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PREFACE

The International Conference on Natural Products and Bioresource Science (ICONPROBIOS) 2017 is a conference organized by Research Unit for Natural Product Technology, Indonesian Institute of Sciences (BPTBA-LIPI), which is conducted in conjunction with the Indonesian Science Expo (ISE) arranged by the Indonesian Institute of Sciences (LIPI) to commemorate its 50th anniversary. ICONPROBIOS 2017 was held on October 23-24, 2017 at Balai Kartini (Convention Center), Jakarta, Indonesia.

By carrying the theme "Natural Products for Sustainable Life", ICONPROBIOS 2017 brought together more than 50 participants and presenters from several background such as university lecturer, researcher, student, and industrial practitioners. ICONPROBIOS 2017 provides a forum for exchange of information on natural products within all of the related topics as well as aims to build and strengthen scientific cooperation among the research institutions. The topics covered include biologically active natural products and drugs, marine natural products, bioactive metabolites from microbes, extraction and separation science, food science and technology, food processing and food engineering, food packaging, feed science and technology, ethno-veterinary, bio-resource for biofuels, bio-resource (including waste) recovery and recycling, bio-refinery and biotechnology, bio-resources for bio-based chemicals and products, and bioremediation. We hope all of us get lots of benefit from this conference thus it will give us inspiration how to enhance natural product to reach sustainable life.

Sincerely,

Dr. Anastasia Wheni Indrianingsih, M.Sc.Eng
ICONPROBIOS 2017 General Chair

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Evaluation of temperature and relative humidity on two types of zero energy cool chamber (ZECC) in South Sulawesi, Indonesia

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Evaluation of temperature and relative humidity on two types of zero energy cool chamber (ZECC) in South Sulawesi, Indonesia

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Abstract. Zero Energy Cool Chamber (ZECC) is a cooling chamber for storing fruits and vegetables from the viewpoints of low cost and energy savings. The aim of the present study is to evaluate temperature and relative humidity (RH) on two types of zero energy cool chamber (ZECC) in South Sulawesi, Indonesia. The first category was placed underground while the second category was on the surface. Then, the performance of the ZECC was measured by calculating temperature and relative humidity. The results show that the ZECC was constructed on the surface produce lower temperature and higher RH compare to ZECC which placed underground. In average, the temperature in the outside (28.0^{0}C) is greater than in inside (26.2^{0}C) of the ZECC. On the other hand, the relative humidity in the outside (72.9%) is less than in inside (87.2%) of the ZECC. It was concluded that the ZECC where was constructed on the surface is more suitable than ZECC in the underground for decreasing temperature and increasing relative humidity.

1. Introduction

Recently, in developing countries, the postharvest handling practices regarding vegetables throughout the marketing channels remain inadequate. The farmers have no storage facilities, while the transport and commercialization channels also lack storage facilities. As a result, most harvested fruits and vegetables are usually stored in the open, exposed to high temperatures and low relative humidity conditions, until an intermediary, retailer purchases those commodities [1]. The combination of higher humidity and lower temperature facilitates extended shelf life. These conditions can be achieved by using a semi underground storage system with moistened walls. The use of a shading curtain is also an effective means of reducing the temperature. Higher humidity and lower temperature inside the zero energy cool chamber (ZECC) offers a unique advantage for maintaining the firmness of fruits and vegetables by lowering the physiological loss in weight (PLW) and other metabolic processes[1,2].

Some studies on constructing and applying ZECC have been conducted. Islam and Morimoto[3–5] have developed a ZECC consisting of a brick wall cooler and a storage container coated with antimicrobials. In this study, the ZECC can maintain relatively low inside temperature and high relative humidity as compared with outside temperature and relative humidity. Ganesan et al. [6] standardized the quantity of water applied in zero energy storage. In his study, eggplants were stored in zero energy storage and at room temperature. Three different levels of watering operation (100, 75 and 50 l per day) were added to drip irrigation system to moisten the sand in the cool chamber. The physiological loss in weight and rotting percentage increased at room temperature but decreased with increasing water level up to 100 l per day. As a result, the shelf-life of Brinjal enhanced to 9 days with the addition of 100 l of water per day[7]. Narayana et al. [8] investigated the quality of banana packed with low-density polyethene bag with or without ventilation under different storage conditions, namely, ambient temperature, zero energy cool chamber (brick-sand evaporative cooler) and 13.5^{0}C low temperature. Shelf-life of the fruit was highest at 13.5^0 C and minimum under ambient conditions in both vented and unvented poly bags. Non-significant variation was observed for total soluble solids of fruit under all three storage conditions. The acidity increased gradually up to the end of green life and then either decreased (in unvented poly bags) or remained unchanged (in ventilated poly- bags and unpacked control) until the end of life (yellow). Reducing sugars and total sugars increased gradually throughout the storage period and were highest in the control fruit and fruit packed in ventilated poly bags. Spoilage was maximum in unvented poly bags under ambient and zero energy cool chamber conditions. Storing banana fruit in unvented poly bags at low temperature could extend the shelf-life of the fruit up to 19.33 days[7]. From the above studies, it can be seen that all of their ZECC was constructed on the surface. Therefore, in this study focusing on evaluating ZECC which create underground.

