

# Synergistic Effect of 1-MCP Fumigated with Chitosan Coating on Shelf-life and Physico-Chemical Quality of Marian Plum (*Bouea macrophylla*) Fruit

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## Abstract

Marian plum fruit has high nutritional and functional components which are beneficial for human health. However it has a short shelf-life owing to its high respiration and ethylene production. 1-methylcyclopropene is an inhibitor of ethylene action even at low concentration to hinder ripening and improving storage stability on variety of fruits. Chitosan has strong antimicrobial and antifungal properties that could effectively adjust the permeability of gas exchange, slow down respiration rate, hinder fruit decay. Objective of this study focused on the evaluation of 1-MCP fumigation at different levels (20 ppm, 40 ppm, 60 ppm, 80ppm, 100 ppm) in combination with chitosan coating (0.1%, 0.15%, 0.2%, 0.25%, 0.3%) on shelf-life and quality of marian plum during 14 days of storage at ambient temperature. Our findings will provide better insights for manufacturers in postharvest management.

**Keywords:** *Marian plum, Chitosan, 1-MCP, Fumigation, Coating, Posthavest*

## Introduction

Marian plum (*Bouea macrophylla*) belongs to the family Anacardiaceae. It is popularly cultivated in Vinh Long province, Vietnam. It's a cousin of the mango in miniature with acidic taste and super flashy yellow color [1]. It contains high nutritional and phytochemical values such as phenolic, flavonoid, potassium, essential amino acids, soluble fiber, carotenoid, ascorbic acid etc those are useful for health promotion [2, 4].

Chitosan coating was able to prolong fruit shelf-life for both nonclimacteric and climacteric typed fruits [5]. It was highly preferred in application due to its non-toxic, biodegradable, and biocompatible attributes [6]. Chitosan coating was beneficial to fruit by creating a physical barrier to transpired moisture and restricting O<sub>2</sub> consumption to control respiration rate and ethylene production.

Owing to environmental concern, chitosan coating was environmentally friendly and more preferred than plastic packaging. 1-methylcyclopropane (1-MCP) was one of anti-ethylene in delaying fruit ripening. Various studies revealed the high effect of 1-

MCP on horticultural products such as fruits, vegetables and ornamental plants [7, 10]. The effects of 1-MCP combined with chitosan in extending shelf-life and preserving qualities were examined on variety of fruits such as banana, guava etc [11, 13]. There was not any study mentioned to the possibility of 1-MCP combined with chitosan to create a synergistic effect on marian plum during preservation.

Therefore, puposes of our study penetrated on the effectiveness of 1-MCP fumigation at different levels (20 ppm, 40 ppm, 60 ppm, 80ppm, 100 ppm) in combination with chitosan coating (0.1%, 0.15%, 0.2%, 0.25%, 0.3%) on shelf-life and quality of marian plum during 14 days of storage at ambient temperature.

## Material and Method

### Material

Marian plum fruits at the yellow peel maturity stage were obtained from orchards in Vinh Long province, Vietnam. After collecting, they must be conveyed to laboratory for experiments.

Chemical substances such as 1-MCP, Folin-Ciocalteu reagent, sodium carbonate, gallic acid etc were all analytical grade supplied from Rainbow Trading Co. Ltd.

### Researching Procedure

Marian plum fruits were dipped in 1-MCP (20 ppm, 40 ppm, 60 ppm, 80ppm, 100 ppm) then coated in chitosan (0.1%, 0.15%, 0.2%, 0.25%, 0. 3 %). Thereafter, it was cooled by air at ambient temperature. All treated samples were then stored in dry cool place at ambient temperature for 14 days before analysis.

### Physico-chemical, Sensory and Statistical Analysis

Weight loss (%) was estimated by comparison of initial and final weight. Firmness (N) was evaluated by penetrometer.  $\beta$ -carotene content ( $\mu\text{g}/100\text{g}$ ) was analyzed by using high performance liquid chromatography [14]. Ascorbic acid ( $\text{mg}/100\text{g}$ ) iodometric titration [15]. Total phenolic content ( $\text{mg GAE}/100\text{g}$ ) was determined spectrophotometrically according to the Folin-Ciocalteu method [16] the experiments were run in triplicate with three different lots of samples. Statistical analysis was performed by the Statgraphics Centurion XVI.

## Result & Discussion

### Effectiveness of 1-MCP Fumigation to Physicochemical Characteristics of Marian plump during 14 days of Storage

The weight loss percentage of marian plum fruit was strongly affected by 1-MCP fumigation. The lowest weight loss percentage was recorded in marian plum

fruit fumigated at 80 ppm. Postharvest weight loss in fruit was normally owing to the moisture loss through transpiration. Moisture loss in preservation was a main cause of fruit decomposition. Decreased turgidity as a result of moisture loss led to shriveling and nutritional depletion. Shriveling created a reduction of economic value and consumer acceptability [12]. The highest firmness of marian plum fruit was observed at 1-MCP fumigated at 80 ppm.

Fruit texture firmness was one of the key parameters of marian plum represented to physical destruction during handling and preservation. Reduction in fruit texture firmness is an vital indicator of the softening scale in cell wall of fruit. It may be owing to the softening enzymatic reaction [17].

1-MCP probably delayed the speed of respiration rate and ethylene production. The competitive binding of 1-MCP to the ethylene binding site may suppress an auto inhibitory [18]. The highest amounts of beta-caroten ( $\mu\text{g}/100\text{g}$ ), Ascorbic acid ( $\text{mg}/100\text{g}$ ) total phenolic content ( $\text{mg GAE}/100\text{g}$ ) were also observed at marian plum samples fumigated by 80 ppm of 1-MCP. Similar results were mentioned by another report.

