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Post Harvest Quality of Apple "Red Starking" was affected by 1-MCP Application

Mousa Arshad* and Afshar Amini**
**Department of Engineering Plant Production and Horticultural Sciences,*
Islamic Azad University of Mahabad, Iran.
***Graduate of Engineering Department of Plant Production and Horticultural Sciences,*
Islamic Azad University of Mahabad, Iran.

(Corresponding author: Mousa Arshad)
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ABSTRACT: 1-Methylcyclopropene (1-MCP) is a strong inhibitor of ethylene synthesis, which plays role in regulation and control of endogenous and exogenous ethylene, so it is an important matter of increasing apple shelf life. In order to increase the shelf life and keep quality of apple fruit in storage, an experiment was conducted basis on completely randomized design with three replications and different concentrations of 1-MCP (0, 0.014, 0.021 and 0.028 µLL^{-1}) were applied. According to the results, fruit firmness was affected by application of 1-MCP (P<0.01), also 1-MCP affected postharvest quality of apple fruits. The highest fruit firmness was in 0.021µLL^{-1} concentration that was about 50% higher than control (non-application of 1-MCP). Application of 1-MCP significantly affected to maintain weight, volume and fruit appearance quality in all applied concentrations. 1-MCP can eliminate or prevent the effects of ethylene and plays an important role in keeping postharvest quality of climacteric fruits like apple.

Keywords: 1-MCP, Fruit firmness, Fruit quality, Postharvest

INTRODUCTION

Apple (*Malus domestica* Borkh.) is one of the most important horticultural crops, which a large share of Agribusiness has been allocated to annually (FAO, 2014), and this is due to the high storage life, handling capability and nutritional value of apples. High quality, productivity, and preventing covert and overt waste of this crop, improves nutritional value and health of community (Harker *et al.,* 2003). Applying new technologies in apple post-harvest is one of the most effective ways in keeping quality and fruit firmness (Kader, 2008).

Ethylene is one of several plant growth regulators that affect growth and development processes including ripening and senescence (Watkins, 2006). Ethylene can profoundly affect quality of harvested products. These effects can be beneficial or deleterious depending on the product, its ripening stage and its desired use (Saltveit, 1999). Using 1-MCP is an efficient method to reduce respiration rate (Fan *et al*., 1999), ripening delay and increasing storage life of apple cultivars (Rupasinghe *et al*., 2000). 1-MCP is the best gas in keeping quality of apples (Tatsuki *et al*., 2007) and is extensively uses in keeping quality of fruits during storage and delaying peel greasiness (Watkind, 2006; Cheng *et al*., 2012). 1-MCP is also effective in keeping apple flavonoids content (Lu *et al*., 2012). Considering the little researches on 1-MCP effects, the aim of this work was to study the effects of 1-MCP on characteristics and quality of apple "Red Starking".

MATERIAL AND METHODS

In order to evaluate the effects of 1-MCP on apple "Red Starking", an experiment was conducted in completely randomized design with three replications and 1-MCP at three concentrations (0.014, 0.021 and 0.028 µLL^{-1}) and control (non-application of 1-MCP) were applied. After Treatment, fruits were carried to cold storage (4±1 °C) and RH (90-95%) for seven months and then quality parameters were studied.

A. Fruit Volume

Fruit volume was measured by immersing fruits in water inside a calibrated cylinder. The difference between water level after immersing fruits considered as fruit volume.

B. Fruit Firmness

Fruits with nearly same shape, diameter and length were selected. Fruit firmness was measured using penetrometer with applying pressure to middle part of fruit.

C. Total Soluble Solids (TSS)

Two drops of filtered fruit extract were put on the refractometer glass and read at 20°C. Read numbers were considered as mean for every experiment unit. Numbers were kept as Brix degree (Jalilimarandi, 2012).

D. Fruit Concentrate pH

Filtered extract were used for measuring pH level. pH was read with a digital pH meter at 20°C.

