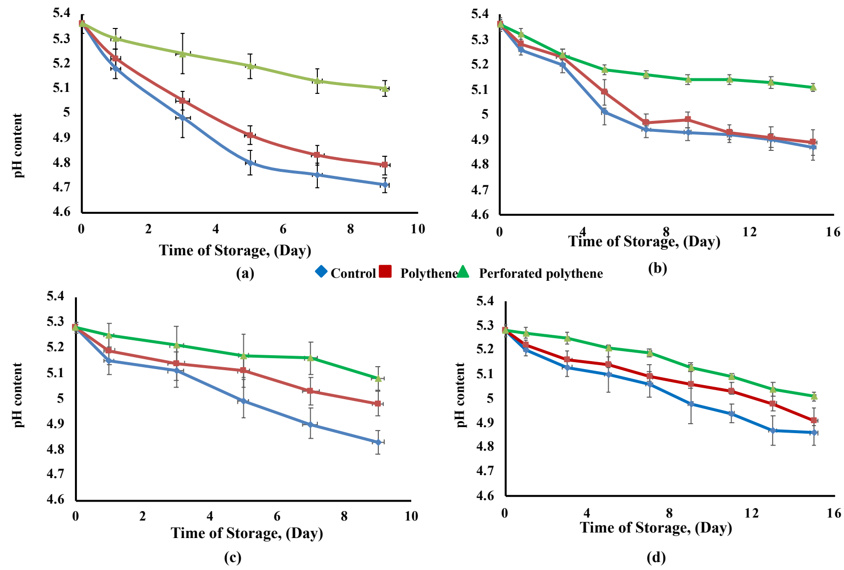

Fig. 2. Changes of pH with time for (a) Deshi guava at RT; (b) Deshi guava at RFT; (c) Hybrid guava at RT; (d) Hybrid guava at RFT under different packaging materials

B. Changes of Vitamin C

Fig. 1 depicts the changes in vitamin C content of deshi and hybrid guava at room and refrigeration temperatures treated with various packaging materials. It has been shown that vitamin C content decreases over time, whether packaged or not. The rate of decrease in vitamin C content was observed to be different for different packaging materials. The sample with no packaging materials had the highest rate of degradation of vitamin C content, whereas the guava packaged with polythene had a lower rate of decrease. Perforated polythene, on the other hand, has the best ability to conserve vitamin C of deshi and hybrid guava, with the lowest decreasing rate. From the diagram, it is also observed that hybrid variety guava showed the higher degradation rate rather than deshi guava at room and refrigeration temperature.

For deshi variety, at room temperature, the degradation rate was greater than the refrigeration temperature but opposite results were observed in the hybrid variety. The highest degradation rate of vitamin C was in the deshi sample (0.0183/day) stored in no packaging condition and at room temperature while the lowest rate was in the hybrid sample stored in a polythene bag at the same temperature. The degradation rate varied due to the storage condition, temperature, oxygen availability, fruit composition, and so on. Shomodder *et al.* [15] also found that vitamin C of fresh-cut guava slices dipped in different solutions was degraded with storage time.

C. Changes of pH

The changes in pH content of deshi and hybrid guava at room and refrigeration temperature when they are treated with different packaging materials are shown in Fig. 2. As the statistics show a significant result, different packaging materials have variations in their effect on the pH content of stored fruits at both temperatures. It is seen that the control sample showed the highest rate of decrease in pH content whereas the lowest decrease rate of pH content was in perforated polythene packaging.

Comparing the temperature effect on the pH of guava, it can be concluded that fruits stored at refrigeration temperature depicted the lowest rate of decrease at room temperature. Of the two varieties, hybrid guava showed the best result than the deshi one.

D. Titrable Acidity

Fig. 3 depicts the change in acidity production with time for deshi and hybrid guava at room and refrigeration temperatures under various packaging conditions. It demonstrated statistically significant results when treated with various packaging materials at room and refrigeration temperatures. The sample with no packaging materials has the highest rate of acidity production, whereas the guava packaged with polythene has a lower rate. Perforated polythene, on the other hand, produces the best results of the three.

