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## Effect of Atmospheric Packaging Method on Quality of Packaged Cooked IR 64 Rice (*Oryza sativa* L. *indica*)

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### Abstract

Rice is considered as staple food that consumed in the form of steamed rice. Due to the emergency condition, like volcano eruption or flood, the availability and accessibility might be a serious problem. Therefore, a ready-to-eat rice is necessary. It would need a design processing condition to produce practical cooked rice in more economically packaging with different method.

Normal packaging and vacuum packaging of cooked rice followed by steaming for 60 minutes was conducted in this study. Two different storage temperatures include cold and room storage in day 0, 1, 4, and 7 was used to evaluate. The result showed that vacuum packaging gave better reduction in microbial parameter. However, panelist gave same preference in both normal and vacuum packaged cooked rice. Overall, cold stored-packaged cooked rice gave better quality than room stored-packaged cooked rice, especially in microbial parameter. Thus, combination of vacuum packaging and cold storing could be an alternative way to produce cooked rice which can be consumed in difficult condition.

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**Keywords:** Cooked rice; packaged cooked rice product; packaging methods; vacuum packaging

### Introduction

Indonesia has a high potential of disaster (Association Of Indonesian Environmental Observers, 2015) like earthquake, eruption, tsunami, flood, etc (National Coordination Agency, 2002). That disaster causes a lot of victim, in 2010 until 2014, there are 1.699.247 victims, 1.001.662 refugee (Gaffar, 2015). During refuge, a lot of food aid for the victims is instant noodle and rice. In emergency condition several food supplies such as instant noodle, rice, and else, cannot be prepared well because there are lack of potable water, fuel and cooking set (Daniel, 2014). Commonly

rice is cooked by rice cooker because this way is the easiest and simplest way in cooking rice (Marsudi, 1984).

Storage of cooked rice in rice cooker for periods can increase microbial total in cooked rice (Sari et al, 2012). Therefore, innovation about cooked rice products is needed for maintaining microbial quality of cooked rice. By the presence of innovative cooked rice product, it is highly expected to reduce consumption of fuels, time and energy. According to Billiris et al. (2012) the suitable rice:water ratio could be reduced fuel consumption in cooking rice. Suitable

rice:water ratio can be maximized by increasing temperature of processing in terms cooking temperature (Winarno, 1992).

One of the commercial cooked rice product is ready-to-eat rice in Korea and Japan. According to Lee (2006), the product has reached commercial value of 300 million dollar. Hence, study about cooked rice product is promising in food technology. Byun et al. (2010) showed that no significantly different in organic and inorganic retort pouch packaging toward ready-to-eat cooked rice product shelf-life, so it can be said that organic material can be used to an alternative in retort pouch material packaging. In another study, Jae Byun et al. (2007), had studied about irradiation on packaged cooked rice. In Indonesia, Daniel (2014) showed that rendang cooked rice canned could be an alternative emergency food product with adequate acceptability and stable during the storage.

Based on several studies, the gap of the research used is expensive packaging material, namely retort pouch packaging and canned packaging. This material did not economically suitable for the emergency food product. This research aimed to develop a packaged cooked rice with nylon material packaging because nylon plastic packaging has barrier properties like gas and high temperature (Sulchan and Nur, 2007). It is suitable for vacuum packaging and good for the product in packaged food, such as instant noodle, and for sterilization products (Julianti and Nurminah, 2006). Vacuum packaging method was used in this study which reduced pressure in packaging so that O<sub>2</sub> content in vacuum packaged food is lower than in normal packaged food (Basworo, 1998). This method can reduce contact between product and O<sub>2</sub>.

In this research, the effect of normal packaging with hand sealer and vacuum packaging with vacuum sealer toward water content, color, pH, microbiology and

acceptable consumer in different storage condition that was room temperature and cold temperature, were observed in order to evaluate the physical properties, sensory, and microbiology in the packaged cooked rice product during storage.

## **Material and Method**

### **Material**

The primary material used in this research is IR64 rice bought in Kranggan Market, Yogyakarta. Material for analysis used Plate Count Agar (Merck, Germany) and NaCl (Merck, Germany).