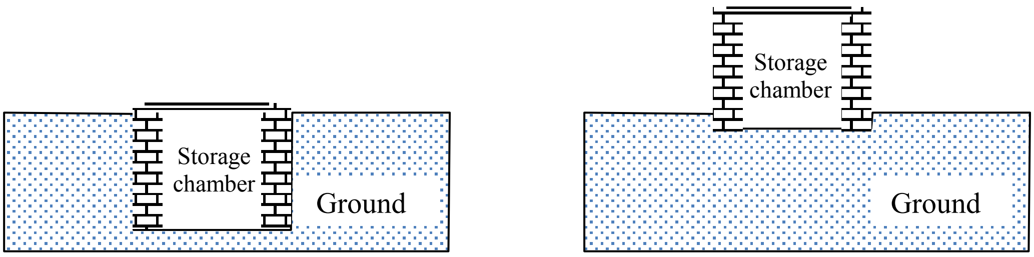
To the best of the author's knowledge, this is the first study to evaluate ZECC which construct underground, particularly in South Sulawesi, Indonesia. The objective of this study is to assess temperature and relative humidity inside two different of zero energy cool chambers (ZECC) in South Sulawesi, Indonesia.

2. Material and Method

This experiment was conducted at Makassar, South Sulawesi, Indonesia from June to July 2017. Two ZECCs were set up located at the complex residential for lecturer of Hasanuddin University.

2.1. Structure of the ZECC

The design was based on the evaporative cooling of a porous body [1,7,9,10]. Two different of ZECC were constructed. The first ZECC was placed underground while the second ZECC was on the surface as can be seen in Figure 1. Figure 2 shows the complete randomized block design of the ZECC. The dimensions of the outer and inner brick walls were 100 (L) × 100 (W) × 50 (H) cm and 80 (L) × 80 (W) × 50 (H) cm, respectively. The 7.5-cm gap left between the outer and inner wall was filled with sand as the use of a porous material for a particular type of evaporative cooler could reduce ambient temperature by as much as 15°C. Tap water was supplied to the sand area through drip irrigation using a valve. The cooling chamber's storage area was 45 (L) × 45 (W) × 50 cm (H) in size. A foam mattress made frame measuring 55 (L) × 55 (W) cm was used to cover the chamber.



(a) (b)

Figure 1. Two type of ZECC (a) ZECC was placed underground (b) ZECC was placed on the surface

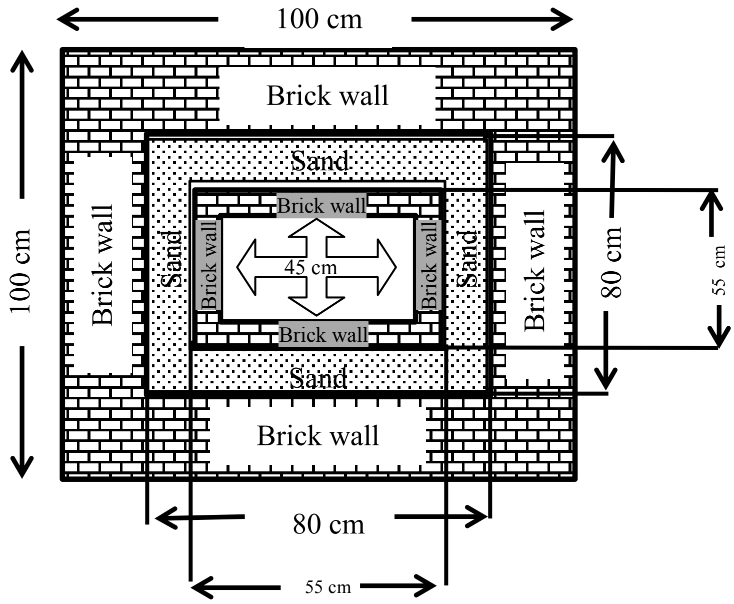


Figure 2. Pictorial (top) view of the ZECC

Shading curtain was used to cover ZECC which made from Palm's roof. The use of a shading curtain prevents an increase in ZECC temperature effectively [1].

