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Effect of different post-harvest treatments and LDPE packaging on moisture content of Guava (Lucknow-49 L.)

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Abstract
Effect of different post-harvest chemical treatments combined with LDPE packaging on the moisture content of guava (cv. Lucknow-49) fruits harvested at mature green and colour turning stages was studied. Fruits were stored at low temperature (10±2 °C and 90±5 percent relative humidity) and evaluated for moisture content after 3, 6, 9 and 12 days of storage. It was observed that all the chemical treatments and packaging with LDPE were found to exhibit better effect than the control. After 12 days of storage, the moisture content was remarkably higher for Gibberellic Acid (GA_3), Benzyl Adenine (BA) and Spermine (SPM) in comparison to $Ca(NO_3)_2$ and $CaCl_2$. Among these, Spermine presented the best efficiency with minimum reduction in moisture content during the course of storage. However, MG stage fruits exhibited longer shelf life and better fruit quality compared to CT stage during storage.

Keywords: LDPE, moisture, Guava, Lucknow-49 L.

Introduction
Guava (*Psidium guajava* L.) fruit is an important crop of India, as it can withstand adverse climatic conditions and grows under a wide range of soil types (Dhaliwal and Singla, 2002) [5]. Generally, it is consumed as a fresh dessert fruit, or processed into juice, puree, jam, jelly, concentrate, nectar or syrup (Jagtiani *et al*., 1988) [6]. It is well known for its refreshing taste, pleasant flavour, and nutritional value, and it is considered as one of the exquisite, valuable and remunerative fruit crop. It excels most other fruit crops in productivity and adaptability. Besides its high nutritive value, it bears heavy crop every year and give good economic returns involving very little input. It is one of the most well-known edible tree fruits grown widely in more than sixty countries throughout the tropical and sub-tropical regions in the world. Guava fruit is known for 'vitamin-C', minerals like calcium, iron and phosphorous, with pleasant aroma and flavour (Dhaliwal and Dhillon, 2003) [4]. Due to these properties, there is a great demand of guava fruits in both domestic and international markets for fresh and processing purposes. India is one of the largest producers of guava in the world and it is the fifth most widely grown fruit crop in India (Momin *et al*., 2018) [7].

Guava is a climacteric fruit; it ripens rapidly after harvest and become over-ripe and softens within a week after harvest at room temperature. Ripening is the most important process for acceptability of fruits for edible purposes, involving changes in texture, color, and flavour. Various biochemical, physiological, and structural changes take place during the ripening of fruits mainly including the starch degradation, sugars production, pigments and volatile compounds synthesis along with partial solubilization of cell wall. A thorough understanding on these changes during ripening is of great importance while studying the post-harvest losses for any technology in enhancing shelf life of fruits. In climacteric fruits like guava, these changes take place over a relatively short period of time as it exhibits considerable increase in respiration and ethylene production during the ripening (Singh, 2005) [11]. Therefore, it cannot be sent to distant marketplaces under normal conditions, as the ripe fruits become very soft and get damaged easily during handling, transit and storage. Due to such perishability, control of fruit ripening is fundamental for increasing the utilization of fruit after harvest. The share of guava in fresh fruit export from India can be easily boosted, if fruit is properly handled after harvest.

Various technologies for improving the shelf life and marketability of horticultural commodities have evolved during the past decades, like use of various chemicals, fungicides, growth regulators, retardants, wax coatings, different types of packing materials, modified and controlled atmosphere storage etc. Treatments with various chemicals have been observed as economically viable and potential tool for reducing the post-harvest losses (Wijewardane, 2018). However, temperature and relative humidity during storage are also fundamental to obtain a high-quality fruit with good storage potential (Vazquez-Ochoa and Colinas-Leon., 1990) [12]. Reduction in storage temperature has been proved as an efficient method in reducing respiration rate, delaying ethylene production during storage and transport. Storage of fruits at low temperature for a definite period is a common practice to delay or retard the ripening and reducing the spoilage. The use of polyethylene film for storage is also preferred nowdays, as it creates a modified atmosphere within the packaging, and reduces the losses related to transpiration and respiration (Nagaraju and Banik, 2019) [8]. The packaging of guava a fruits in polyethylene film greatly minimizes the post-harvest losses and chilling injury and ensures the better quality of fruits during cold storage.

Hence, present study was executed to evaluate the cumulative effect of different chemical coatings and polyethylene film packaging on guava fruits for the extension of shelf life during storage at low temperature. The study was conducted at Department of Botany, CCS University, Meerut (U.P.) during the winter season.