E. Fruit Weight

For measuring fruit water juice percent, peel and pulp of fruits in each unit were sampled separately. After weighting fresh weight, put in oven with 70 °C for 72 hours and weighted again. Fruit weight was measured using the following formula.

$$W(\%) = \frac{FW-DW}{FW} * 100$$

In which:

W%: fruit weight loss percentage Fw: Fruit fresh weight Dw: Fruit dry weight

F. Mineral Percentage

Samples after weighting were put in porcelain cruise in oven with 600 ?C for six hours and mineral percentage were measured using followed formula

$$\text{Mineral Percentage} = \frac{FD-FQ}{FW}$$

In which;

FD: Cruise weight with ash FW: Fresh weight FQ: Empty cruise weight

G. Determine the apparent quality of fruit

To determinate the apparent quality of fruits and fruits marketing (Mental scale), a six grade sorting was applied: 1-very bad 2- bad 3- average 4- good 5- very good 6- excellent

H. Statistical analysis

Data analysis and mean comparison were done with SAS software version 9.2 and Duncan's multiple range test at 5% level respectively.

RESULTS

According to the results, 1-MCP affected the fruit fresh weight ($P<0.01$) and dry matter percentage ($P<0.05$) (Table 1). Maximum fruit fresh weight and dry matter percentage were in 0.021 μLL^{-1} concentration and increasing in 1-MCP concentration led to the decline in fruit fresh weight and dry matter percentage (Fig. 1,2).

Table 1: Variance analysis of 1-MCP effect on shelf life of apple "Red Starking".

S.O.V	DF	Mean Square			
		Fresh weight fruit	Fruit dry matter content	Fruit firmness	Fruit quality
1-MCP	3	20.4**	2.5*	6.58*	10.3*
Error	8	0.7	0.13	0.3	0.41
Coeff. Var (%)	-	3.3	9.7	9.6	15.1

*,** indicate significant difference at 0.05, 0.01 level respectively

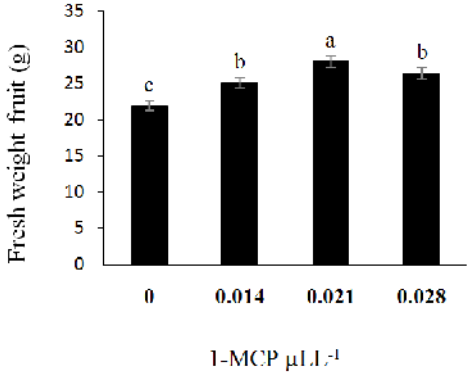


Fig. 1.

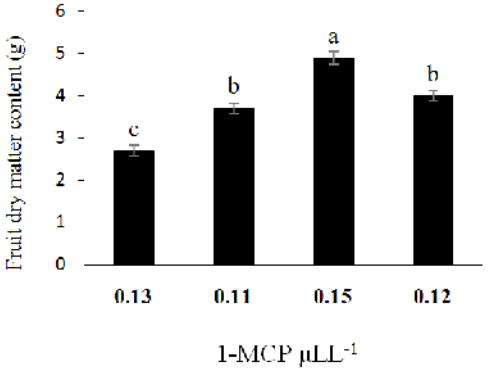
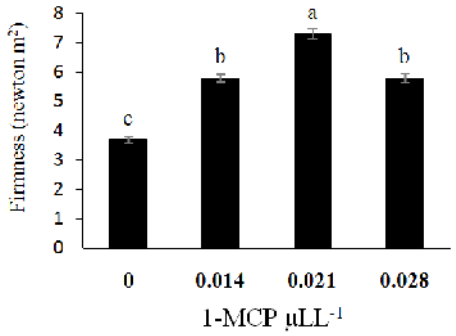


Fig. 2.

According to the data variance analysis, fruit firmness and fruit quality were affected by 1-MCP treatment ($P<0.05$), (Table 1). The highest and lowest fruit firmness was in 1-MCP treatment (0.021 μLL^{-1}) and control respectively. 1-MCP (0.021 μLL^{-1}) increased fruit firmness by 50% comparing control (Fig. 3). 1-MCP at all applied concentrations significantly maintained the fruit quality at longer time comparing control (not application of 1-MCP), (Fig. 4).

Results indicated the significant effect of 1-MCP on fruit volume ($P<0.01$) and mineral percentage ($P<0.05$) comparing control (Table 2). The highest fruit volume stability was in 1-MCP application at all applied concentrations (Fig. 5). Also 1-MCP treatment (0.014, 0.021 and 0.028) produced the highest mineral percentage but no significant difference were observed between applied concentrations together (Fig. 6).