2.2. Watering

The level of water (20 litres per day) was added to drip irrigation system to moisten the sand in the cooling chamber In the ZECC. Water is distributed from a water supply to low-pressure drip nozzles through a programmable flow valve for wetting the layer of sand.

2.3. Measurements of temperature and relative humidity

The temperatures at all places were simultaneously measured by using a digital thermometer (DS18B20 Waterproof Temperature Sensor Probe with an accuracy of ± (0.4%+0.9°C) with two thermocouples (0.3 mm d.). One thermocouple was placed inside storage chamber in the centre; another one has been put outside the ZECC for measuring the outside temperature. The relative humidity (RH) of the ZECC was measured simultaneously using a thermohydrometer (SHT11 humidity sensor module SHT 11). All instruments have data logger function. The data were recorded at ten-minute intervals for 24 hours. Thus, about 270 points of data for two days were obtained.

3. Results and discussion

3.1. Temperature

Figure 3 explains the typical diurnal changes temperature in inside and outside of the ZECC under the watering condition where the ZECC placed in the underground and surface. The highest temperature (34.0°C) and lowest temperature (23.5°C) were recorded in outside of the ZECC. In average, the temperature in the outside is higher than in inside of the ZECC, particularly in daylight. For instance, while the temperature in T1 (inside + underground + watering) and T2 (inside + surface + watering) of the ZECC at 5 hours is about 27.1^{0}C and 26.3^{0}C, respectively, the corresponding values for T0(outside) is about 33.3^{0}C. This result was consistent with a study by Islam and Morimoto[1], in which the temperature of the ZECC investigated; the temperature inside of the ZECC is lower than the outside one. As a result, the temperature inside of the ZECC can be potentially reduced using watering for the sand. This result happens as an effect of the evaporative cooling mechanism by water and the reduction of solar radiation by the shading curtain. Here, the vapour pressure of the moist sand and surrounding air and the outside temperature around the ZECC attempt to equalize. Liquid water molecules of the moist sand-zeolite mixture gasify under the influence of outside air through a process that uses energy to change the physical state. Convection and conduction were heat transitions that happened from the higher temperature of the air and brick walls to the lower temperature of water[1]. There is a drop in ambient temperature during this conversion process. This cooling temperature caused by the effect of evaporation cools down the inside temperature of the ZECC below the dry-bulb temperature. This is the result of the combined effects of underground temperature, the moist inside walls, and watering. Consequently, the inside air temperature of the ZECC became cooler. On the other hand, the sun's infrared rays were blocked 60% by the shading curtain, thereby lowering both the temperature inside the ZECC and that surrounding it[1,9,10].

