Different Levels of 1-Methylcylopropene to Keep the Quality of Pineapple

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ABSTRACT
Pineapple is one of Indonesia's leading tropical fruits distributed in both domestic and international markets. High demand for pineapple leads to the development of pineapple preservation in Indonesia. However, postharvest handling constraints that have not been optimally hampered restrict the development of the pineapple agroindustry due to fruit damage. In addition, it can cause problems in the form of quality degradation such as the appearance of mold, decay, shell pitting, chilling injury, and internal browning. One way to inhibit damage and extend pineapple's shelf life is applying 1-Methylcyclopropene (1-MCP). This study used 1-MCP treatment with a concentration of 1 ppm to keep the pineapple quality for long-term storage. This study used 192 fresh pineapples produced by PT Great Giant Pineapple. The treated pineapples were kept at a display temperature of 25 ± 0.5°C and a cold temperature of 7 ± 0.5°C. Changes in physiological parameters such as carbon dioxide (CO_2) production, texture, weight loss, and shell color were analyzed every 4 days in display temperature and every 7 days for 42 days of storage in cold temperature. Statistical analysis was implemented to test the 1-MCP effect on pineapple for each parameter. This study has a conclusion that pineapple with 0,5 ppm treatment has the best results as also shown for other fresh products.

Keywords: *Postharvest, Tropical fruit, Shelf-life, Respiration, Cold storage.*

1. INTRODUCTION

Pineapple (*Ananas comcolor* (L.) Merr.) is one of Indonesia's leading tropical fruits traded in both domestic and international markets. Pineapple grows in almost all parts of Indonesia because it is supported by Indonesia's tropical climate and can be obtained at any time because pineapple is included in the fruit throughout the season. Indonesia's pineapple production in 2020 reached 2.45 million tons[1]. The production amount is the third highest in Southeast Asia after the Philippines and Thailand. Pineapple with low acid content is the most exported type of pineapple, so pineapple with low acid content has a great opportunity to be cultivated on an industrial scale[2]. MD2 is one type of pineapple that has a low acid content and has a higher price than other types of pineapple. MD2 is characterized by bright golden color, sweeter taste, low fiber, and acidity content, and has a uniform size3.

Problems that occur in MD2 pineapple are susceptibility to natural flowering, shell burning, and decreased physiological quality of the fruit[4]. The decline in the physiological quality of pineapple can be minimized with proper post-harvest handling. Post-harvest handling that was not optimal caused fruit damage[5]. In addition, it can cause problems in the form of quality degradation such as the appearance of mold (mold), decay, shell pitting, chilling injury, and internal browning. One way to control fruit physiological decline is by applying 1-MCP or 1-Methyl Cyclopropene.

1-MCP is a chemical substance that can block ethylene receptors so that it can extend shelf life and maintain the quality of horticultural products[6]. 1-MCP can be used in horticultural commodities such as vegetables, fruits, and ornamental plants. Types of fruit are distinguished based on the characteristics of maturity during storage, namely climacteric, and non-climacteric. In climacteric fruit, ethylene plays a very

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large role in stimulating ripeness so that the shelf life is very easy to extend. In non-climacteric fruit, the role of ethylene is almost non-existent because ripening during storage is not required, but 1-MCP can increase fruit freshness. More than 100 studies have investigated the details of the action of 1-Methyl Clopropene (1-MCP) which can inhibit ethylene in various fruits, vegetables, and floriculture crops[7]. 1-MCP has a very small residue, even none so it is one of the advantages of 1-MCP[8].

The purpose of this study was to determine the effect of 1-MCP at various temperatures on the quality and shelf life of pineapples. The quality parameters observed were weight loss, shell color, hardness, and CO_2 production.

2. MATERIALS AND METHODS

2.1. Experiment design and treatments

This research was conducted in East Lampung, Lampung, Indonesia. This study used pineapple varieties MD2. The research was conducted from May to July 2022.

This study used a completely randomized block design with each treatment having 5 replications. The study used 2 variations of treatment, namely the concentration of 1-MCP and storage temperature. The concentration of 1-MCP uses a concentration of 1 ppm while the storage temperature uses the display temperature (25°C) and cold storage temperature (7°C). the research phase begins with cleaning the pineapple and is divided into 4 groups. 2 of the 4 groups were given 1-MCP treatment for 24 hours. After being treated with 1-MCP the fruit was stored in the storage room.