Material and Methods

Guava fruits

Guava fruits cv. Lucknow-49 were selected for the experimentation. They were obtained from a farmer's field at Meerut district which is at nearly 10 km from the place of experimentation. Uniform medium sized guava fruits were manually harvested at two stages of maturity, i.e., Mature Green (MG) and Colour Turning (CT). Sorting for various defects, blemishes, and diseases was carried out in the field itself. Fruits were washed immediately after reaching the laboratory with tap water to remove the adhering dust, dirt from the surface before subjecting to chemical treatment.

Chemicals and Packing

All the chemicals used during experimentation and analysis were of analytical grade, purchased from the standard Indian chemical companies, i.e., Sigma, Hi-media and SRL. Low Density Polyethylene (LDPE) bags of two different thicknesses (100 and 200 gauge with 1% ventilation) were locally purchased. The aqueous solution of $CaCl_2$ (2%), $Ca(NO_3)_2$ (2%), Gibberellic acid (GA_3, 200 ppm), Benzyl Adenine (BA, 50 ppm), and Spermine (SPM,100 ppm) were used for dipping the fruit for 5-10 minutes. The control fruits were kept for comparison after dipping it in tap water. The surface of fruit was air dried and thereafter packed in polyethylene film. All the fruits were stored at low temperature (10±2 °C) and 90±5 percent relative humidity. The experiment was laid out in completely randomized design with three replications.

Methods

The studies were conducted continuously for two years and pooled data was reported. The physico-chemical parameters were recorded at an interval of 3 days. The statistical analysis of data was done by method of "analysis of variance". The moisture content was measured by the methods of AOAC (1965) [1].

Results and Discussion

Mature Green (MG) guava fruits

The data pertaining to moisture content of Mature Green (MG) guava fruits *cv.* Lucknow-49 taken at 3, 6, 9 & 12th days of low temperature as influence by post-harvest application of various chemical treatment and polyethylene film LDPE (100 & 200 gauge thickness with 1% ventilation) packaging is presented in Figure 1.

In comparison to control, significant differences in Moisture Content were recorded with application of different chemicals and packaging with polyethylene film (LDPE 100 gauge thickness with 1% ventilation). While, among all the chemical treated fruits, no significant difference was observed for moisture content. All the chemical treatments and packaging with polyethylene film were found to exhibit better effect than the control. Among these, Spermine (SPM) 100 ppm presented the best efficiency with minimum reduction in moisture content during the course of storage. During the storage (up to 12th days), there was not much difference in the moisture content for Gibberellic Acid (GA_3) 200 ppm, Benzyl Adenine (BA) 50 ppm & Spermine (SPM) 100 ppm. After 12 days of storage the moisture content was remarkably increased for Gibberellic Acid (GA_3) 200 ppm, Benzyl Adenine (BA) 50 ppm & Spermine (SPM) 100 ppm with the maximum value of 80.37%, 80.62% and 80.95%, respectively on 12th day of storage.

The data regarding moisture content of Mature Green (MG) fruits with various chemical treatments and packaging with polyethylene film (LDPE 200 gauges thickness with 1% ventilation) presented a significant difference for all the treatment in comparison to control. The moisture content observed for Calcium Chloride 2% and Calcium Nitrate 2% on 12th days of storage was 80.19% and 80.09%, respectively. In case of Gibberellic Acid (GA_3) 200 ppm, Benzyl Adenine (BA) 50 ppm & Spermine (SPM) 100 ppm, the moisture content was found to be 80.35%, 80.49% and 80.76%, respectively. Spermine (SPM) 100 ppm was found to exhibit the maximum amount of moisture content after storage.

Colour Turning (CT) guava fruits

Figure 2 indicates the moisture content of colour turning (CT) guava fruits after application of various chemicals and polyethylene film (LDPE-100 & 200 gauge with 1% ventilation) during storage at low temperature. For Colour Turning (CT) fruit, the interaction between all the treatments and control were found to be significant, but the increase in moisture content was to a higher extent when compared to Mature Green (MG) stage guava fruits.

During all the days of storage, Spermine (SPM) 100 ppm, Benzyl Adenine (BA) 50 ppm & Gibberellic Acid (GA_3) 200 ppm with polyethylene film LDPE 100 & 200 (Gauge with 1% ventilation) exhibited the comparable efficiency with moisture content of 81.69% 81.55% & 81.35% and 81.52%, 81.43% & 81.35%, respectively on 12th days of storage.

While a similar pattern for moisture content of Colour Turning (CT) guava with chemical treatments and polyethylene film packaging (LDPE 100 & 200 gauge thickness with 1% ventilation) was observed for Calcium

Chloride $CaCl_2$ 2% and Calcium Nitrate 2%. The result revealed that treatment of Colour Turning (CT) guava fruits with different chemicals followed by packing with polyethylene was found to be less effective in controlling the decrease of moisture content in comparison to Mature Green (MG) fruits.

