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Application of Clay Pot as Post Harvest Storage for Tomato

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ABSTRACT - In Indonesia, tomato is considered as an important economical crop. However, most of harvest ended up being wasted due to lack of proper post harvest processing technology. Since most of the Indonesian farmers are considered as low-income rural farmers and have limited access to reliable power supply the development of a low cost and low energy demand storage system is needed. This research applies the concept of evaporative cooling using clay pot filled with water soaked sand as storage system for fresh tomato. The effectiveness of this system to maintain fruit quality (weight loss, water content, and fruit sweetness) was compared with common domestic refrigerator. On average, this system has lower temperature than room temperature with average temperature between 21-23°C. Tomato stored inside clay pot filled with lowest water soaked sand (sand volume 500 g) has lowest weight loss (3.01%),lowest water content (94%), highest fruit sweetness (4.675 brix). Further research on various regions with different environment condition and measurement on other fruit quality variables, efficiency, and economic benefit is needed prior to its application on rural farming.

Keywords: Clay pot, Evaporative cooling, fruit quality, post harvest storage, tomato

Introduction

In Indonesia, despite being perfectly capable of producing abundant harvests, without any means of store and preserve crops, Indonesian farmers are at risk for heavy economic loss due. One of the crops that experience heavy loss of harvest is tomato (*Lycopersicon esculentum*). Annually, total tomato production is 853,061 ton (Statistik Indonesia, 2009) and in tropics estimate about 20-50% of production is loss due to poor post harvest handling (Prajawati, 2006).

Common application to prevent harvest lost of tomato is cool storage (Aguayo *et. al.*, 2004) at 10-15°C with average humidity 85-95% (Shewfelfat, 1986; De Castro *et. al.*, 2005). In order to achieve this condition, farmers require specific machinery, such as domestic refrigerator, which quite expensive and inefficient for farmers with low income and access to epileptic power supply. Furthermore, tomato stored under this condition for a long period is susceptible to chilling injury which reduce quality and price of the products (Olosunde *et. al.*, 2009). Thus, in order to improve income of low income farmer, FAO (1983) advocated a low cost storage system based on principle of evaporative cooling for storage of harvested fruits and vegetables. Evaporative cooling is working on the concept of increased relative humidity of storage environment (or decreasing the vapor pressure deficit) between fruits and its environment). Increased relative humidity will reduce the rate of water loss (Katsoulas *et. al.*, 2001) which in advance will inhibit respiratory processes and activities of destructive micro-organisms (Barre *et. al.*, 1988).

Various design evaporative coolers have been reported (Redulla, 1984; FAO, 1986; Roy, 1994; Acedo, 1997) yet most of them either using expensive material, susceptible to rodent attack, or has large size that required enormous space.In order to overcome these problems, some researcher tried different approach using clay pot such as a porous wall (pot in pot) (Anyanwu, 2004) and cuboids clay pot (Ndukwu, 2011). The benefit of using clay pots are: they easily developed using local resources, does not need any electricity, and could encourage the development of local clay pot industry.

This study investigatedthe effectiveness of an evaporated cooler system construct with local clay pot to maintain quality of local tomato. Tomato quality (weight loss, water content, and sweetness) was evaluated as a function of storage time for 20 days from the harvesting time.

Material and Methods

Description of the Evaporative Cooling System

The evaporative cooler is made up of 5 liter clay pot, purchase from local clay pot industry, filled with water soaked sand. Sand used in this study was common sand apply for building construction. During this research various proportion of water and sand were applied, as evaporative cooling system,in order to find perfect combination for the cooler (Table 1). Each combination was replicated three times and domestic refrigerator was applied as control treatment.

Table 3 Summary of combination of water and sand used in the research

Group	Water Volume (ml)	Sand Weight (g)	Group	Water Volume (ml)	Sand Weight (g)
E			Control		
A1	40	500	C1	40	1500
A2	80	500	C2	80	1500
A3	120	500	C3	120	1500
A4	160	500	C4	160	1500
B1	40	1000	D1	40	2000
B2	80	1000	D2	80	2000
B3	120	1000	D3	120	2000
B4	160	1000	D4	160	2000

Experimental Methods

During this study, six clay pots were used for each experimental group. Inside each pots, 12 tomatoes, previously wash by tap water, were kept on water soaked sand layer. All pots were tightly sealed by plastic sheet and kept in room temperature for 20 days. Every two days, temperature inside clay pots and fruit quality variables was measured.

Fruit quality

Weight Loss

Weight loss was expressed as a percentage of difference in weight between tomatoes that had been kept for 20 days and the initial weight of tomatoes. The weight of fruits was recorded to an accuracy of ± 0.1 g (Žnidarčič *et.al.,* 2010).

Water content

Water content of tomatoes was measured by gravimetric test. Fresh tomatoes were heated by oven at 105°C for 6 hours. Water content was expressed as percentage of weight loss after treatment (Musaddad, 2002).

Fruit Sweetness

Fruit sweetness was measured using refractrometer digital ATAGO®. Sweetness was expressed as brix value.

Statistical Analysis

The data obtained from this investigation were analyzed by One Way ANOVA with confidence level of 95%. Significant value then became subject of further analysis by Tukey. All analysis was carried out using STATISTICA 7.0.

Results and Discussion

Temperature changes inside clay pot

On average, temperature inside clay pot was lower 2.066 °C than room temperature (Figure 1). Among all treatments, clay pot filled with lowest total volume of water soaked sand (A1-A4) has significantly higher temperature differences (-2.133 °C) compare with treatment B1-B4 (-2.075°C), D1-D4 (-2.047°C), and C1-C4 (-2.00 °C) (*One way ANOVA*, $P<0.05$).