When compared to refrigeration storage, guava samples stored at room temperature showed the highest rate of acidity production after 9 days. Among the treatments, the hybrid guava stored at room temperature (0.89% acidity) had the highest rate of production, while the deshi sample stored at room temperature produced the least (0.63% acidity). While stored at the same temperature and packaging conditions as the deshi variety, hybrid guava produced the highest rate of acidity.

E. Percentages (%) of Physiological Weight Loss

Fig. 4 shows the percentages of physiological weight loss of deshi and hybrid guava at room and refrigerated temperatures under various packaging materials. The samples stored at two different temperatures and under diverse packaging conditions (control, polythene, and perforated polythene) showed considerable variances, as shown in the figure.

According to the graph, the percentage of weight loss (19.50%) was highest for an unpackaged control deshi sample stored at room temperature, while the hybrid guava showed the lowest percentage of weight loss (4.15%) after 15 days of storage in a perforated polythene bag at refrigeration temperature. It was discovered that the temperature at which guava is stored has a significant impact on its weight loss.

The packaging circumstances have a considerable impact on percent weight loss, as illustrated in Fig. 4. Guava wrapped in regular polythene resulted in a medium range of weight loss percentages. Deshi guava lost the most weight while stored at the same temperature and under the same packaging conditions as the hybrid variety.

F. Decay Loss

The impacts of different packaging materials on the proportion of decayed fruits of deshi and hybrid guava under room and refrigerator temperature conditions are depicted in Fig. 5 below. The unpackaged deshi guava sample had the highest percentage of decaying at room temperature, as shown in the graph. Guava that was wrapped in a perforated polythene bag had the least amount of decaying fruit. The declining percentages of guava wrapped in regular polythene were in the middle range. When compared to deshi guava, the degradation loss of hybrid guava is smaller. This variance is attributable to variations in composition, physiological changes, and so on.

G. Percentage of Marketability

Fig. 6 depicts the percentage of marketability of Deshi and Hybrid guava at room temperature and refrigeration temperature, as well as the packaging materials used. Under both conditions, significant statistical analysis of the data on the diagram reveals a significant difference between the impacts of different packaging materials on the marketability of guava.

Under varied temperature conditions (room and refrigerated), guava packaged with perforated polythene has a higher percentage of marketability than guava packaged with no packaging materials, which has the lowest percentage of marketability. When the two varieties were compared at room temperature, no differences were found. Hybrid guava, on the other hand, has a higher percentage of marketability at refrigeration temperatures.