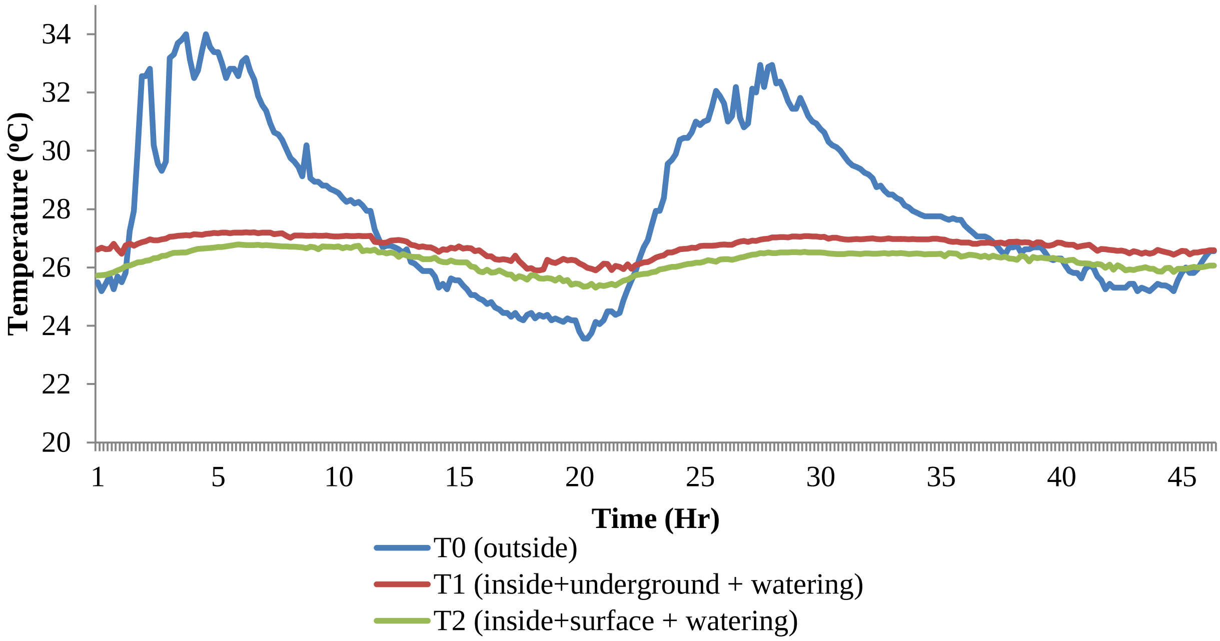


Fig. 3. Diurnal temperature in inside and outside of the ZECC under watering condition

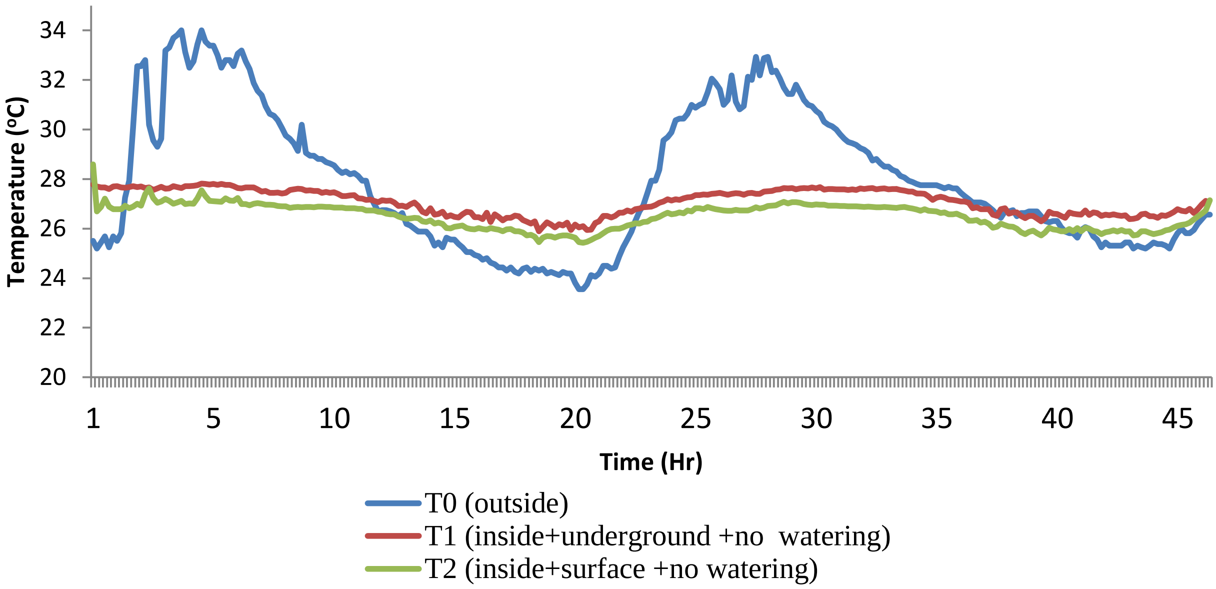


Fig. 4. Diurnal temperature in inside and outside of the ZECC without watering

Figure 4 shows the typical daily changes temperature in inside and outside of the ZECC without watering condition where the ZECC placed in the underground and on the surface. The highest temperature (34.0°C) and the lowest one (23.5°C) was recorded in outside of the ZECC. In average, the temperature in the outside is higher than in inside of the ZECC, particularly in daylight. The temperature in T1 and T2 of the ZECC for 5 hours was about 27.8°C and 27.1°C. The corresponding values for T (outside) is about 33.8°C. This result was also consistent with a study by Islam and Morimoto[1], in which the temperature of the ZECC investigated; the temperature inside of the ZECC is lower than the outside one.

