INFLUENCE OF 1-METHYLCYCLOPROPENE ON PHYSICO-CHEMICAL PROPERTIES OF '*GOLA*' AND '*SURAHI*' GUAVA (*Psidium guajava* L.) UNDER AIR STORAGE

Zafar Iqbal[1],[*], Muhammad Atif Randhawa[1], Tahir Zahoor[1], Muhammad Asghar[2] and Randolph Beaudry[3]

[1]National Institute of Food Science and Technology, University of Agriculture, Faisalabad- 38040, Pakistan; [2]Department of Biochemistry, University of Agriculture, Faisalabad 38040, Pakistan; [3]Department of Horticulture, Michigan State University, East Lansing 48824, USA.
[*]Corresponding author's e-mail: zafri52@hotmail.com

1-Methylcyclopropene (1-MCP) was used as an ethylene antagonistic in the present research to suppress the ethylene induced ripening and preserve the post-harvest quality of guava. Physiologically mature guava (cvs. '*Gola*' and '*Surahi*') were exposed to 1-MCP with different levels (0, 200, 500 and 800 nL·L^{-1}). Samples were held at 10°C and 80% RH and ripening indices were measured every 6 days for 1 month. The patterns for soluble solids and ethylene were typical of climacteric fruit for both cultivars. Results illustrated that ripening advanced rapidly for the fruits without 1-MCP. 1-MCP significantly reduced the weight loss, which was higher in '*Gola*' compared to '*Surahi*'. Control fruits started to decay at day 12, whereas, treated decayed on day 18. Low to intermediate levels of 1-MCP was effective in preserving desirable firmness. Control fruits showed change in Hue angle from yellowish green to ripe yellow at 6th day compared to 1-MCP treated which delayed the color change to 12-18 days. The data suggest that dose levels of 1-MCP below 800 nL·L^{-1} were not sufficient to saturate the response to 1-MCP.
Keywords: 1-methycyclopropene, Myrtaceae, guava, ethylene, climacteric fruits, postharvest storage

INTRODUCTION

Guava (*Psidium guajava* L.; Myrtaceae) locally known as '*Amrood*' is a nutritionally important tropical fruit in Pakistan. It ranks 4th after citrus, mango and date with respect to area (63739 hectares) and production (488017 tonnes) per annum (GOP, 2016). Guava is hundred percent edible and is considered as 'apple of the poor' due to its low cost, easy availability and high nutritive value. Guava is highly acceptable for 'in nature' consumption as it has been termed as 'super fruits' (Kareem *et al*., 2013; Kanwal *et al*., 2016). Guava undergoes physiological changes during and after harvest which accelerates ripening process and prevents fruit from being stored successfully (Bassetto *et al*., 2005). Guava cannot endure extended distance transportation and reach the market in a soft, over-ripe state, which has less value in the marketplace and compromises prosperity of producers (Steinhaus *et al*., 2008). After-harvest losses are about 25-40% of the guava production (Kanwal *et al*., 2016). Ripening of climacteric fruits like guava is either triggered by natural production of endogenous ethylene or by exogenous ethylene application (Sisler and Serek, 2003). There is strong relationship between ethylene production and expected post-harvest shelf life of horticulture produce (Kader and Saltveit, 2003). Guava is a rapidly ripening climacteric fruit, exhibiting ethylene and respiration peaks within 4-5 days after harvest

when harvested at mature green stage (Bashir and Abu-Goukh, 2003). High levels of ethylene have negative effects such as excessive softening, fruit decay, discoloration, wilting, mold, scald and scald (Lelievre *et al*., 1997).

To increase the post-harvest storage life of guava, one option is to inhibit or slow down the action of ethylene. 1-MCP is alleged to bind the receptors of ethylene in target plant material, preserving fruit from the effect of ethylene (Sisler and Serek, 2003). 1-MCP is believed to work as a competitive gas to ethylene, occupying the ethylene receptor site so that ethylene cannot bind to trigger its action (Blankenship and Dole, 2003). 1-MCP has 10 times greater affinity to bind with receptor sites than ethylene (Sisler and Serek, 2003) and binds ethylene receptor sites strongly as compared to ethylene (Tatsuki *et al*., 2007). Even a single dose of 1-MCP can make product insensitive to ethylene effects several for days (Sisler and Serek, 2003). The effectiveness of 1-MCP depends on different factors like storage atmosphere and treatment duration (DeEll *et al*., 2002), treatment temperature (Mir and Beaudry, 2001; Mir *et al*., 2001), 'non-target' material (Vallejo and Beaudry, 2006), stage of maturity (Watkins *et al.*, 2000), cultivar (DeELL *et al*., 2002; Blankenship and Dole, 2003) and the time between harvest and 1-MCP application (Blankenship and Dole, 2003; Tatsuki *et al*., 2007).