### **Method**

#### **Production of packaged cooked rice product**

Rice was washed rice and then added with water with the ratio of water and rice 1: 2.25. After that, rice was cooked using rice cooker (Miyako MCM-838, Indonesia) for 30 minutes. Cooked rice was packed using 100-gram nylon plastic, afterwards the cooked rice was sealed using hand sealer (Double Leopard SF-200, Chinese Taipei) and the vacuum sealer (Henkeman 200 A, Netherland) with scale 5 (0.78 bar), 6 (0.86 bar), 7 (0.90 bar) and 8 (0.92 bar). It was then subjected to steaming process at 100°C for 45 minutes, then stored at room temperature ( $\pm$  28°C) and cold temperature (4°C). Thereafter, analysis of lightness, pH, microbiology, and sensory were performed on days 1, 4 and 7.

#### **Lightness Analysis**

Color assessment on the ready-to-eat rice product is done by assessing the intensity of lightness (L) on the product. This analysis was done by sampling method, using a chromameter tool (CR-400) that could bring up the parameter number "L" on the digital screen. The sampled part is the top, middle, and bottom.

### pH Analysis

Five gram samples were added 5 ml of aquadest until the packaged cooked rice product could be crushed, completely homogenized and measured with pH-meter (Crison Instruments, Spain) under room temperature.

### Microbiology analysis

Colony measurement was calculated using Total Plate Count (TPC) method by FDA (1995). The homogenized sample (5 gram of sample and 45 mL NaCl) was diluted to a series of simple dilutions. Thereafter, 1 ml of the last 2 dilutions were taken and then sterilized in an empty sterile petri dish and subsequently poured the medium for melting and mixing evenly by rotating the plate back and forth on the table. As the control, plate dilution was poured on agar medium. After being solidified, incubated at 37°C with upside-down petri dish conditions, for  $\pm$  24 hours.

### Sensory Analysis

The sensory evaluation were done by 19-20 untrained panelists. It was a preference test for several attributes i.e. aroma, texture, and taste. The assessment were done using numerical scale from 1 to 7 according to its preferences.

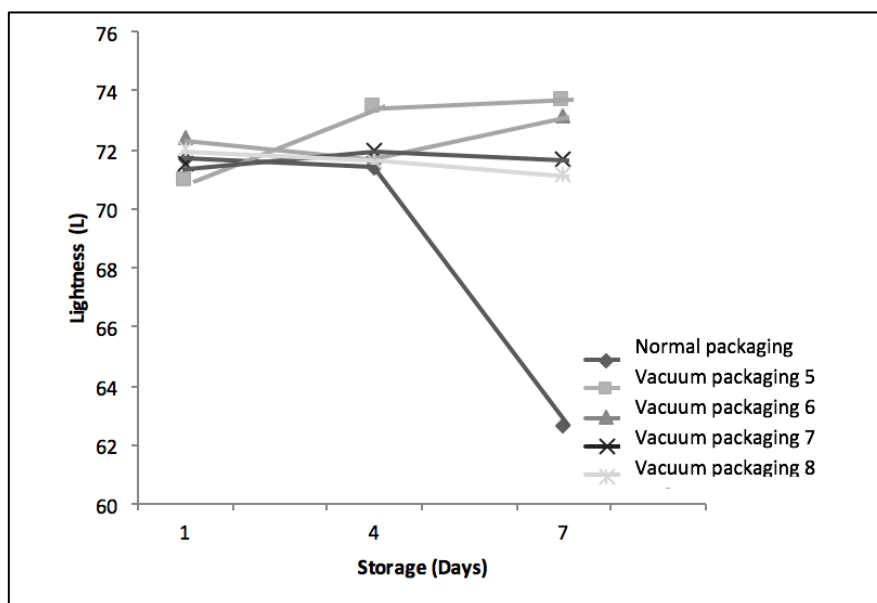
### Experimental Design

The experimental design used completely randomized design. The analysis of variance was done using SPSS v 20.0 software at 0.05 of significancy.

### Result and Discussion

#### Lightness analysis

From **Figures 1** and **Figures 2**, it can be seen that the sample lightness tended to be constant for 7 days storage, except in the usual packing samples of day 1 storage of room temperature. It was most likely due to the substance decomposition by microbes which damaged the color pigment in the cooked rice, thus reduced the lightness value.



