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THE STUDY OF *HOT WATER TREATMENT* (HWT) AND ANTIMICROBIAL COATING TO EXTEND SHELF-LIFE OF RED CHILI (*Capsicum annuum* L.)

Cicih Sugianti[1)*], Dwi Dian Novita[1)], Diana Mustika[1)]
[1)] Agricultural Engineering Department, Agriculture Faculty, Lampung University, Soemantri Brojonegoro St, No. 1 Gedong Meneng Bandar Lampung, Lampung, Indonesia 35145.
*corresponding author: cicih.sugianti@fp.unila.ac.id

ABSTRACT

An anthracnose disease is one of the dangerous diseases in chili plants caused by *Colletotrichum capsici* fungus. *Hot water treatment* (HWT) is one technology that can be applied in post-harvest handling to suppress the spreading of anthracnose disease in red chili plants. Coating treatment with antimicrobial is also needed to prolong shelf life to help to supply chilies and surpress the price of chilli that keeps increasing. The purpose of this research was to investigate the effect of temperature and immersion time on hot water treatment of post-harvest disease, to investigate the effect of anti microbial coating on shelf life on the red chili plants, and to determine the best combination formulation of hot water treatment and anti microbial coating which can maintain the quality of red chili pepper. This research used a completely randomized design with factorial design. The first factor was HWT temperature at 3 levels (45° C, 50° C, and 55° C) for 15 minutes, and the second factor was ginger extract treatment at 2 levels (30% and 40%). The experiments were repeated 3 times and compared with the control groups. The results showed that the identification of fungus that attacked red chili causing anthracnose disease were *Colletotrichum capsici, C. gloeosporioides*, and *C. acutatum.* Based on the analysis of variance at 5% level of treatment, the immersion temperature significantly affected the weight shrinkage, hardness, and water content. The ginger concentration factor has a significant effect on the hardness and water content. While the interaction of immersion temperature and ginger concentration has a significant effect on the hardness and water content. The Duncan's further analysis showed that the best interaction parameters of hardness, water content, and red chili appearance on the 18th day of storage was obtained at 45° C and 30% of ginger concentration.

Keywords: red chili, anthracnose, hot water treatment, antimicrobial coating.

INTRODUCTION

Red chili (*Capsicum annuum L.*) is one of horticultural products which is high in demand by Indonesian consumers. The red chili is usually used as spices and food flavor. The demand for chili's supply keeps increasing along with the growing of the new type of chili and various of food menu. According to Statistics of Lampung Province (2014), the production of red chili of Lampung in 2013 has reached 35.23 thousand tons, decreased by 7.21 thousand tons (16.98%) compared to 2012. The decrease of chili production in 2013 occurred in the central of red chilli production, called Pesawaran District, West Lampung and Tanggamus respectively at 7.46 thousand tons, 1.07 thousand tons, and 510.9 tons compared to 2012.

The decrease in the production of chili is one caused by the attack of anthracnose pathogen of fungus disease on chilies. This disease is one of the most vital diseases in chili plants, caused by *Colletotrichum capsici* fungus. According to the Horticulture Research Institute Report of Lembang (2002) and Duriat and Sudorwahadi (1995) in Yani (2003), the yield loss on chili crops was due to anthracnose disease which could reach 14-100% in rainy season cultivation. Suhardi (1992) also reported that the loss of chili fruit due to anthracnose disease could reach 100% if the control is less precise, especially in the rainy season. Symptoms of disease attack on young fruit and crop ready fruit can continue to grow during transport and storage (post-harvest) if environmental conditions support so that an effective post-harvest control measures are needed.

A good postharvest handling is necessary to control post-harvest disease. The application of technology is also seen as crucial in postharvest handling to minimize disease progression and to extend shelf life, thus it can help the chili supplies and suppress the increasing price of chilies. Hot water treatment (HWT) is one technology that can be applied in postharvest handling. This treatment uses a combination of temperature and immersion time at a certain temperature. The coating treatment using anti-microbial natural materials is also considered necessary to suppress the spread of diseases that we consider already invested in fungus. Kusmiadi, R., et al (2011) stated that the coating on the fruits using a combination of beeswax with antimicrobials made from ginger extract can suppress the rot of the base of the bark fruit at a concentration of 30% or more.

RESEARCH METHODOLOGY

The materials used in this research are chili plants obtained from farmer's garden in Kalianda, South Lampung (quality I or II according to quality standard of SNI 01-4480-1998). The equipment used in the research are: *water bath* for HWT treatment, rheometer (CR-300 model) to measure the level of hardness, digital scales (Mettler PM-4800), digital camera, burette, erlenmeyer tube and dropper/pipette.

The preparation of the research was carried out by cleaning and sorting chili samples to maintain the uniformity of the samples. The chilies are then divided into samples for control (without treatment) and samples for Hot Water Treatment (HWT) and anti microbial coating with the total number of samples according to the combination of treatments. The entire combination of treatments in this research was stored at room temperature for 28 days. The testing was done by isolating the fungus which can cause postharvest disease in the red chili; then a pathogenesis test was conducted. The quality observation on chili was done in accordance with parameters of weight shrinkage, vitamin C, hardness, and water content.