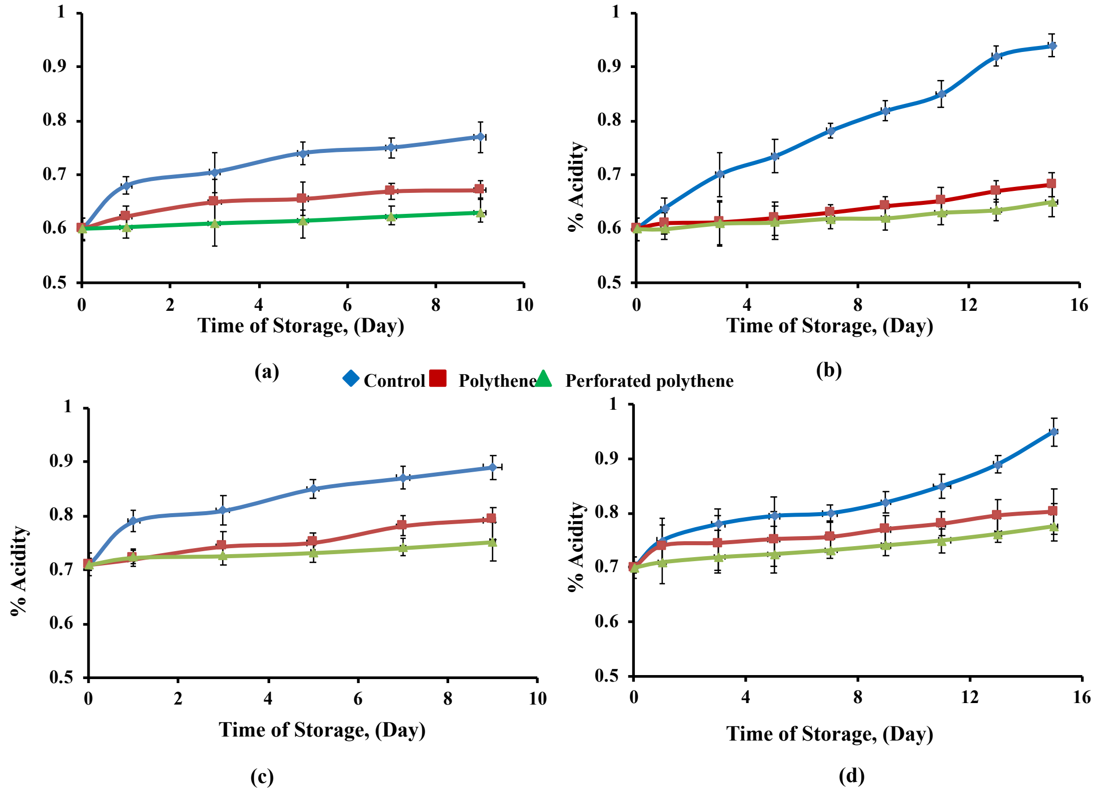

Fig. 3. Percent (%) tritable acidity with time for (a) Deshi guava at RT; (b) Deshi guava at RFT; (c) Hybrid guava at RT; (d) Hybrid guava at RFT under different packaging materials.

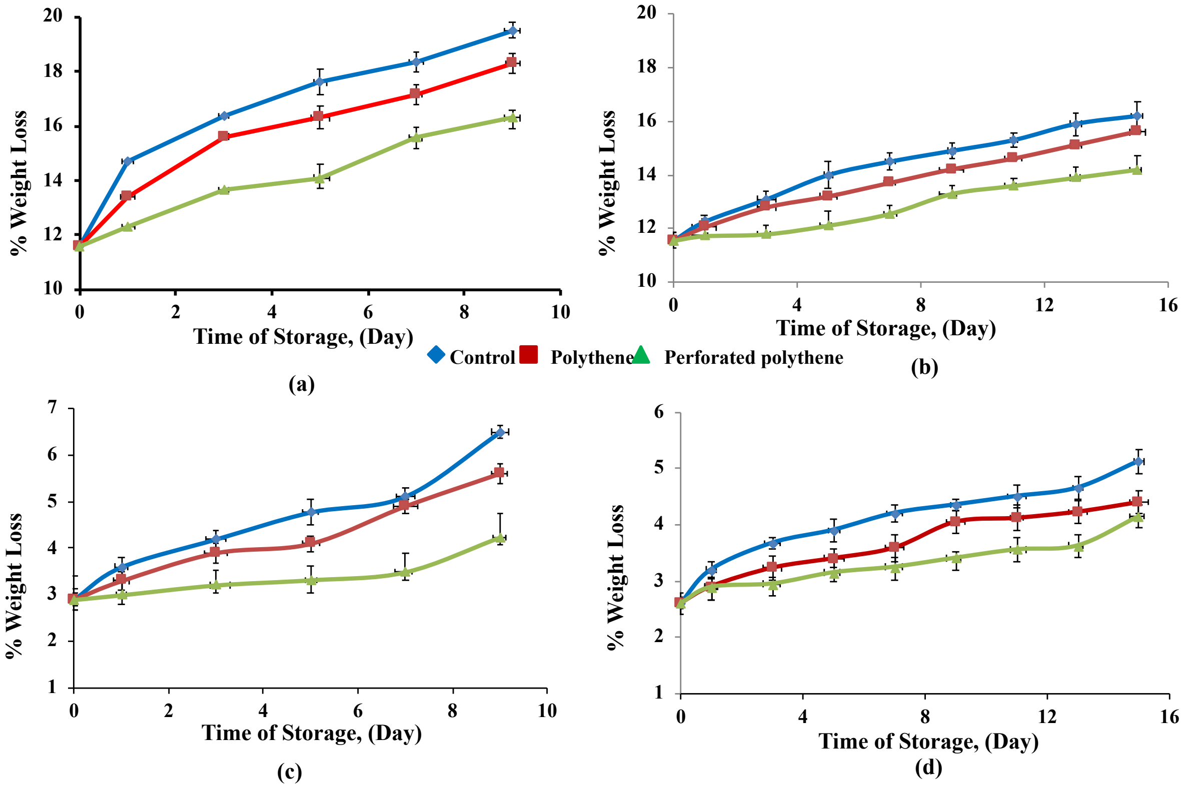

Fig. 4. Percent (%) physiological weight loss with time for (a) Deshi guava at RT; (b) Deshi guava at RFT; (c) Hybrid guava at RT; (d) Hybrid guava at RFT under different packaging materials.