**Figure 1.** Lightness of the packaged cooked rice product during storage at room temperature ( $\pm$ 28°C)

Packaging method did not greatly affect the lightness change in cooked rice, except in the

normal packaging of storage of room temperature. This was attributed to browning

enzymatic that probably happened in cooked rice. Polyphenol oxidase was one of the

enzyme which responsible to this phenomenon (Yu et al., 2017).

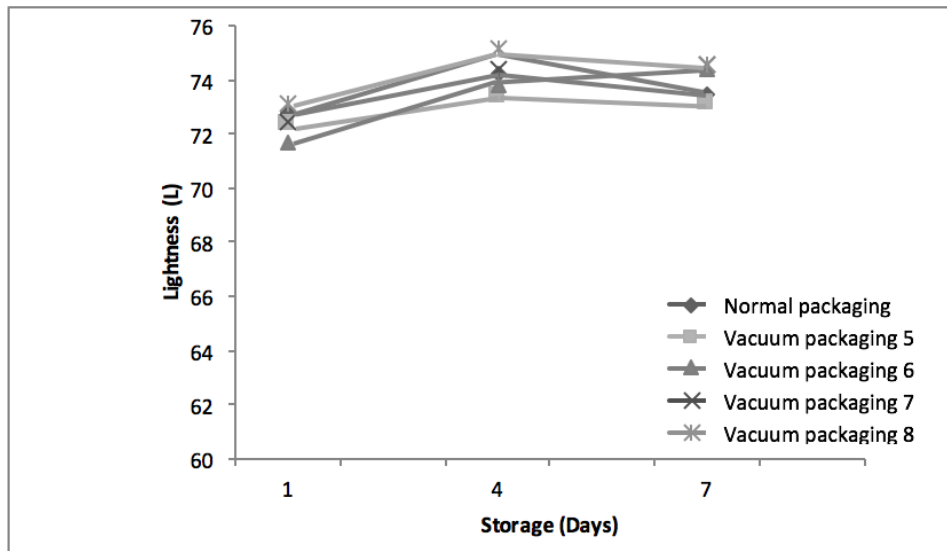


Figure 2. Lightness of the packaged cooked rice product during storage at cold temperature ( $\pm 4^{\circ}\text{C}$ )

**pH analysis**

Generally, cooked rice has a neutral pH ( $\pm 7$ ), the taste of freshly cooked rice was sweet and creamy taste. In other hand, unpleasant taste of cooked rice was sour taste

as described in Gayin et al., (2009). Therefore, decreasing pH of cooked rice lead to the reduce of panelist’s preference (Figures 3 and 4).