RESULTS AND DISCUSSION

3.1 Fungus Causing Anthracnose

Anthracnose is a major problem in the production of tropical fruits, especially the red chili, causing considerable economic loss in crops. Anthracnose is caused by *Colletotrichum spp*.; namely *C. capsici*, *C. gloeosporiodes* and *C. acutatum* (Than et al. 2008a). However, in Fitriani's research result, M (2014) showed the percentage of *C. capsici* presence in the red chili is more dominant (63.89%) (Table 1).

Table 1. Persentage of *Colletotrichum spp*. in red chili

Species	Percentage of *Colletotrichum spp*. (%)
Colletotrichum capsici	63.89
C. gloeosporioides	35.56
C. acutatum	13.33

Persentase of *Colletotrichum* spp. according to the number of colony of *Colletotrichum* from 9 slices of chili's fruit skin and fruit flesh on PDA medium contained 100 mg/L cloramphenico

The red chili which are attacked by anthracnose showed symptoms of an enlarged hollow on the surface of the fruit. In the center of the basin there is a collection of black dots which are the aservulus group. The attack of *C. capsici* on fruit is not toxic to humans and animals, but the damage to fruits becomes a consideration for the feasibility of human consumption (Nayaka et al., 2009).

3.2 Quality Parameter of Red Chili

Weight Lose

The average weight at the beginning of storage was 42.543 g, at the end of storage i.e on the 20th day the average weight of red chili became 39.409 g. It showed a reduced percentage of red chilies' weight loss during storage of 6.653%. From the result of the analysis of 5% variance level of Appendix 1, the temperature factor has a significant effect on the decrease of weight loss during the 10th, 14th, 16th, 18th and 20th day of storage. The concentration factor of ginger extract on coating showed no effect on weight shrinkage. The interaction between HWT temperature and ginger extract concentration in coating did not affect weight loss. Next, Duncan's advanced test of temperature during influential days can be seen in Table 2.

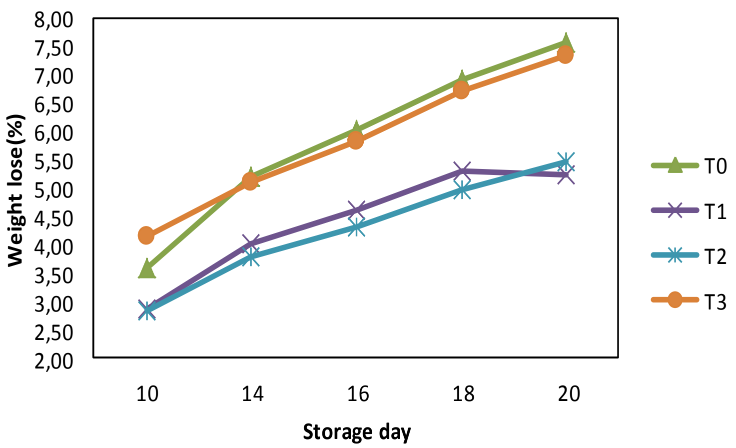

Figure 1. Graphic of rising weight lose on red chili during storage

From Figure 1, it can be seen that hot water treatment at 50° C could suppress the weight loss on red chilies. Based on Duncan's further analysis, the effect of using temperatures of 50° C and 55° C has the same effect during storage. In this research, HWT with a heating temperature of 55° C did prevent chilies from anthracnose disease, but chilies with this treatment experienced heat injury, namely the softening of fruit flesh in some parts and contain lots of water. This condition is likely due to overheating time. According to Martoredjo (2009), the optimal heating temperature in horticultural products for its control of Anthracnose disease is by treating hot water at 55° C for 5 minutes or combined with fungicide until the temperature could be lowered to 52-53° C.

Table 2. Duncan's further analysis of temperature influence on red chilies' storage

Treatment	Average of weight shrinkage day-				
	10	14	16	18	20
T0	3,589[ab]	5,198[a]	6,043[a]	6,937[a]	7,572[a]
T1	2,873[b]	4,005[ab]	4,605[b]	5,321[b]	5,244[b]
T2	2,841[b]	3,799[a]	4,322[b]	4,960[b]	5,457[b]
T3	4,156[a]	5,118[b]	5,843[a]	6,738[a]	7,339[a]

Notes : Numbers followed by the same letters showed no real difference influence

Hardness

The value of hardness of red chilies either at the tip, the middle or the base showed that the data continued to decline due to respiration activities in red chilies which experienced evaporation of water contained in the fruit into the environment. So, if the water in the fruit is reduced then the chilies will become soft. The reduce of water content in an agricultural product will reduce the density of the tissue on the fruit skin so that the water is volatile. Based on the analysis of variance with 5% level, it showed that factors of HWT temperature, concentration of ginger extract, and interaction of these two factors had a significant effect on the hardness of the fruits during storage.