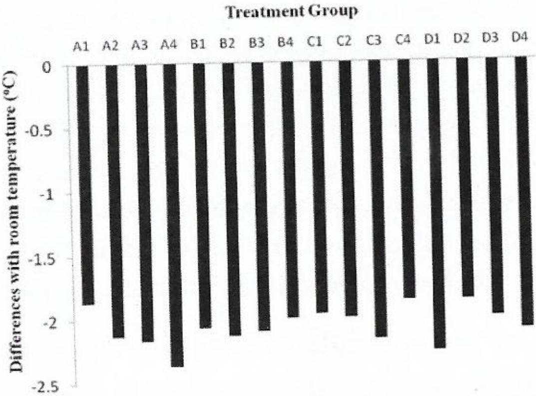

Figure 5 Average temperature differences between inside clay pot and room temperature. Average daily room temperature was 23-25°C.

Lower temperature inside clay pot worked based on principle of evaporative cooling whereby liquid evaporates into air, releasing latent heat, and cooling the object that the air comes into contact with (Shama *et. al.*, 2011). This study showed highest temperature differences when less volume of sand were used. This phenomenon could be explained by concept of thermodynamic and gas movement as bigger empty space reduces collision among gas molecules thus the amount of heat produces.

Fruit Quality

Weight Loss

Storing tomato in clay pot filled with least volume of water soaked sand better in maintained weight of tomato than clay pot with higher volume of sand and domestic refrigerator (*One Way ANOVA*, $P < 0.05$)(Fig. 2).On average, weight loss experienced by tomato stored inside type A system (3.01%) were less than acceptable maximum weight loss for tomato, which is 6-7% (Robinson, 1975; Hruschka, 1977). This result showed that this system able to prevent weight loss even though temperature inside clay pot much higher than temperature suggested for tomato post harvest storage, which is 5-15°C (Shewfelfat, 1986; De Castro *et. al.*, 2009; Žnidarčič & Požrl, 2006).

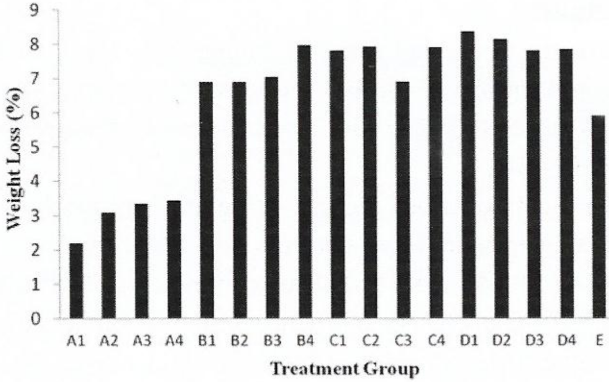

Figure 6 Average weight loss of tomatoes kept in clay pots for 20 days.

Water content

Tomato kept inside clay pot with least volume of water soaked sand has lowest water content compare with all treatment and control (Fig. 3). Lower water content probably correlated with changes in permeability of tomato fruit cuticles due to effect of temperature and relative humidity (Matas *et. al.*, 2005). Further study is needed to confirm about this since loss in water content influenced the shelf life and toughness of the fruit which is crucial for long distance transport.

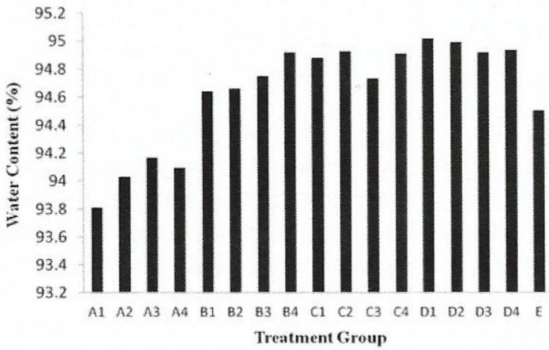

Figure 7 Average water content of tomatoes kept in clay pots for 20 days.

Fruit Sweetness

Tomatoes stored inside clay pot had higher brix level compare with tomatoes stored inside domestic refrigerator. Among all treatment, tomatoes kept inside clay pot with lowest amount of water soaked sand had highest brix level.

Low brix level of tomatoes stored inside refrigerator because sugar converted into starch in low temperature (Adegoroye *et. al.*, 1989; McDonald *et. al.*, 1999). Low brix level also indicated low soluble solids content of fruit, mainly sugar and acid, which would greatly effect to flavor of tomatoes (Moretti *et. al.*, 1998).

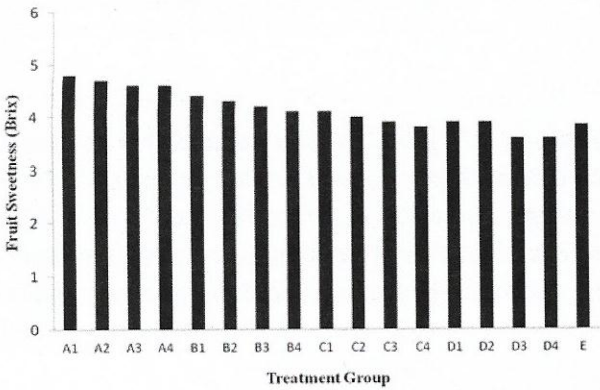

Figure 8 Average fruit swetness of tomatoes kept in clay pots for 20 days.

Conclusion

Clay pot filled with water soaked sand could be used as low cost post harvest storage system for tomato. This system is much better on preventing weight loss and maintaining fruit flavor compare with domestic refrigerator. Further study is needed to confirm the maximum shelf life of fruit, efficiency, and economic benefit of the system.

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