3.2. Relative Humidity

Figure 5 shows the daily changes in inside and outside relative humidity of the ZECC over 45 hours. Overall, it can be seen that relative humidity in outside is lower than inside of the ZECC. In average relative humidity of RH0, RH1, RH2, RH3 and R4 were 72.9%, 92.9%, 94.1%, 83.1% and 79.2% respectively. Also, relative humidity of ZECC with watering condition (RH1, RH2) is always higher than ZECC without watering (RH3, RH4). Differences this relative humidity could be due to moisture in the sand caused by evaporative cooling method[6]. Lower temperature and higher relative humidity in cooling chambers contributed to the improved shelf life of fruit and vegetables. For instance, increasing humidity of the storage container for mushrooms from 76% to 96% decreased transpiration rate by 87% at 4^0C while decreasing the temperature from 16 to 4^0C decreased transpiration rate by 61%at 96% RH[11].

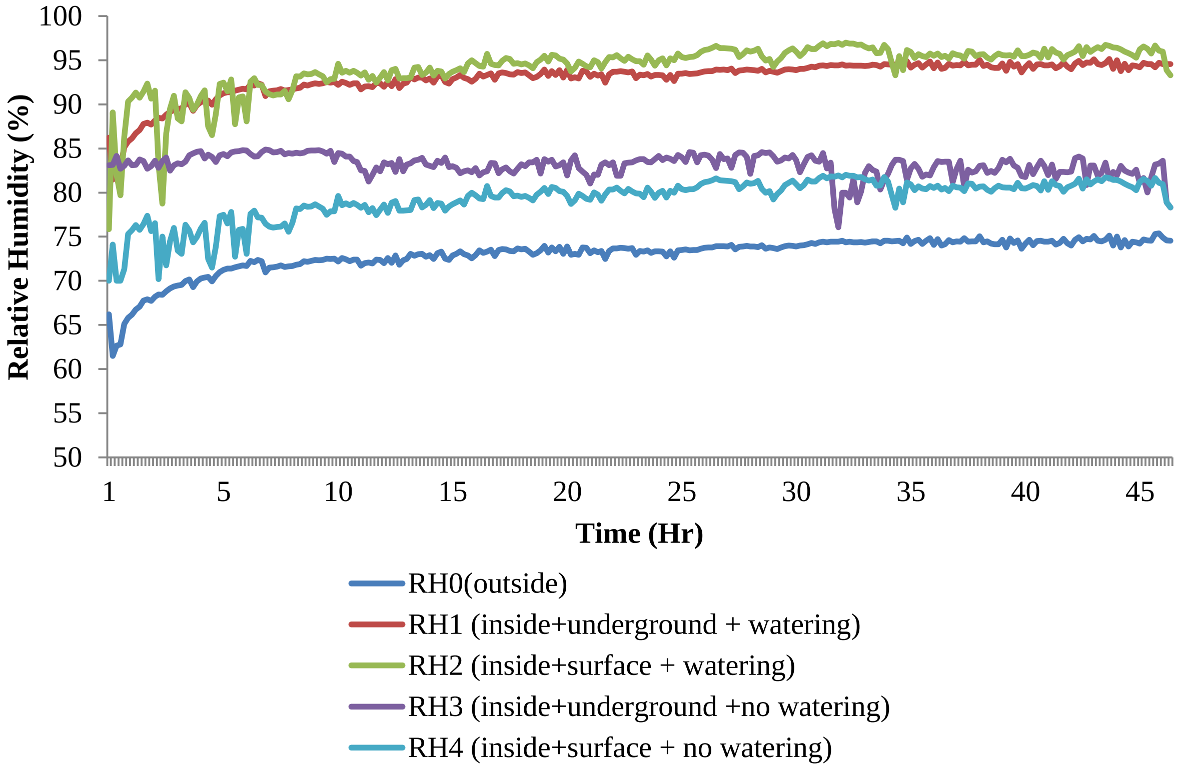


Fig. 5. Diurnal changes in inside and outside relative humidity (RH) of the ZECC under watering and no watering condition

4. Conclusion

Two types of ZECC were constructed; underground and on the surface, to evaluate temperature and relative humidity inside the ZECC compared to the outside one. A level of water (20 litres per day) was added to drip irrigation system to moisten the sand in the cooling chamber In the ZECC. The results show that the ZECC was constructed on the surface produce lower temperature and higher RH compare to ZECC which placed underground. In addition, the average of the temperature outside of the ZECC (28.0^{0}C) is higher than the inside one (26.2^{0}C). On the other hand, the relative humidity outside of the ZECC (72.9%) is less than the inside one (87.2%). It was concluded that the ZECC where was constructed on the surface is more suitable for decreasing temperature and increasing relative humidity inside the ZECC compared to the underground one. The use of a watering can potentially reduce the temperature inside of the ZECC.

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