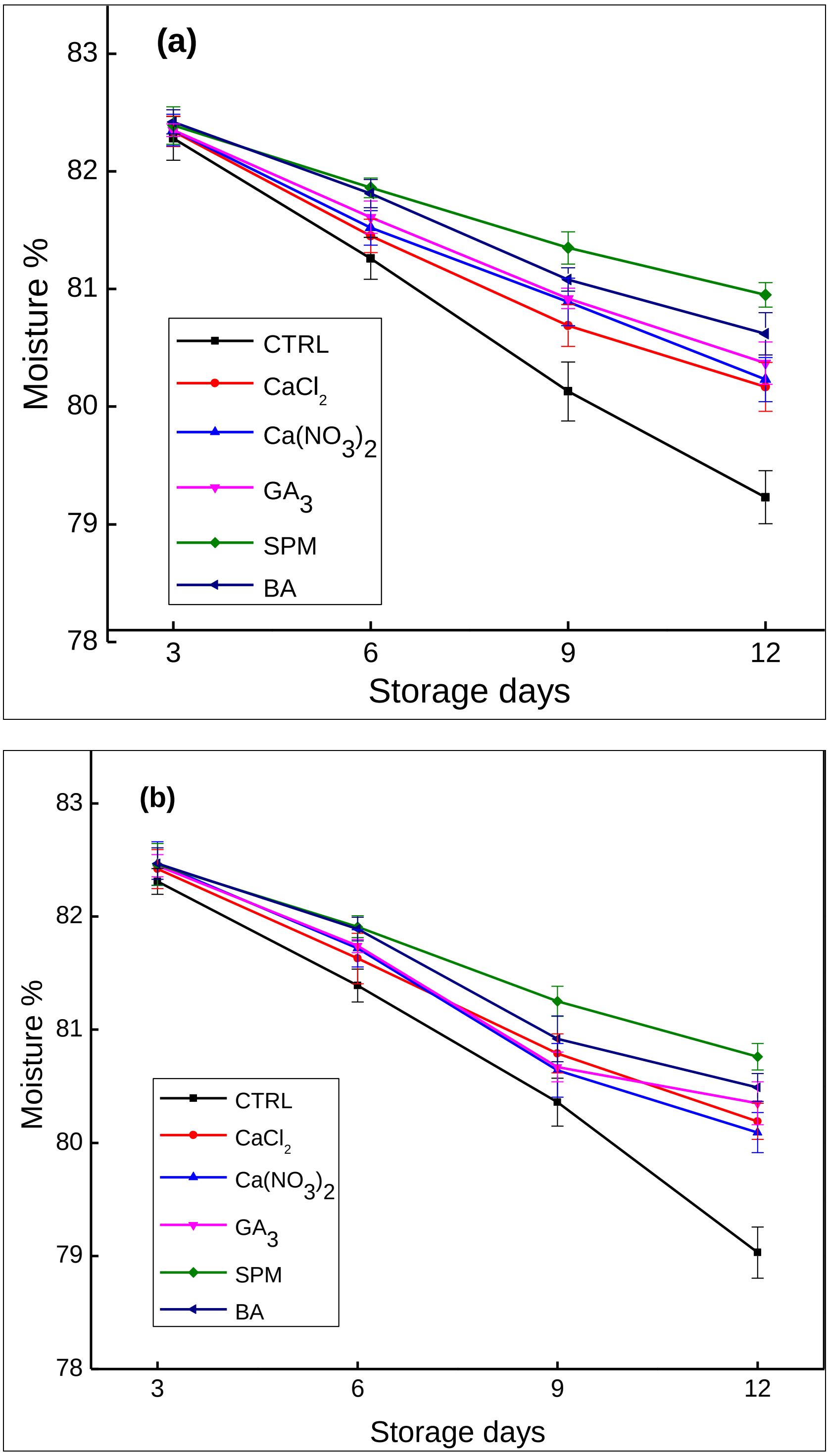

Fig 1: Effect of different chemical treatments and packaging (a) LDPE 100 and (b) LDPE 200 gauge thickness with 1% ventilation on Moisture content of mature green guava fruits cv. Lucknow-49 at low temperature, two years pool data (2018-19 to 2019-20)