Numerous studies have been made to check the response of 1-MCP on guava fruit ripening in different guava producing countries such as in India (Singh and Pal, 2008), China (Hong *et al.*, 2013), Brazil (Bassetto *et al.*, 2005), Mexico (Ortiz-Hernandez *et al.*, 2010) and Malaysia (Phebe and Ong, 2010) under different experimental conditions. To the best of our knowledge, no such study has been conducted in Pakistan to check the storage responses of 1-MCP on local cultivars of guava. *Gola* (thin skin, medium size and thick white flesh with few seeds) and *Surahi* (rough skin, medium large, pear-shaped furrowed with soft granulated white flesh) are among commercial cultivar of guava in Pakistan. The present research was an effort to find out the best combination of 1-MCP dose level for each cultivar to improve storability and avoid storage problems.

MATERIALS AND METHODS

***Procurement of guava*:** Fine quality guava of commercial cultivars, 'Gola' and 'Surahi', were procured from *Shahzad Cheema* Agri. Farm, Faisalabad-Pakistan (latitude 31°, 25 ′N, longitude 73°, 4 ′E), apparently free from disease, insect-pest infestation and bruises were harvested in the morning to avoid shock by heat and sun. Winter season fruits were used in present study due to high insect pest attack in summer. Extreme small and large size fruit were removed by selecting fruits having weight 150±50 g. Physiologically ripened fruits were manually harvested at yellowish green stage (Hue angle: 112±2 for 'Gola' and 115±2 for 'Surahi') as outlined by Mercado-Silva *et al.* (1998). After harvest, fruits were placed in wooden boxes and were immediately brought to food processing hall of National Institute of Food Science and Technology; University of Agriculture Faisalabad, Pakistan. From those fruit harvested, only those of healthy appearance, uniform skin color, and uniform maturity were used in the storage experiment after proper washing under tap water and air drying.

***Treatment plan*:** Stock solution of 1-MCP (Lanzhou Jiacheng biotechnology, China) was prepared by taking known quantity (in mg) of 1-MCP powder in micro centrifuge plastic tube having cap. After weighing, 1-2 drops of water at room temperature were added in micro centrifuge tube and shake vigorously for 3-5 times after closing the cap. Cap of centrifuge tube was opened in 600 mL glass bottles having rubber septum. After 1 h of 1-MCP release, working concentrations were taken with the help of syringe at STP. Application of 1-MCP was carried out in air tight plastic bucket (70-L) by focusing the free air space in the bucket. Fruits were exposed to 0, 200, 500 and 800 nL·L^{-1} 1-MCP for 12 h at 15°C. After exposure to 1-MCP, fruits were removed from the bucket, placed in a pre-clean plastic box, and loosely wrapped with 0.02 mm thick polyethylene sheet (LDPE; Jilani Poly Industries-Pakistan). 1-MCP treated and control fruits were placed in climate chambers (Memmert ICH s260

C; Germany) at 10°C and 80% relative humidity for 30 d and destructive analyses (titratable acidity, °Brix , firmness, color and ethylene production) were performed every 6 d. As physiological mature fruits were treated with 1-MCP, which can ripen without ethylene application so fruit were not treated with any exogenous ethylene after 1-MCP application. Fruits from each cultivar were divided to provide three replicates for each treatment and control. Eighteen fruits for each replicate were monitored for non-destructive analyses (weight loss and decay) throughout the storage.

Analysis

***Titratable acidity* (%):** Titratable acidity (TA) as percent citric acid of homogenized guava pulp was determined by neutralizing the acid present in known quantity of guava pulp against standard NaOH till pH 8.1 as end point (AOAC, 2003).

Total soluble solids (°**Brix**): The total soluble solids (TSS) of homogenized pulp was directly recorded by using hand refractometer (Model: BS Eclipse 45-03; UK) at room temperature and readings were directly recorded as percent soluble solids (°Brix) (AOAC, 2003).

***Physiological loss in weight* (%):** The weight loss (%) throughout storage was calculated from the difference between weight on day 1 and days 6, 12, 18, 24 and 30. Data are expressed in percentage on fresh weight basis (AOAC, 2003).

***Decay index* (%):** Decay index was calculated from fruits that showed signs of decay over the initial number of fruit and results were expressed in percentage. The decay index was calculated by evaluating the degree of decayed surface by using the scale outlined by Zheng *et al.* (2007): 0 = no visible decay; 1 ≤ 1% decay spots; 2 = 1-20% decay; 3 = 20-50% decay and 4 ≥ 50% decay;

$$\text{Decay index (\%)} = \frac{\text{number of fruit in each class} \times \text{Decay scale}}{\text{highest disease scale} \times \text{Number of total fruit}} \times 100$$

Fruit with score 1and 0 had commercial value and were considered as marketable fruit.

Firmness (**N**): Whole fruit firmness measurement was conducted with texture analyzer (Model: TA-XT plus, Stable Micro System, UK) fitted with a 5 mm diameter stainless steel probe. Fruits from each treatment were compressed to 5 mm at a rate of 1.0 mm/s and firmness was expressed in Newton. Whole fruit measurements were carried out at the tip-end, mid-region and stem-end of a face of guava fruit as described by Singh and Pal (2008) with slight modifications.

