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Effect of 1-Methylcyclopropene and Wrapping Material on Shelf-Life and Postharvest Qualities of Spine Gourd (*Momordica dioica*)

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ABSTRACT

Spine gourd (*Momordica dioica)* is a tropical under-utilized, climbing creeper vegetable (commonly known as kakrol, spiny gourd or teasle gourd) belonging to the family *cucurbitaceae*. It is native to Asia and now extensively distributed in Sri Lanka due to boosted commercial cultivation of hybrid varieties. Spine gourd has a growing demand both in the local and the export market for its distinct taste and promising health properties over thousands of years. However, vulnerability to postharvest damages due to large area/volume ratio and climacteric ripening behaviour result in short shelf-life for this commodity. Consequently, its market potential is significantly affected. The present study attempts to extend shelf-life while maintaining postharvest qualities in spine gourd by using 1-methylcyclopropene (1-MCP) and Low-Density Polyethylene (LDPE) wrapping at an ambient temperature (27 ± 1 °C). The experiment was conducted according to the Completely Randomized Design (CRD) using eight treatments: 0, 0.5, 1.0, 1.5 $\mu L\ L^{-1}$ 1-MCP treated for 15 hours and stored with and without LDPE wrapping under ambient temperature (27 ± 1 °C). Physical parameters; fresh weight loss, firmness, peel colour changes, and chemical parameters; total soluble solids, titratable acidity, were evaluated daily. Fresh weight loss and peel colour changes significantly declined in wrapped Spine gourd fruits. The highest firmness was observed in chemically treated and LDPE wrapped fruits than the control during 5 days of the storage. Thus, it can be concluded that some postharvest qualities of Spine gourd are positively affected by 1-MCP treatment and LDPE wrapping.

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INTRODUCTION

Postharvest management is the main quality dependent factor of any harvested commodity. Freshly harvested commodities are made to undergo postharvest treatments to minimize losses and increase their shelf-life. Worldwide postharvest losses are as high as 30 to 40 % in developing countries due to ineffective postharvest treatments (Jiang *et al*., 1999).

Spine gourd is referred to as "King of Gourds" due to its higher nutrient content (Saha *et al*., 1991). It contains a remarkable amount of carbohydrates, protein, fat, fiber, vitamins and minerals that increase their market demand, for both processed and fresh consumption.

Spine gourd shows some climacteric behavior which is more or similar to Bitter gourd (Payal, 2013). Ethylene (C_2H_4) is a ripening hormone of climacteric fruits. At a certain maturation stage, ethylene is linked to its binding-site in the cell and promotes ripening and senescence of fruits (Lelievre *et al*., 1997). Such Ethylene actions can be blocked by 1-Methylcyclopropene (1-MCP) (Sisler and Serek, 1997) that delay ripening and senescence.

Low density polyethylene wrapping is a common postharvest technique to increase the shelf life of different commodities. It creates a modified atmosphere around the fruits. Normally, edible Spine gourd fruits are rich with 84.1 % moisture (Singh *et al*., 2009). Also, the spine like projections result in a large surface area/volume ratio. The high specific surface area of the fruit leads to increased moisture loss through fruit surface, resulting in fresh weight loss, wilting and ultimately short shelf life with low quality. Wrapping greatly reduces moisture loss and also reduces the respiration rate, chilling injuries, deformation, blemishes and the fruit decay (Mohommad and Wickham, 1993). Therefore, the present study was carried out to evaluate the shelf-life and postharvest qualities of the Spine gourd treated with 1-MCP and low-density polyethylene wrapping.

OBJECTIVES OF THE STUDY

- To improve the shelf-life and postharvest qualities of Spine gourd by 1-MCP
- To improve the shelf-life and postharvest qualities of Spine gourd by LDPE wrapping

METHODOLOGY

The experiment was conducted at the Sabaragamuwa University of Sri Lanka. Uniform Spine gourd fruits, harvested freshly at horticulture maturity were treated with Agrofresh™, in powder form, having 4% active ingredient 1-MCP. The following 1-MCP concentrations; 0 $\mu L\ L^{-1}$, 0.5 $\mu L\ L^{-1}$, 0.1 $\mu L\ L^{-1}$ and 1.5 $\mu L\ L^{-1}$ (1-MCP gas volume/chamber volume) with and without LDPE wrapping were used as treatments. There are eight treatments with three replicates.