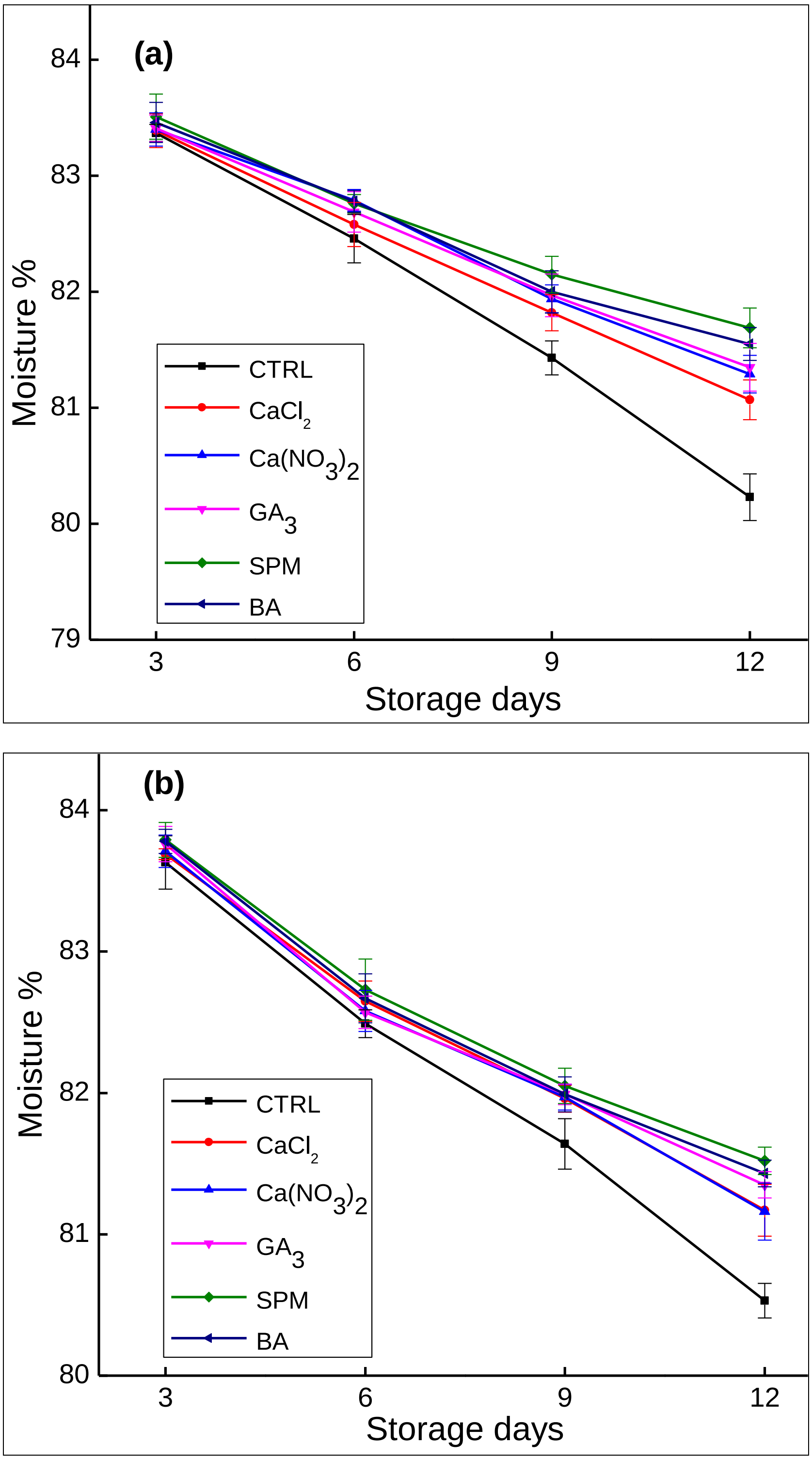

Fig 2: Effect of different chemical treatments and packaging (a) LDPE 100 and (b) LDPE 200 gauge thickness with 1% ventilation on Moisture content of color turning guava fruits cv. Lucknow-49 at low temperature, two years pool data (2018-19 to 2019-20)

The superior performance of SPM in retaining the moisture can be attributed to their hydrophobic nature, which improves the water vapor barrier by providing hydrophobicity to the surface (Asrey and Barman, 2015; Chauhan *et al*., 2014) [2, 3]. The combined application of SPM and polyethylene was effective in retarding ripening and senescence by helping in retaining the moisture contents of fruit. Petriccione *et al*., 2015 [10], reported that an excellent semi-permeable barrier against oxygen, carbon dioxide and moisture, was formed by application of chitosan which reduced the water loss and counteracting the dehydration and shrinkage of the sweet cherry fruit. This behaviour was also observed in some previous studies by Ozdemir and Topuz, 2004 [9]; Yousef and Hassaneine, 2010 [14].

Conclusion

Application of different chemicals and polyethylene significantly decreased the loss in moisture content, and the maximum decrease in moisture was recorded with application of calcium based chemicals on Colour turning (CT) stage guava. The differences in moisture of chemically treated fruits narrowed down and became impractical over a period of 12th days of prolonged storage. SPM -100 ppm was best among the chemicals studied in delaying the drop in moisture of guava fruits during storage at 10±2°C. Hence the combined application of SPM and polyethylene was effective in retarding ripening and senescence by helping in retaining the moisture contents of fruit, and maintain the quality for longer period with fairly acceptable quality.

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