Fruit skin color (°**H**): Fruit skin color was measured on equatorial region using a colorimeter (Model: CR-400 Minolta Chroma, Japan) as described by Rocha and Morais (2003). After calibration with white ceramic plate, hue angle values were evaluated from *a** and, *b** values and used to describe the color change during storage according to the following equation: °Hue =*ATAN(b*/a*)*180/PI*.

***Ethylene production* (µL·Kg^{-1}·hr^{-1})*:* A static headspace technique was used to measure the ethylene biosynthesis rates as described by Singh and Pal (2008). After transfer from storage chamber to ambient conditions, fruits were allowed to warm up for 2 h to reach ambient conditions of temperature before calculating ethylene production. Fruits were weighed then enclosed for 2 h in hermetically sealed chamber (1500 mL) fitted with silicone rubber septum. The rates of ethylene production were recorded in the head space of container using a gas analyzer (Model: SKY2000-M2 Multi Gas Detector, China).

***Statistical analysis*:** Data was analyzed using completely randomized design. All data were subjected to analysis of variance (ANOVA) as outlined by Steel *et al*., (1997). TableCurve 2D software was used to generate regression equations describing the relationship between the different levels of 1-MCP and storage period. Selection of regression equation was based on shape of the response surface curve and r^2 values (Draper and Smith, 1998) and. For titratable acidity, physiological loss in weight, fruit decay and firmness, TableCurve 2D Sigmoid Eq. 8011 {y=a+b/(1+exp(-(x-c)/d))} was used while for skin color, Eq. 4585

{y=a+bx+CX^2.5+dx^3+ex^0.5} was fitted. It was not possible to fit a single equation for each treatment for TSS and ethylene rates so data were fit with bar chart.

RESULTS

***Titratable acidity*:** Variety, 1-MCP treatment, and storage duration influenced titratable acidity (Table 1). Titratable acidity followed a decreasing trend in both cultivars, which was best maintained in 1-MCP treated fruits (Fig. 1). Treatments with higher levels of 1-MCP (800 nL·L^{-1}) depicted maximum value for titratable acidity followed by treatments with intermediate and low levels of 1-MCP (500 and 200 nL·L^{-1}). The rapid decrease in TA was observed in control and was more prominent in '*Gola*'. From trend lines of *Gola* (Figure 1A), acidity of 0.44% was recorded in control fruits at day 6 while it took 10 days for 200, 17 days for 500 and 20 days for 800 nL·L^{-1} 1-MCP treated fruits to reach the same acidity. Similarly, for *Surahi* (Figure 1B), acidity of 0.39% was recorded in control fruits at day 6, but it took 12 days for 200, 16 days for 500 and 21 days for 800 nL·L^{-1} 1-MCP treated fruits to reach the same acidity level.

Table 1. Mean squares for physico-chemical parameters of 1-MCP treated guava during storage.

Sources	DF	Titratable acidity	TSS	Weight loss	Decay	Firmness	Fruit color	Ethylene production
Cultivar (A)	1	0.08033**	95.800**	25.000**	9.30ns	1508.90**	134.70**	12.400**
Treatments (B)	3	0.03706**	5.360**	46.800**	2846.10**	8537.00**	1062.00**	7.580**
Storage duration (C)	5	0.09815**	8.310**	193.800**	2750.60**	5643.60**	628.50**	32.600**
A×B	3	0.00027ns	0.104ns	2.680ns	57.50**	23.60ns	3.11ns	0.756ns
A×C	5	0.00091ns	0.298ns	1.860ns	4.20ns	16.80ns	5.51ns	1.900**
B×C	15	0.0016**	3.730**	3.840**	497.20**	503.50**	51.70**	7.400**
A×B×C	15	0.00016ns	0.023ns	0.282ns	9.44ns	5.62ns	0.55ns	0.190ns
Error	96	0.00049	0.318	1.210	9.04	23.90	10.70	0.360
Total	143							