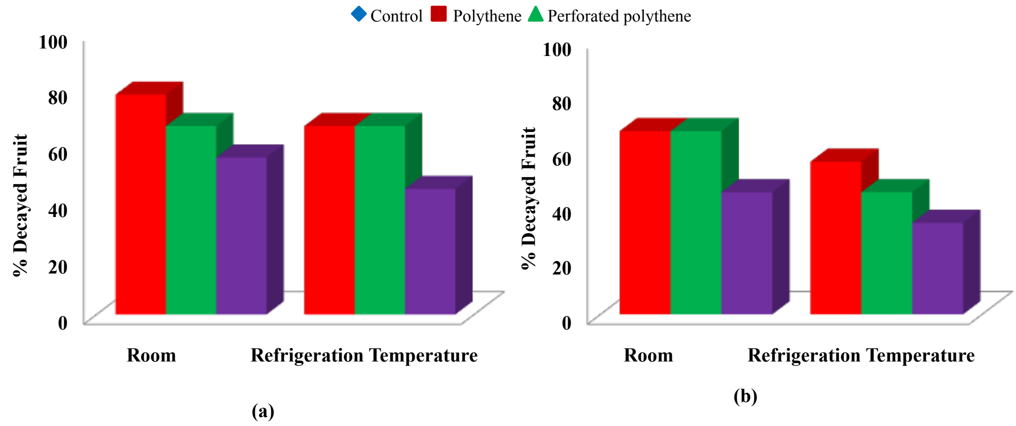

Fig. 5. Percent (%) decayed fruits of (a) Deshi guava and (b) Hybrid guava at room & refrigeration temperature under different packaging materials.

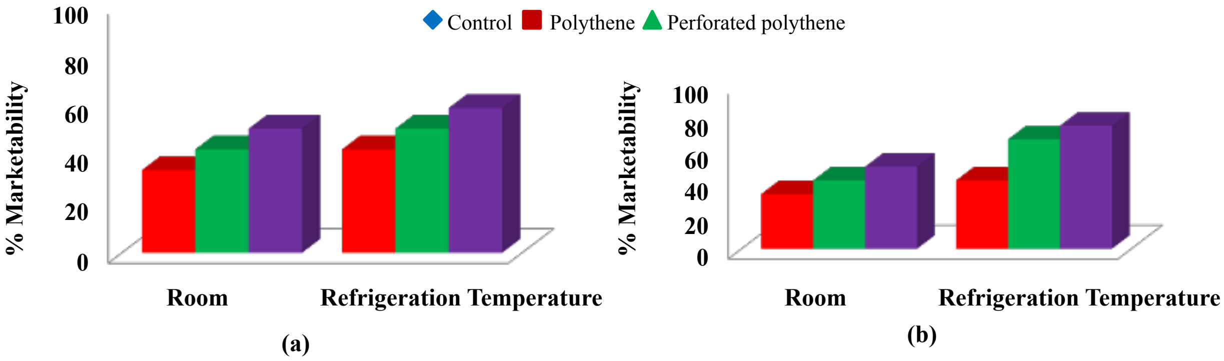

Fig. 6. percent (%) marketability of (a) Deshi guava and (b) Hybrid guava at room & refrigeration temperature under different packaging materials.

IV. Conclusion

Packaging materials are found to have significant effects on physiological weight loss, decay percentage, pH content, titrable acidity, vitamin C content, overall acceptability, and marketability of both deshi and hybrid varieties of guava fruits under two conditions of room temperature and refrigeration temperature. Hybrid varieties of guava have better quality retention capacity in terms of a higher shelf life than the local deshi varieties. Refrigerated temperature condition is always seen to have longer shelf life than the normal room temperature condition. This study could be concluded that a perforated polythene bag might be served as a better option for packaging guava produce.

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