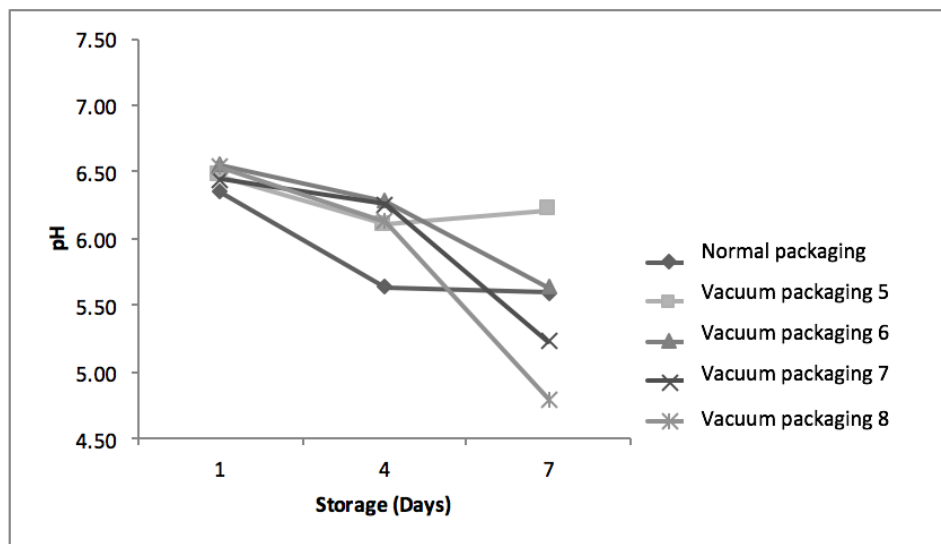


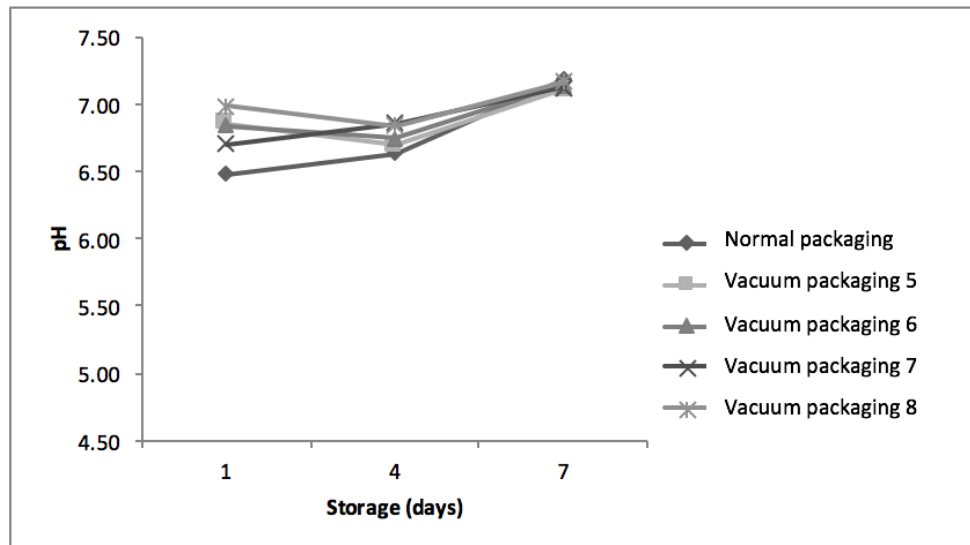
Figure 3. pH the packaged cooked rice product during storage at room temperature ( $\pm 28^{\circ}\text{C}$ )

The results of storage of samples at room temperature as shown in Figure 3 showed that the pH of the sample decreased along with the duration of storage. At room storage, sample had an unstable pH due to

the growth of microbial that possibly could produce acid which is probably attributed to toxin cereulide produce by microbia such as *Bacillus cereus*. Cereulide is a heat-stable, acid and protease-resistant cyclic peptide toxin

that is produced in the food before ingestion. Cereulide intoxication has a short incubation time of 30 min to 6 h, and generally lasts for 6 to 24 h with symptoms of nausea and

vomiting. Indeed, Cereulide intoxication is highly associated with rice and rice products (Luu-Thi et al., 2014; Arnesen et al., 2008; Ehling-Schulz et al., 2006; Mahler et al., 1997).



**Figure 4.** pH the packaged cooked rice product during storage at cold temperature ( $\pm 4^{\circ}\text{C}$ )

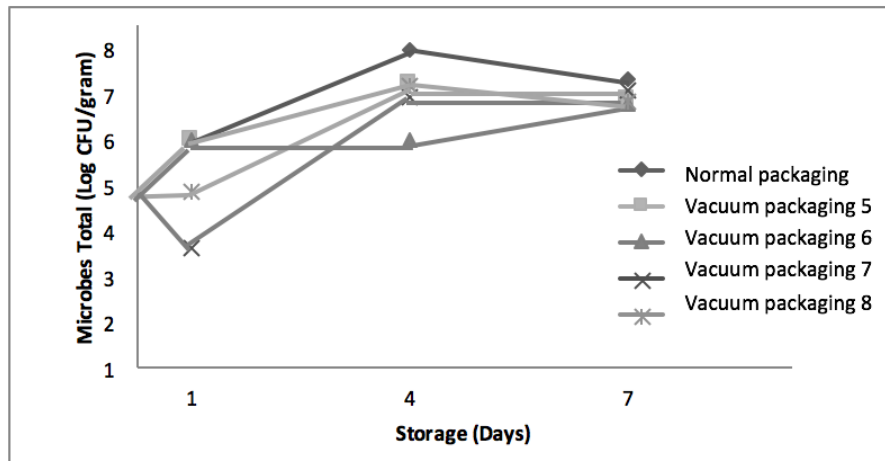
Variations of the packaging method did not significantly affect the pH change of the sample during storage, especially on the variation of the vacuum packaging scale. However, in cold temperature storage shown in **Figure 4**, the pH tended to be constant, close to neutral, presumably due to constant microbial growth. In the storage sample, the room temperature (**Fig. 3**) had an unstable pH and tended to acid. This was presumably because the total microbial of storage sample, so that the acid compounds degradation became higher.