** = Highly Significant (P<0.01); * = Significant (P<0.05); ns = non-Significant (P>0.05); DF = Degree of freedom
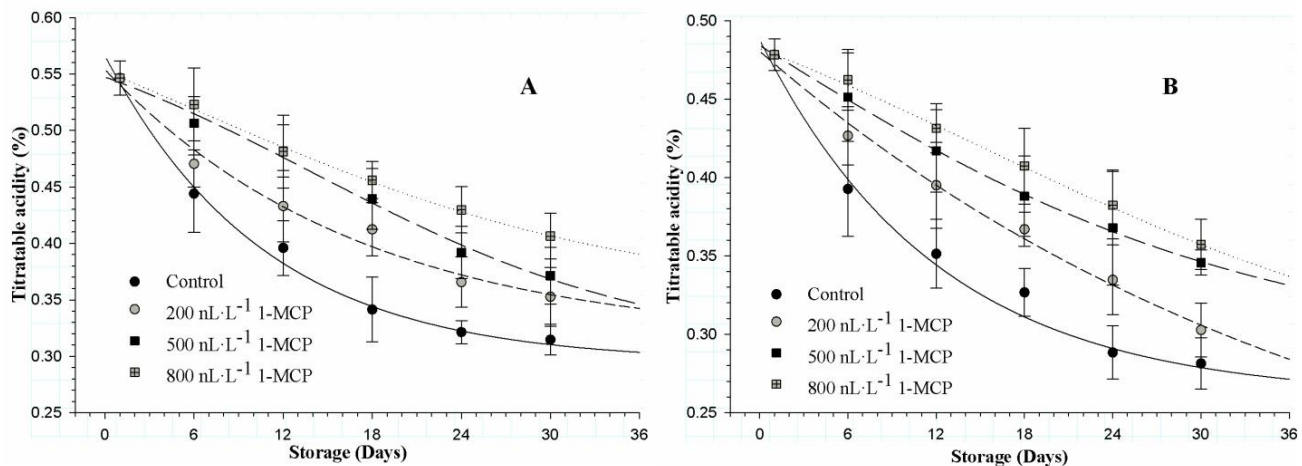

Figure 1. Effect of 1-MCP and storage on titratable acidity (%) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.

Total soluble solids: Variety, 1-MCP treatment, and storage duration influenced TSS (Table 1).

TSS content increased gradually upto 12 days in control fruit with mean value as 11.03 °Brix for 'Gola' and as 8.91 °Brix for 'Surahi'. Treatments with low and intermediate levels of 1-MCP (200 and 500 nL·L⁻¹) showed increase in TSS up to 18th day of storage and thereafter declined until end of storage (Fig. 2). Furthermore, control of *Gola* (Fig. 2A) and *Surahi* (Fig. 2B) recorded an early increase in TSS up to 12 days as 11.03 °Brix and 8.91 °Brix followed by a sharp decline as 7.42 °Brix and 6.10 °Brix at the end of storage, respectively. On the other hand, treatments with higher levels of 1-MCP (800 nL·L⁻¹) yielded a gradual increase in TSS from 8.84 °Brix to 10.33 °Brix and 7.19 °Brix to 8.85 °Brix from 0 to 30 days, respectively for *Gola* and *Surahi*.

Weight loss: Variety, 1-MCP treatment, and storage duration influenced weight loss (Table 1). During the entire period of storage, weight loss in control samples was higher compared to 1-MCP treated (Fig. 3). Until the 6th day, the difference in weight loss between all the treatments was negligible. On the 12th day, the control sample of *Gola* had the highest weight loss (5.77%) followed by control samples of *Surahi* as 3.57%. The maximum weight loss was observed in control of *Gola* followed by control of *Surahi* ranging from 2.87 to 12.22% and 2.43 to 9.71% from 6th to 30th days respectively. The minimum weight loss was observed in treatments with 800 nL·L⁻¹ 1-MCP as 1.08 to 5.43% for *Surahi* and 1.28 to 5.96% for *Gola*, respectively, from 6th to 30th days. From trend lines of *Gola* (Fig. 3A), it was recorded that at 12th day the weight loss in *Gola* was 5.25% whereas it took 16 days for 200 nL·L⁻¹, 21 days for 500 nL·L⁻¹ and 27 days for 800 nL·L⁻¹ 1-MCP treated fruits to reach almost similar values. Storage period of 12, 15, 17 and 20 days was required by control, 200, 500 and 800 nL·L⁻¹1-MCP treated fruits (cv. *Surahi*) to reach the same weight loss (3.49%) as indicated from their trend lines (Fig. 3B).
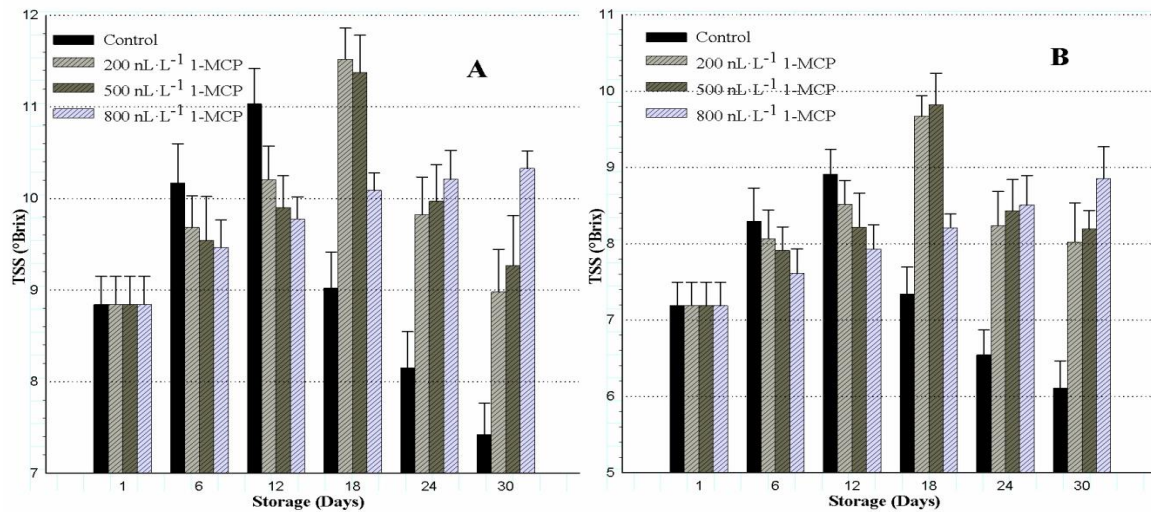