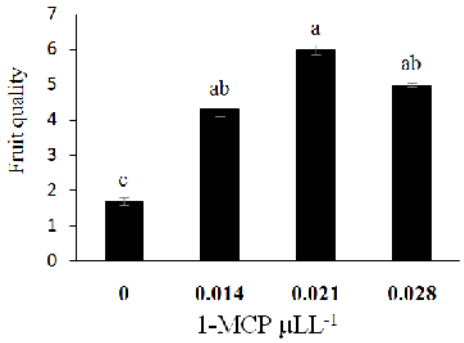
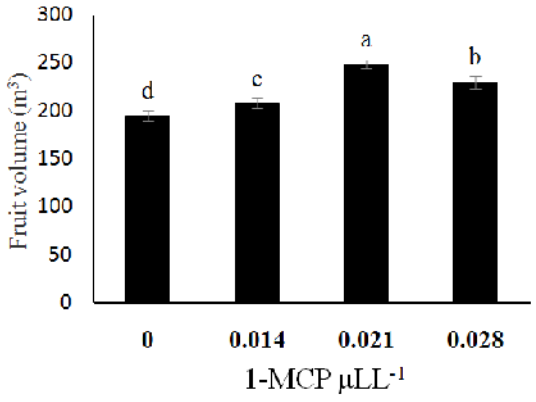


Fig. 3. Effect of 1-MCP on apple "Red Starking" firmness. **Fig. 4.** Effect of 1-MCP on apple "Red Starking" quality.

Table 2: Variance analysis of 1-MCP effect on shelf life of apple "Red Starking".

S.O.V	DF	Mean Square			
		TSS	Fruit volume	Fruit pH	Ash fruit
1-MCP	3	0.88ns	1711.1**	0.005ns	0.009*
Error	8	0.6	40.8	0.004	0.00019
Coeff Var (%)	-	5.9	2.8	1.63	10.7

*,** and NS indicate significant difference at 0.05, 0.01 and not significant respectively



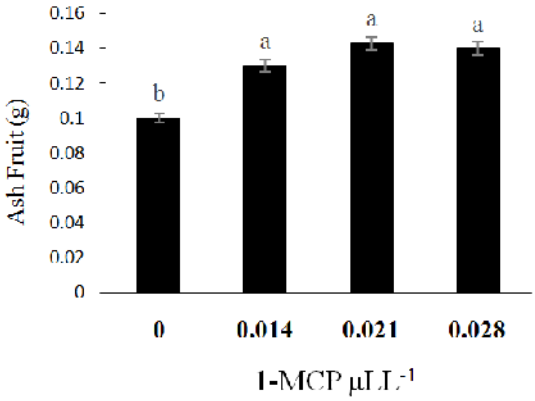


Fig. 5. Effect of 1-MCP on apple "Red Starking" volume. **Fig. 6.** Effect of 1-MCP onapple "Red Starking"Ash.

According to the results, 1-MCP had no significant effect on fruit pH and TSS (Table 2).

RESULTS AND DISCUSSION

Since 1-MCP protects apples from endogenous and exogenous ethylene, therefore is an effective material to maintenance apples (Watkins, 2006). Overall 1-MCP can prevent ethylene effects on apple fruit during ripening and storage and subsequently delay fruit ripening. 1-MCP includes an artificial non-saturated ring related to ethylene (C4H6) which reduces respiration rate (Fan *et al.*, 1999) and delays ripening of apple cultivars (Blankenship Dole, 2003).

1-MCP prevents ethylene activity and reduces apple water loss and subsequently keep fruit weight and water juice percentage (Fig. 2), and affects fruit firmness and quality (Fig. 3 and 4) and prevents cell wall deterioration through ethylene production binding.

In the research ahead, 1-MCP at proper concentration could prevent ethylene activity and as a result kept fruit quality, fruit firmness and increased in apple storage life. According to the experiment results, application of 1-MCP at 0.021 µLL $^{-1}$ concentration is recommended for better effect.

Considering the economic and nutritional importance of apple fruit, application of 1-MCP for increasing the storage life and postharvest characteristics efficiency in recommended and is an effective factor on quality indexes of apple in market.

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