#### Microbiology analysis

The growth of microbial colony can be seen in **Figure 5** and **Figure 6**. It illustrate that the

microbia grown in the sample were predominantly facultatively anaerobic microbia. This was because the packaging condition was lack of oxygen. In this condition facultatively anaerobic microbia can survive and sporulate leading to high number of microbial total in cooked rice during storage especially in room storage (Abbas et al., 2014).

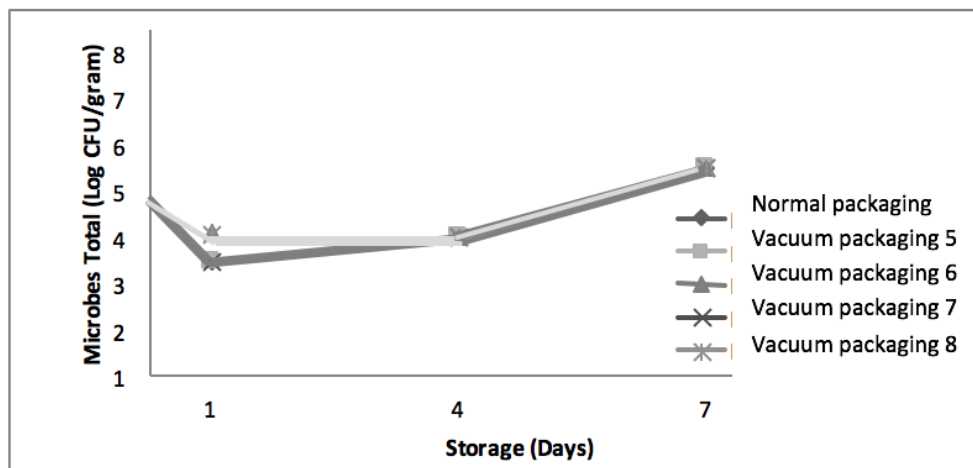
From **Figure 5**, it can be seen that the 2 log microbial growth existed during seven days storage at room temperature. It could be caused by mesophilic microbes such as *Bacillus cereus* as described in Guinebretièrè et al., (2008) that have optimum condition for growth at room temperature.



**Figure 5.** Microbial Total in aerobes incubation during storage at room temperature ( $\pm 28^{\circ}\text{C}$ )

In general, the highest number of total microbial can be seen in day 4 of room storage among other storage days include day 1 and day 4 (Figure 5). According to Food and Drug Administration in Indonesia (2009) recommendation level of total microbes in cerealia food is  $10^6$  CFU/gram. It was predicted that on day 1 to day 4, log phase

occured in microbial and day 4 to day 7, there was a stationary phase so the number was slightly decreased. While in the vacuum packaging samples of scale 6 and 7, the log phase occured until day 7. Such a thing did not occur in cool storage temperature samples, so the possibility of log phase did not occur or slightly slowly-occured until day 7.



**Figure 6.** Microbial Total in aerobes incubation during storage at cold temperature ( $\pm 4^{\circ}\text{C}$ )

In **Figure 6**, it can be seen that the total microbial decreased from the total initial microbes and gradually increased. This was attributed to delaying microbial growth in cold temperature. The same result was reported in Ali et al., (2008) which showed that cooked rice storage in refrigerated and

frozen condition can decrease total microbia in one-day-stored cooked rice. This phenomenon can affect other analyzes, such as the constant sample color/lightness analysis (as shown in Figure 2) and the constant reflection pH analysis (as shown in Figure 4).