Figure 2. Effect of 1-MCP and storage on TSS (°Brix) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.
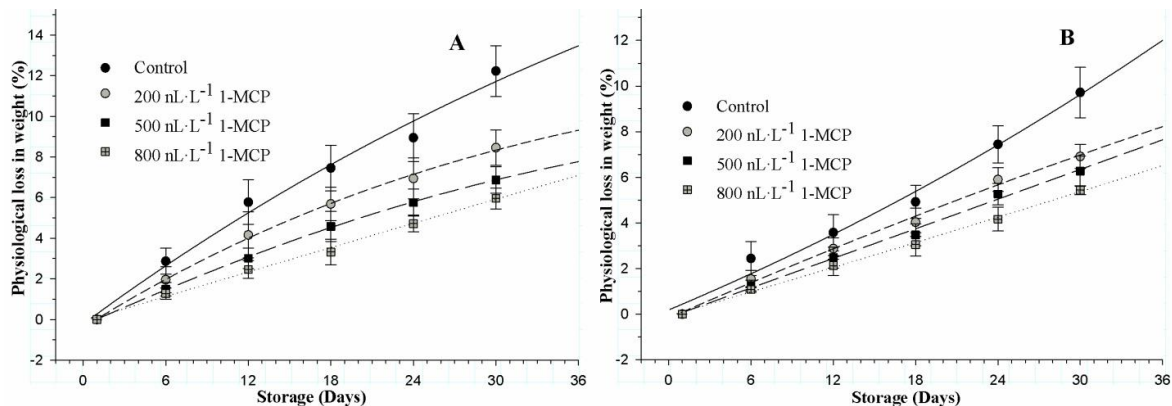

Figure 3. Effect of 1-MCP and storage on physiological loss in weight (%) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.

***Fruit decay*:** Variety, 1-MCP treatment, and storage duration influenced decay (Table 1). Fruit decay increased significantly during storage (Fig. 4). Compared to 1-MCP treated fruits, control fruits showed early fruit decay at 12 day of storage as 16.8% for *Gola* and 10.7% for *Surahi*. Whereas, 1-MCP treated fruits started to decay at 18th days of storage. From trend lines of *Gola* (Fig. 4A), it was recorded that at 12th day of storage control fruits showed 12.6% decay. While it took 25 days for treatments with 800 nL·L^{-1} of 1-MCP, 27 days for 200 nL·L^{-1} 1MCP and 30 days for 500 nL·L^{-1} of 1-MCP to reach almost same decay. It was calculated that at 12th day of storage fruit decay in control fruits was 9.3% while for 200 nL·L^{-1} 1-MCP it was 1.3%, for 500 nL·L^{-1} 1-MCP it was 0.5% and for 800 nL·L^{-1} 1-MCP it was 0.6% as calculated from trend lines of *Surahi* (Fig. 4B).

***Firmness*:** Variety, 1-MCP treatment, and storage duration influenced firmness (Table 1). An initial mean penetration force of 89.7 N and 98.3 N was recorded for *Gola* and *Surahi*, respectively, which decreased 27.6% in *Surahi* and 25.8% in *Gola* at 6th day of storage (Fig. 5). Whereas, fruit treated with lower levels of 1-MCP (200 nL·L^{-1}), firmness decreased 11.3 % in *Gola* and 8.9% in *Surahi* at 6th day of storage. Similarly, lowest decrease in firmness was observed in fruit treated with 800 nL·L^{-1} 1-MCP as 3.1% for *Surahi* and 4.0% for *Gola* at 6th days of storage. At the end of storage period, a decrease of 78.4% and 75.2% was recorded in control of *Surahi* and *Gola* while these values were 20.9% and 19.4% for fruit treated with 800 nL·L^{-1} of 1-MCP, respectively. Fruits of *Gola* with lower (200 nL·L^{-1}) and intermediate levels (500 nL·L^{-1}) of 1-MCP recorded a decrease of 41.2% and 33.5% firmness (Fig. 5A), respectively. Whilst, these values were 41.5% and 32.0% for *Surahi*, at the end of storage period (Fig. 5B).