2.2. Fruits firmness determinations

Fruit hardness was measured at the center of the fruit flesh. Measurement of hardness was carried out with 5 replications for each treatment. Hardness measurement using a penetrometer (GY-2 Portable Hardness Tester; Zhejiang Top Cloud-Agri Technology Co., Ltd; China) with a diameter of 8 mm and a depth of 10 mm. measurement results are expressed in kgf/cm^2.

2.3. Pineapple shell color

Shell color was measured on 5 replicate samples in each treatment. Determination of shell color is seen from the change in the color of the skin at the base of the fruit which is expressed on a scale of 0 to 6 with the following conditions: zero (the entire skin of the fruit is green), one (10% of the skin is yellow), two (10-20% of the fruit skin is green). yellow pineapple), three (20-35% yellow skin), four (35-50% yellow skin), five (50-75% yellow skin), six (>75% yellow skin) yellow)

2.4. CO_2 productions and weight loss (%)

The measurement of CO_2 production was carried out on the same fruit with 4 replications for each treatment. Measurements were made using a 10L capacity glass jar and a portable carbon dioxide sensor AZ7788A (CO_2 range: 0-5000 ppm, RH 10-95%, Temperature 0-50 C; AZ Instrument Corp; Taiwan). Measurements were made by inserting a pineapple and a CO_2 sensor into a jar and closing it tightly. Changes in CO_2 concentration are calculated for 1 hour and the rate of CO_2 production is calculated using the following equation (equation 1):

$$R = \frac{dx}{dt} \times \frac{V}{W} \tag{1}$$

Where:

R = CO_2 production rate

x = CO_2 gas concentration

t = Storage time (hours)

W = Mass of product (g)

V = Free volume of the jar (ml)

While the measurement of weight loss is determined by the percentage of fruit weight loss to the initial fruit weight.

2.5. Statistical analysis

Statistical analysis was performed using SPSS software version 25.0 (SPSS Inc.; Chicago, IL, USA). All data were analyzed by repeated measure two-way (ANOVA). The analysis used a significant difference at $P < 0.05$ determined by Duncan's Multiple Range Tests (DMRT).

3. RESULT AND DISCUSSION

Table 1. Influences of the treatment applied on the physicochemical characteristics of the fruit

Variables studied				
Treatment	Weight loss (%)	Firmness (kgf/cm^2)	CO2 production (ml CO2/Kg*h	Shell color
25 C 0 ppm	5,63±0,49^{a}	25,99±4.14^{ab}	5,41±3,13^{a}	3,77±0,18^{b}
25 C 1 ppm	5,04±0,26^{a}	28,76±5,94^{ab}	17,32±2,18^{a}	3,66±0,22^{ab}

Variables studied				
7 C 0 ppm	3,77±0,61^{b}	41,55±8,90^{b}	2,69±0,44^{a}	0,34±0,22^{b}
7 C 1 ppm	3,61±0,54^{ab}	39,92±8,45^{b}	2,57±0,34^{a}	0,22±0,18^{ab}

Note: each value represents a mean ± standard error. Mean values in each column followed by the same lower-case letters are not statistically different by Duncan's multiple range test (P<0,05)

3.1. Fruits firmness determinations

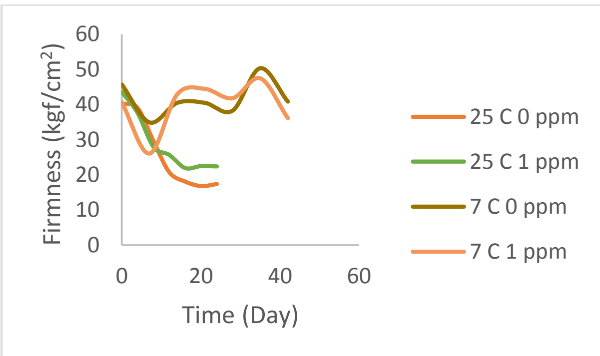

Figure 1 Effects of the 1-MCP treatments employed on the fruits firmness determinations during the experiment, with the average value in each observation time.

Based on statistical tests, 1-MCP did not affect the change in firmness significantly during storage at display temperature but significantly affected at cold storage temperatures. The firmness after 42 days was on average 34,056 kgf/cm^2 (Table 1). Optimal values in the fruit flesh in MD2 pineapple have ranged between 4-7 N or 40,78-71,38 kgf/cm^2 [9]. In this study, the cold temperature treatment without 1-MCP entered the optimal value of pineapple fruit hardness MD2. The softening of pineapple flesh might be caused by physiological and biochemical reactions during the ripening process, such as degradation of pectin by enzyme and hydrolysis of starch to sugar. The degradation of pectin and starch will increase the osmotic pressure in pineapple flesh. The increase of osmotic pressure will decrease the turgor pressure and lead to softening and reduction of firmness10.