1-MCP fumigation at 500 nL/L showed slight effect on retarding an increase of ethylene production and on delaying Gac fruit softening during  $10^{\circ}\text{C}$  storage [12]. There was a quality improvement and shelf-life extension of plum fumigated by 1-methylcyclopropene by ripening stage at harvest [10]. 1-MCP at 1 mL/L had significant effect on stabilizing the quality and prolonging postharvest life of jujube fruit [19].

**Table 1: Effectiveness of 1-MCP fumigation to physicochemical characteristics of marian plump during 14 days of storage**

Parameter	1-MCP fumigation				
	20 ppm	40 ppm	60 ppm	80 ppm	100 ppm
Weight loss (%)	4.13 $\pm$ 0.04 <sup>a</sup>	3.84 $\pm$ 0.02 <sup>ab</sup>	3.41 $\pm$ 0.01 <sup>b</sup>	3.04 $\pm$ 0.02 <sup>bc</sup>	2.98 $\pm$ 0.01 <sup>c</sup>
Firmness (N)	6.71 $\pm$ 0.03 <sup>b</sup>	6.86 $\pm$ 0.01 <sup>ab</sup>	6.95 $\pm$ 0.00 <sup>ab</sup>	6.99 $\pm$ 0.00 <sup>a</sup>	6.99 $\pm$ 0.00 <sup>a</sup>
Beta-caroten ( $\mu\text{g}/100\text{g}$ )	31.74 $\pm$ 0.00 <sup>c</sup>	32.28 $\pm$ 0.00 <sup>bc</sup>	32.73 $\pm$ 0.02 <sup>b</sup>	32.92 $\pm$ 0.03 <sup>ab</sup>	32.97 $\pm$ 0.00 <sup>a</sup>
Ascorbic acid ( $\text{mg}/100\text{g}$ )	26.42 $\pm$ 0.02 <sup>d</sup>	27.04 $\pm$ 0.03 <sup>c</sup>	28.53 $\pm$ 0.01 <sup>b</sup>	29.47 $\pm$ 0.01 <sup>a</sup>	29.52 $\pm$ 0.03 <sup>a</sup>
Total phenolic ( $\text{mg GAE}/100\text{g}$ )	17.83 $\pm$ 0.01 <sup>d</sup>	19.21 $\pm$ 0.03 <sup>c</sup>	21.15 $\pm$ 0.00 <sup>b</sup>	22.48 $\pm$ 0.00 <sup>a</sup>	22.51 $\pm$ 0.02 <sup>a</sup>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ )

### Synergistic Effect of 1-MCP Fumigation Combined chitosan Coating to Physico-chemical Characteristics of Marian Plump during 14 days of Storage

Marian plum fruits were fumigated with 1-MCP 80 ppm and then coated with different concentration of chitosan 0.1%, 0.15%, 0.2%,

0.25%, 0.3%. Our results were clearly presented in table 2. It's obviously revealed that 1-MCP 80 ppm fumigated with chitosan 0.25% could maintain physico-chemical characteristics of marian plum during 14 days of storage at ambient condition. In another report, the combination of chitosan

with 1-MCP could be utilized to prolong the stability of bananas to four more days [11].

Similar findings were also observed on jujube fruit [20].

**Table 2: Synergistic effect of 1-MCP 80ppm fumigation combined chitosan coating to physico-chemical characteristics of marian plump during 14 days of storage**

Parameter	1-MCP 80 ppm fumigated with different chitosan levels (%)				
	0.1%	0.15%	0.2%	0.25%	0.3%
Weight loss (%)	2.51±0.02 <sup>a</sup>	2.04±0.02 <sup>ab</sup>	1.78±0.03 <sup>b</sup>	1.03±0.02 <sup>c</sup>	1.01±0.03 <sup>c</sup>
Firmness (N)	7.09±0.00 <sup>b</sup>	7.11±0.01 <sup>b</sup>	7.36±0.01 <sup>ab</sup>	7.53±0.03 <sup>a</sup>	7.55±0.01 <sup>a</sup>
Beta-caroten (µg/ 100g)	33.17±0.03 <sup>c</sup>	33.86±0.03 <sup>bc</sup>	34.37±0.01 <sup>b</sup>	35.03±0.01 <sup>a</sup>	35.06±0.01 <sup>a</sup>
Ascorbic acid (mg/100g)	30.59±0.00 <sup>d</sup>	31.85±0.01 <sup>c</sup>	33.52±0.00 <sup>b</sup>	34.61±0.00 <sup>a</sup>	34.70±0.00 <sup>a</sup>
Total phenolic (mg GAE/100g)	24.03±0.00 <sup>c</sup>	24.79±0.00 <sup>b</sup>	25.37±0.02 <sup>ab</sup>	25.87±0.01 <sup>a</sup>	25.80±0.03 <sup>a</sup>

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant ( $\alpha = 5\%$ )

## Conclusion

Integrated application of chitosan coating and 1-MCP fumigation attracted much more interest in fruit preservation because of their relatively safe property, wide range of acceptance and potential diversified-purpose

exploitation. Our results concluded that 1-MCP combined chitosan could lengthen shelf-life of marian plum fruits by slowing fruit quality decomposition in 14 days at ambient environment. The synergistic effect was clearly observed in dual coating compared to single chitosan manipulation.

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