***Fruit skin color*:** Variety, 1-MCP treatment, and storage duration influenced color (Table 1). The maximum change in hue angle was observed in control of *Gola* and *Surahi* which varied as 112.5 °H to 97.7 °H and 116.4 °H to 99.4 °H from
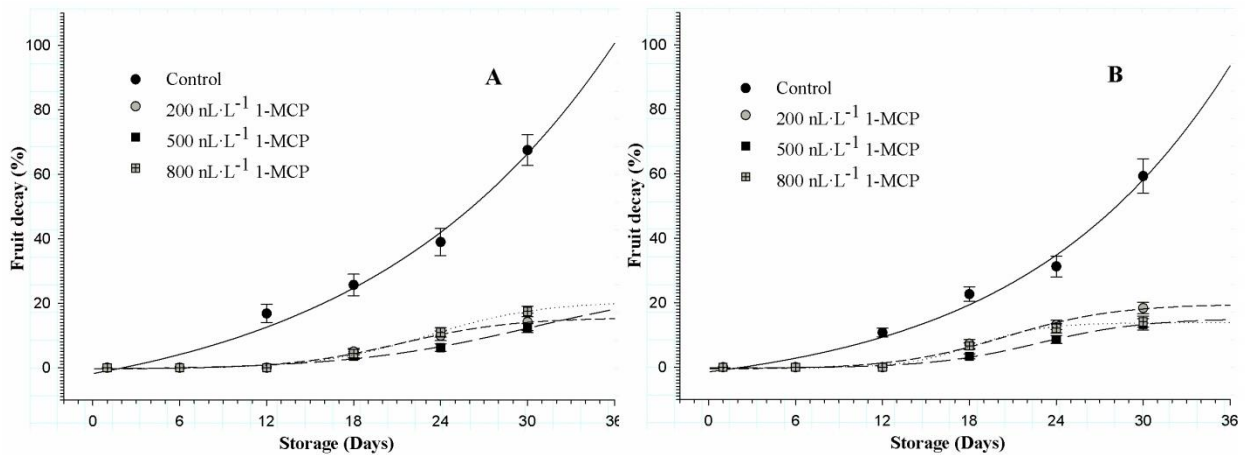

Figure 4. Effect of 1-MCP and storage on decay (%) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.
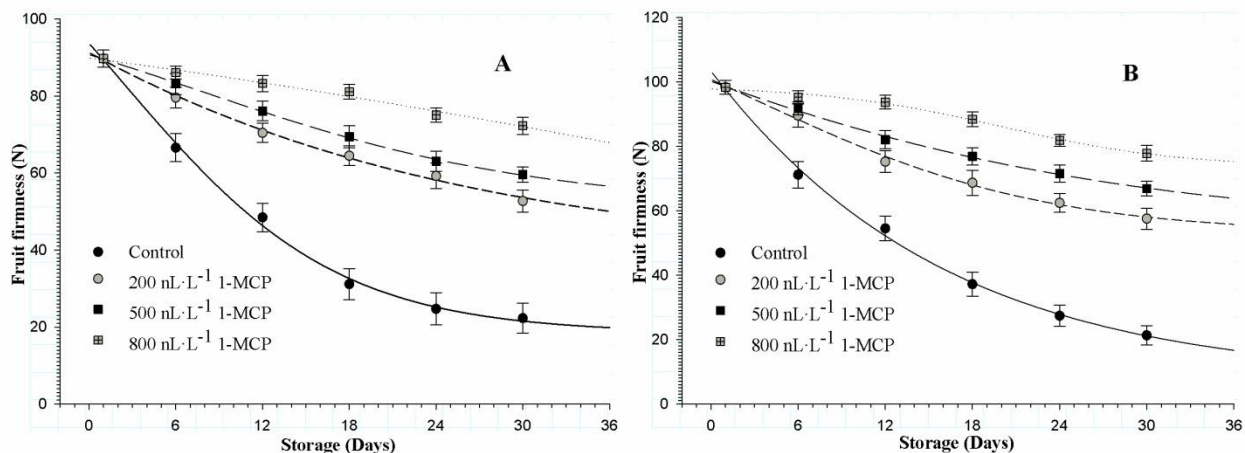

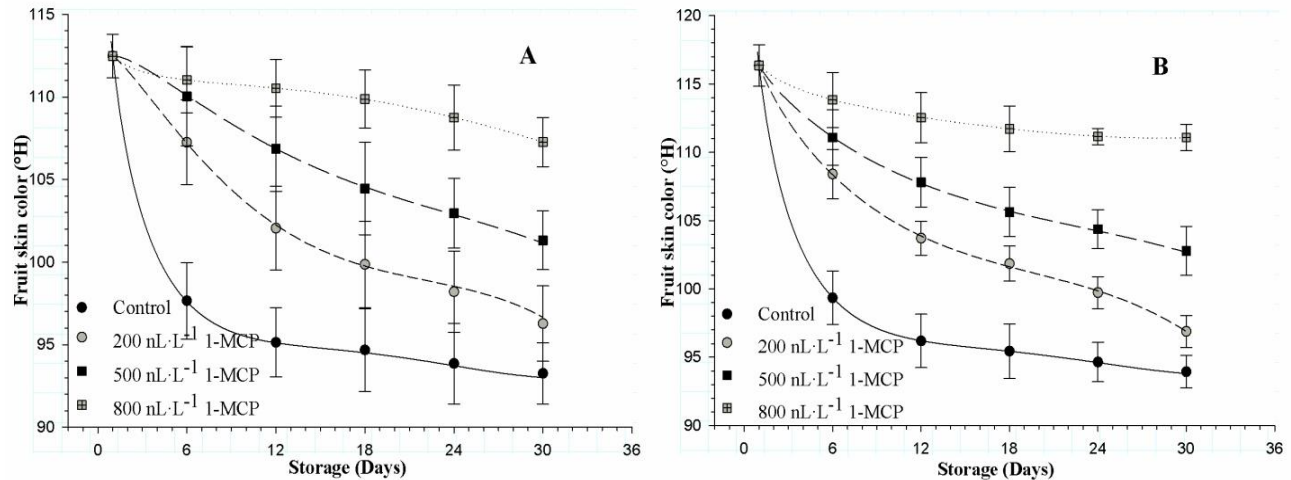**Figure 5. Effect of 1-MCP and storage on firmness (N) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.**