The decrease in hardness at display temperature is higher than at cold temperatures. This is because pineapples stored at display temperature will ripen faster. The ripening process of pineapple is due to the high respiration rate at room temperature so that the metabolic rate that converts complex compounds into simple compounds in the cell becomes faster. Pineapple fruit stored at display temperature was not able to slow down the rate of respiration so that the fruit ripened quickly with a softened texture. Meanwhile, fruit stored at cold temperatures tends to have a slower respiration rate. This is because the low temperature can slow down the respiration rate so that the fruit does not ripen quickly and the texture does not soften quickly.

3.2. Pineapple shell color

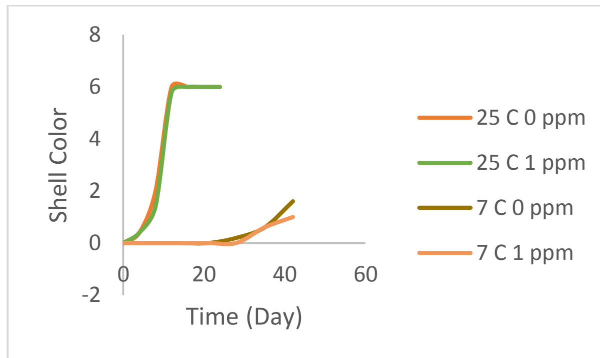

Figure 2 Effects of the 1-MCP treatments employed on the shell color during the experiment, with the average value in each observation time.

Effects of the 1-MCP employed on the fruit respiration rate during the experiment, with the average value in each observation time. Based on statistical tests, 1-MCP did not affect the change in shell color significantly during storage at display temperature but significantly affected at cold storage temperatures. Shell color after 42 days averaged 0,2 in cold storage and 3 in the display room (Table 1). Pineapple clones like MD2 in optimal quality typically display a bright green-yellow color11. This bright green-yellow color usually is related to a superior carotenoid content and antioxidant capacity in the shell[9].

3.3. CO_2 productions and weight loss (%)

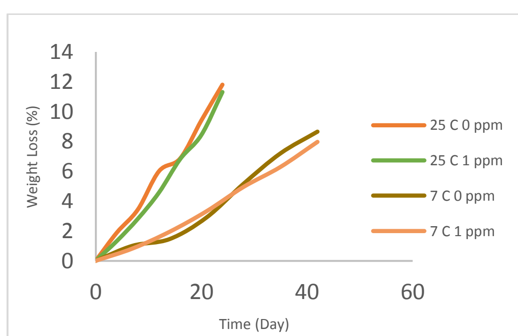

Figure 3 Effects of the 1-MCP treatments employed on the weight loss during the experiment, with the average value in each observation time.

Based on statistical tests, 1-MCP did not affect the change in weight loss significantly during storage at display temperature but significantly affected at cold storage temperatures. Weight loss after 42 days averaged 3,7% in cold storage and 5,3% in the display room (Table 1). Changes in weight loss in fresh pineapple are caused by the process of respiration and transpiration which results in loss of substrate and air. Respiration continues during storage until it enters the aging phase which is characterized by the absence of substrate to continue to be synthesized [12].

At cold temperatures, the weight loss is lower than the display space. Temperature variations greatly affect changes in weight loss during storage. The high percentage of weight loss is influenced by temperature where the higher the temperature, the higher the weight loss. This is because the higher the temperature, the higher the respiration and transpiration rate which causes the loss of water in the fruit.

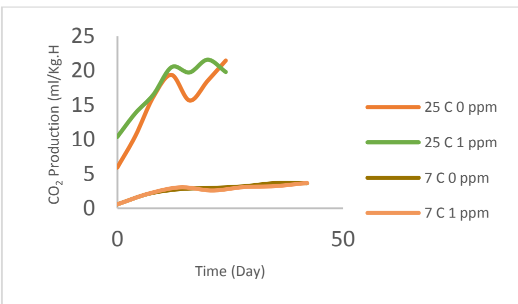

Figure 4 Effects of the 1-MCP treatments employed on the CO_2 production during the experiment, with the average value in each observation time.

Based on statistical tests, 1-MCP did not affect the change in CO_2 production significantly during storage at cold temperatures but significantly affected display storage temperatures. Shell color after 42 days averaged 0,2 in cold storage and 3 in the display room (Table 1).

4. CONCLUSION

1-MCP did not significantly affect the quality of non-climacteric fruit such as pineapple. Further tests with higher concentrations can be tested to confirm the effect of 1-MCP

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