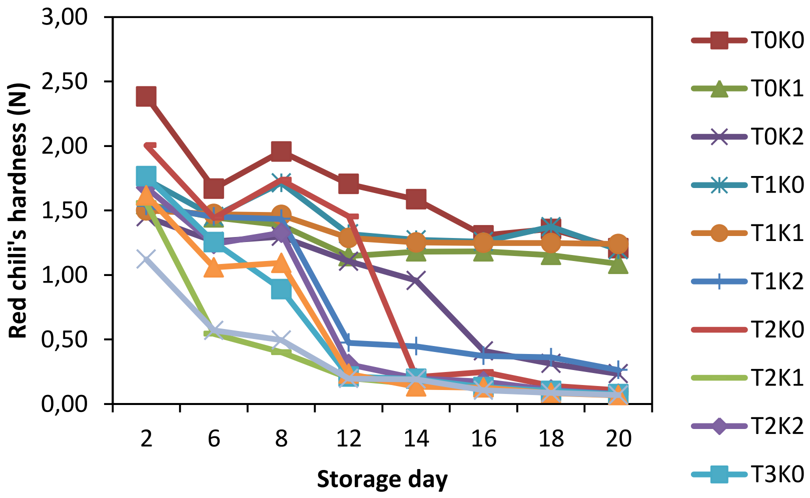

Figure 2. Graphic on the hardness of red chilies during storage

Water Content

The content of water in horticultural products is one of the parameters of shelf life. The result of the analysis at 5% level variation showed that the temperature factor influenced the water content on the 10th day of storage, the ginger extract concentration had an effect on the water content on the 8th day of storage, and the interaction of the two factors influenced the water content on the 12th day and the 18th day of storage. The advanced test results on interaction at the 12th and 18th day of storage were shown in Table 3.

Table 3. Duncan's further analysis result on interaction of temperature treatment and ginger extract concentration coating towards water content

Treatment	Storage Day-	
	12	18
T0K0	76,014^{d}	78,773^{b}
T0K1	78,936^{ab}	80,018^{ab}
T0K2	79,163^{ab}	79,093^{b}
T1K0	79,789^{a}	80,756^{ab}
T1K1	77,060^{cd}	78,452^{b}
T1K2	80,214^{a}	80,859^{ad}
T2K0	80,148^{a}	80,703^{ab}
T2K1	78,491^{abc}	78,530^{b}
T2K2	79,850^{a}	83,462^{a}
T3K0	77,752^{bcd}	79,680^{b}
T3K1	78,986^{ab}	81,827^{b}
T3K2	80,273^{a}	78,876^{b}

Notes : Numbers followed by the same letters at the same columns showed no real difference influence

Wax coating causes transpiration to run slowly, so that the free water content contained in the fruits and the results of respiration can be maintained. Transpiration causes the fruits to lose water so that it affects the freshness and crispness of the fruits. The smaller the transpiration, the fresher the fruits, vice versa. Water content is an important factor in storage, especially in the storage of fresh crops, because water content will affect the consistency of the foodstuffs and affect their durability (Winarno et al., 1997). After picking the crops, the fruits still contain high water content then will continue to decline until cooking (Pantastico, 1986).

Based on the observation on quality parameters including weight shrinkage, hardness, vitamin C, water content, and colors, the best treatment for this research can be determined. The best treatment can be seen from parameters in which the interactions affected the parameters. The interaction that has an influence in this research is seen from the interaction values. The results of Duncan's further analysis on interactions of hardness and water content on the 18th day of storage can be seen in Table 4.

Table 4. The result of further analysis on interactions of hardness parameter and water content on 18th day of storage

Treatment	Storage Day-18	
	Hardness	Water Content
T0K0	1,357^{a}	78,773^{b}
T0K1	1,154^{b}	80,018^{ab}
T0K2	0,313^{c}	79,093^{b}
T1K0	1,373^{a}	80,756^{ab}
T1K1	1,247^{a}	78,452^{b}
T1K2	0,361^{c}	80,859^{ad}
T2K0	0,141^{d}	80,703^{ab}
T2K1	0,101^{d}	78,530^{b}
T2K2	0,110^{d}	83,462^{a}
T3K0	0,101^{d}	79,680^{b}
T3K1	0,084^{d}	81,827^{b}
T3K2	0,087^{d}	78,876^{b}

Notes : Numbers followed by the same letters at the same columns showed no real difference influence

Based on the parameters of hardness and water content, the best treatments were decided; T0K0 and T1K1. Then the comparison of fruits' appearance on the 18th day showed that the appearance of red chilies treated with T1K1 was better than the treatment of T0K0. Thus, it can be determined that the best combination of HWT and coating treatment using ginger extract was obtained in the T1K1 treatment as in accordance with the parameters of hardness, water content, and the appearances of the red chillies.

T0K0 TIKI

Figure 3. The red chilies' appearances on the 18th day of storage

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