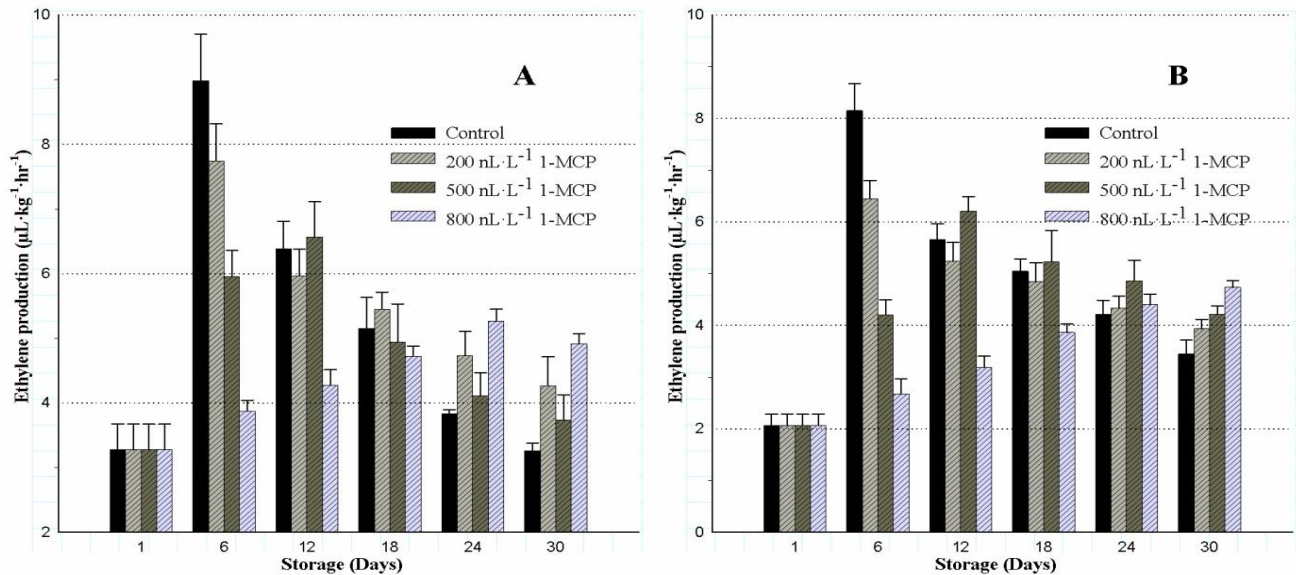**Figure 6. Effect of 1-MCP and storage on skin color (°H) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.**

Figure 7. Effect of 1-MCP and storage on ethylene production (µL· kg^{-1}·hr^{-1}) of guava; (A) cv. *'Gola'* and (B) cv. *'Surahi'*.

1st to 6th day, respectively (Fig. 6). The least decrease in hue angle was observed in fruits treated with 800 nL·L^{-1} of 1-MCP, which varied to 107.3 °H and 111.1 °H for *Gola* and *Surahi* respectively, at the end of 30 days. From trend lines of *Gola* (Fig. 6A), Hue value as 97.6 °H was recorded at 6th day of storage in control. While it took almost 27 days to reach same values for fruits treated with 200 nL·L^{-1} 1-MCP and fruit treated with 500 nL·L^{-1} and 800 nL·L^{-1} of 1-MCP never gain this value till 30 days. More or less, similar trend was observed for *Surahi* (Fig. 6B).