Table 1: Treatments of the Experiment

T_1	–	Control 1 (Without Chemical and Wrapping)
T_2	–	0.5 $\mu L\ L^{-1}$ 1-MCP
T_3	–	1.0 $\mu L\ L^{-1}$ 1-MCP
T_4	–	1.5 $\mu L\ L^{-1}$ 1-MCP
T_5	–	Control 2 (Only wrapping)
T_6	–	0.5 $\mu L\ L^{-1}$ 1-MCP + wrapping
T_7	–	1.0 $\mu L\ L^{-1}$ 1-MCP + wrapping
T_8	–	1.5 $\mu L\ L^{-1}$ 1-MCP + wrapping

First, 400 ml, 10 % $NaHCO_3$ solution was prepared. Next, randomly selected fruits and a beaker containing 10 % $NaHCO_3$ were kept inside the sealable same size chambers. Relevant amount of weighted 1-MCP was put in to $NaHCO_3$ and the chambers were sealed to avoid gas loss. Fruits were exposed to the gas released by the product for 15-hours at room temperature (27±1 °C). After 15-hours, one set of Spine gourd fruits were wrapped individually with Low Density Polyethylene (LDPE). The experiment was arranged according to Completely Randomized Design (CRD) at room temperature (27±1 °C). The observations were made daily.

Fresh Weight Loss of Fruits (FWLF) was calculated by using the following formula,

$$\text{FWLF} = \frac{\text{Initial weight of fruit (W1)}}{\text{Weight of fruits daily (W2)}}$$

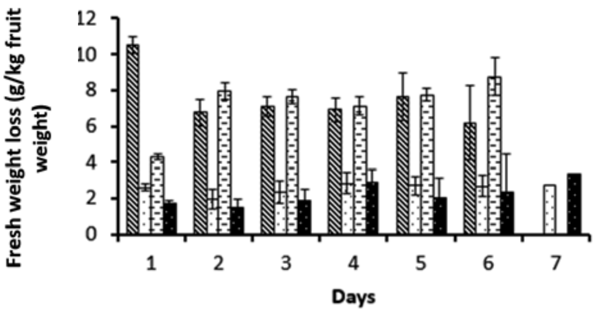

Figure 1: Fresh Weight Loss Changes During the Storage in 1-MCP Treated Unwrapped Fruits

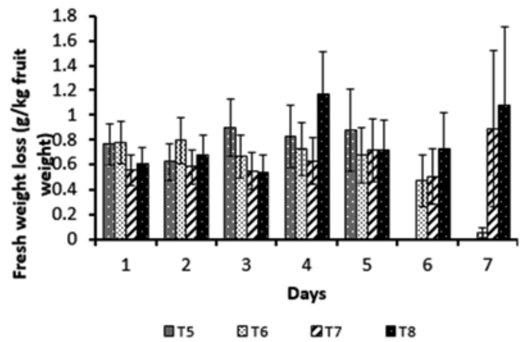

Figure 2: Fresh Weight Loss Changes During the Storage in Only Wrapping Treated Fruits

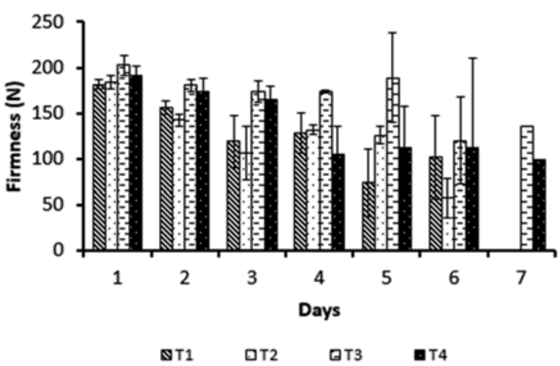

Figure 3: Firmness Value Changes During the Storage in 1- MCP Treated Unwrapped Fruits

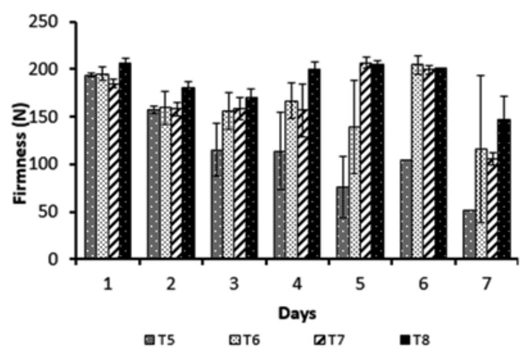

Figure 4: Firmness Value Changes During the Storage in Only Wrapped Fruits

Firmness was determined by using fruit firmness tester (FHP-803). The color of the fruit peel was determined as L*, a*, b* values using a Colorimeter (CR-400). The Total Soluble Solids content of fruits was estimated using the Digital refractometer (ORD 85BM).

The Titratable Acidity (TA) was determined by the method described by Kumari *et al*. (2017)., Two grams of fruit sample was weighed and crushed. The homogenate was diluted up to 100 ml with distilled water, then it was filtered, and two drops of 1 % phenolphthalein indicator was added to 10 ml of the filtered solution. Finally, it was titrated with 0.1 N NaOH solution till a pink color appeared. The TA was calculated using the following formula.

Data were subjected to statistical analysis using Analysis of variance (ANOVA) (Proc GLM) and Duncan's Multiple Range Test to compare mean values at the 5 % significance level.

RESULTS AND DISCUSSION

Fresh Weight Loss (g/kg Fruit Weight)

Fruit weight reduction was expressed in terms of grams per kg fruit weight during storage. There was no significant interaction ($p \geq 0.05$) chemical wrapping on loss during the storage. The main effects of chemical and wrapping were significantly different ($p < 0.05$). Chemical treated wrapped fruits showed the lowest fresh weight loss than the control.