***Ethylene production*:** Variety, 1-MCP treatment, and storage duration influenced ethylene (Table 1). The ethylene production rates of guava cultivars varied based on the 1-MCP levels and storage intervals as depicted in Figure 7. At

start of the experiment, the ethylene production rates were 3.27 and 2.07 µl·Kg^{-1}·hr^{-1} for *Gola* and *Surahi*, respectively. The ethylene peak for control samples was recorded on the 6th day of the experiment where fruit produced 8.98 and 8.15 µl·Kg^{-1}·hr^{-1} ethylene for *Gola* and *Surahi*, respectively. On the same day, 1-MCP treated samples of *Gola* (Fig. 7A) produced 7.74 to 3.87 µl·Kg^{-1}·hr^{-1} of ethylene while these values were in the range of 6.44 to 2.67 for *Surahi* (Fig. 7B). Treatments with lower levels of 1-MCP (200 nL·L^{-1}) also exhibited ethylene peak at 6th day of storage as 7.74 and 6.44 for *Gola* and *Surahi*, respectively. The ethylene peak of the samples treated with intermediate levels of 1-MCP (500 nL·L^{-1}) was observed at 12th day of storage as 6.56 for *Gola* and 6.20 for *Surahi*. Whereas, fruits (cv. *Gola*) with higher

levels of 1-MCP (800 nL·L^{-1}) showed peak at 24th day of air storage. While, Fruit of cv. *Surahi* treated with 800 nL·L^{-1} of 1-MCP did not show any prominent peak.

DISCUSSION

The reduced changes in titratable acidity in 1-MCP treated fruits exhibited effectiveness of 1-MCP in regarding fruit ripening. In parallel to present study, higher values for acidity were recorded in fruits treated with 1-MCP (Watkins *et al*., 2000; Bassetto *et al*., 2005). In contrary to this, titratable acidity was not affected by 1-MCP during storage (Phebe and Ong, 2010; Hong *et al*., 2013). Higher values and early rise in sugar illustrated that the fruits without 1-MCP were at an advanced stage of ripening. Initial increase in sugars during ripening may be due to conversion of starch to sugar (Biale, 1961), on complete conversion a decline in sugars was recorded (Jain *et al*., 2003) as these sugar and organic acids were prime substance for respiration (Wills *et al*., 1981). Present results regarding sugars were in accordance with the previous finding of Phebe and Ong (2010), who experimentally proved that sugar contents of 1-MCP treated guava increased during storage except at the end of the ripening. In contrast to the present find no decrease in TSS was recorded in some 1-MCP treated fruit due to non-climacteric pattern (Bashir and Abu-Goukh, 2003).

Like present research, Gill *et al*. (2016) recorded weight loss as 3.4% in hexanal treated guava compared to untreated which have 7.3%. On the other hand, Fan *et al*. (2000) reported no-significant difference in weight loss of 1-MCP treated apricots. The advantageous effects of 1-MCP in preventing the guava decay were visibly verified as 1-MCP treated guava showed the sign of decay at day 18 compared to control which started to decay after 6 day of storage. Less fruit decay and weight loss was recorded in guava treated with 1-MCP (Phebe and Ong, 2010) due to reduced respiration thus resulting less water loss (Blankenship and Dole, 2003). In a similar manner, Gonzalez-Aguilar *et al*. (2004) recorded lower decay in treated guava.

Control fruits of both the cultivars changes to fully ripened yellow color at day 6 of storage, while treatments with 800 nL·L^{-1} of 1-MCP failed to ripen as indicated by higher values of hue angle and firmness. Use of 1-MCP considerably delayed the loss of yellowish green color resulting from the normal process of ripening. The firmness and color (°H) values of present study were relative to previous findings of Bassetto *et al*. (2005) and Feng *et al*. (2000). Bashir and Abu-Goukh (2003) recorded values in guava as they changed color from mature green to ripe yellow and observed eight-fold decrease in firmness. Early rise in climacteric peaks exhibited that control fruits and fruits treated with lower level of 1-MCP were at an advance stage of ripening. Absence of climacteric peak in fruits with high levels of 1-MCP showed improper ripening during storage. Golding *et al*. (1998) found that

autocatalytic ethylene production was suppressed by 1-MCP treatments. Similarly, Singh and Pal (2008) concluded that 1-MCP significantly inhibited ethylene production during ripening. In a similar study, Fan *et al*. (2000) recorded that ethylene peaks occurred at 17 d in fruit with 30 ppb 1-MCP and after 18 and 19 days in apricot treated with 50 and 70 ppb 1-MCP, respectively.

Conclusions: The results of present study illustrated that guava without 1-MCP were of a market quality for the initial 6 days only. The treatments with a low level of 1-MCP (200 nL·L^{-1}) was effective in maintaining the quality of yellowish green guava up to 12 day as indicated by hue angle, firmness and ethylene peaks. Effects of lower levels of 1-MCP diminished over time, suggesting the 1- MCP dose was not sufficient to saturate response for both of cultivars. Therefore, lower level 1-MCP was not able to inhibit the action of ethylene and delay further ripening after 12 days. At the same time, higher doses of 1-MCP (800 nL·L^{-1}) were too high to prevent the guava from proper ripening as indicated by maintenance of high firmness and prevention of fruit skin color change. These results indicated that for 1-MCP to be effective, intermediate dose levels of 1-MCP (500 nL·L^{-1}) were best to maintain the quality of guava during storage. Moreover, cultivars responded differently to 1-MCP and cv. *Surahi* maintained its keeping quality better compared to cv. *Gola*.

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