The lowest fresh weight loss was revealed by wrapped fruits than the non-wrapped fruits throughout the storage period. Mean fresh weight loss values of 1-MCP treated fruits were lower than the control due to blocking the actions of the ethylene that greatly retarded the respiration rates (Benassi *et al*., 2003). LDPE act as a gas barrier that greatly reduces gas exchange in the fruits and also modify the atmosphere around the fruit reducing the transpiration losses. Singh et al. (1979) reported that fruits packed in 400-guage polyethylene at room temperature had 9 days more shelf-life than the control fruit.

Flesh Firmness

Interaction (chemical*wrapping) was not significantly observed on firmness during the storage. Significant firmness ($p < 0.05$) was observed among the treatments that progressively declined during the storage. Significant difference ($p=0.0356$) was observed after the 2nd day of storage revealing that chemical treated fruits and wrapped fruits extend the highest firmness than the control fruits. Only chemical treated fruits had the best firmness quality during 3-5 days of the storage than the control fruits. After 5 days of the storage, significant firmness changes could not be observed in only chemically treated fruits. After 6 days of storage, a significant difference ($p=0.0045$) was observed among treatments; wrapped fruits revealed the highest firmness value than the non-wrapped fruits. Major fruit softening enzymes are polygalacturonase (PG) and cellulase (endo-1.4, β-glucanase) which breakdown cell wall polysaccharides, resulting in soft fruit. This process can be delayed by the action of 1-MCP that blocks the ethylene receptors. That treatment showed the highest firmness quality during 3-5 days of the storage.

Mohommed and Wickham (1993), found that the firmness drop in wrapped fruits was lower than that of the non-wrapped fruits. At the beginning of the storage, there was no difference in firmness among the treatments, but with time, the wrapped fruits' firmness values were greater than the non-wrapped fruits due to the wrapping protecting the moisture level in the fruits that maintain the rigidity of the cells by turgidity.

Peel Color Changes

L*-value indicating the brightness (0 – Black, 100 – White), was progressively changed during the storage. After 5 days of the storage, there was a significant different ($p=0.0113$). Lower brightness development was revealed by chemically treated fruits than the control. The highest brightness development was observed in non-wrapped fruits than the wrapped fruits after 6 days of the storage. The negative a*-value indicates greenness and positive a*-value indicates red color. There was no significant effect of chemical and wrapping on a*-value changes in Spine gourd. The positive b*-values indicate yellowness; that gradually increased with time due to degradation of the chlorophyll and production of the carotenoids. After 3 days of the storage, a significant development that was yellow in color (p=0.0045) was observed in non-wrapped fruits than in the wrapped fruits. The 1-MCP concentration had no significant effect to delay the pigment development in the Spine gourd. Similarly, there was no influence of 1-MCP on postharvest color changes in apricots (Dong *et al.,* 2002). Wrapped fruits greatly reduce the chlorophyll loss due to blocking the gas exchange, which results in a lower respiration rate and ethylene activity in the fruits.

Total Soluble Solids (TSS)
There was no significant interaction (chemical*wrapping) effect on TSS content during the storage. Wrapping and 1-MCP did not significantly affect TSS content during the 4 days of the storage. After 4 days of the storage, the wrapping significantly affected (p=0.0089) TSS content in Spine gourd. Wrapped fruits showed the lowest TSS development than the non-wrapped fruits.

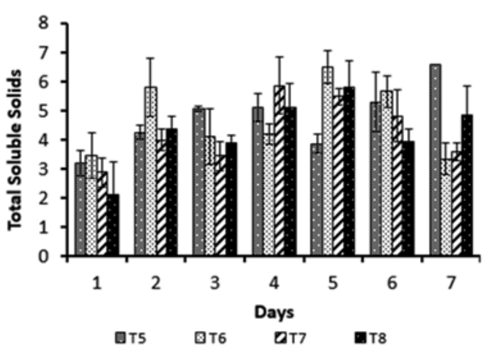

Figure 5: TSS changes during the storage in untreated wrapped fruits

Figure 5: TSS Changes During the Storage in Untreated Wrapped Fruits

Pongener *et al*. (2011), found that the TSS content slowly increased in polyethylene wrapped Peach fruits than in the control under cold storage conditions. The delayed increase in TSS content in Spine gourd fruits might be due to retarded ripening and senescence processes which reduced the conversion of starch into sugars.

Titratable Acidity (TA)
There was no significant effect of 1-MCP and wrapping on titratable acidity of Spine gourd.

CONCLUSION

The fresh weight loss and peel color changes significantly declined in wrapped Spine gourd fruits and the highest firmness was observed in chemically treated and LDPE wrapped fruits than the control during the storage. Thus, it can be concluded that some postharvest qualities of Spine gourd are positively affected by 1-MCP treatment and LDPE wrapping.

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