## Sensory analysis

### Assessment of Aroma Attributes

In this study, sample cooked rice in day 4 and day 7 room storage can't be assessed in sensory evaluation because of unfeasible consuming. High level of propanal, pentanal, hexanal, caused by lipid oxidation in cooked rice, (Zhou et al., 2002) and microbial level beyond recommendation level ( $10^6$ ) (Frazier, 1995) were the two main reasons responsible to this phenomenon.

The results of the aroma attribute assessment in **Table 1** showed that the panelists had a 'rather like' to 'normal' rating

range on day 1 storage of room temperature of day 1 to day 7 cold temperature storage. It was marked with the highest score is 4.75 and the lowest score was 3.60. These results indicated that during storage, the aroma in the cooked rice was still fairly acceptable by the panelists even though the score decreased during storage. This meant that the panelist's preference decreased. It was mainly caused by the possibility of unexpected volatile compounds in rice by microbial or by chemical reactions even in small quantities such as the results shown in Figures 5 and 6.

**Table 1.** Favorite Aroma Score of the packaged cooked rice product during Storage

Type of Packaging	Storage on day 1		Storage on day 4	Storage on day 7
	Room Temperature	Cold Temperature	Cold Temperature	Cold Temperature
Normal Packaging	4.15 ± 1.14 <sup>a</sup>	4.40 ± 1.50 <sup>a</sup>	3.85 ± 1.09	-
Vacuum 5 Packaging	4.40 ± 1.23 <sup>a</sup>	4.20 ± 1.15 <sup>a</sup>	4.25 ± 0.72	2.35 ± 1.18
Vacuum 6 Packaging	4.70 ± 0.98 <sup>a</sup>	4.70 ± 0.86 <sup>a</sup>	4.15 ± 0.99	2.60 ± 1.05
Vacuum 7 Packaging	4.25 ± 1.45 <sup>a</sup>	4.75 ± 1.16 <sup>a</sup>	4.45 ± 1.10	3.00 ± 1.34
Vacuum 8 Packaging	4.65 ± 0.88 <sup>a</sup>	4.70 ± 0.86 <sup>a</sup>	4.20 ± 1.06	2.95 ± 1.47

Score 1 = Very unlike; 2 = unlike; 3 = rather unlike; 4 = cursory; 5 = rather like; 6 = like; 7 = very like

### Assessment of Texture Attributes

Room-stored cooked rice texture had been damaged (soft), so it was not feasible to be presented to the panelist and to the possibility of the high microbial activity as shown in Figure 5 could be a health damage so this was not presented. The texture of the rice was usually assessed from the level of hardness (pera) on the cooked rice. More hardness of cooked rice, more unlike by panelist.. However there were some people who liked hard rice (pera). The results in **Table 2** indicated that the texture of the sample was

not particularly favorable, especially in cold storage day 7. Most likely because during storage of cold temperatures, starch in rice was retrograded so the rice became hard and the panelists were less fond of hard rice. Thus, the texture of packed rice during storage appeared to be less acceptable to the panelist or the acceptance level was low in terms of texture.

**Table 2.** Texture Favorite Score of the ready-to-eat cooked rice product during Storage

Type of Packaging	Storage on day 1		Storage on day 4	Storage on day 7
	Room	Cold	Cold Temperature	Cold Temperature
	Temperature	Temperature		
Normal Packaging	3.60 ± 1.43 <sup>a</sup>	3.50 ± 1.67 <sup>a</sup>	3.15 ± 1.09	-
Vacuum 5 Packaging	4.75 ± 1.25 <sup>b</sup>	4.40 ± 1.79 <sup>a</sup>	3.65 ± 1.18	2.00 ± 1.08
Vacuum 6 Packaging	4.15 ± 1.76 <sup>ab</sup>	4.15 ± 1.35 <sup>a</sup>	2.95 ± 1.10	2.20 ± 1.01
Vacuum 7 Packaging	3.75 ± 1.77 <sup>ab</sup>	3.65 ± 1.39 <sup>a</sup>	3.30 ± 1.34	2.45 ± 1.32
Vacuum 8 Packaging	4.05 ± 1.57 <sup>ab</sup>	3.55 ± 1.36 <sup>a</sup>	3.25 ± 1.12	2.45 ± 1.50

Score 1 = Very unlike; 2 = unlike; 3 = rather unlike; 4 = cursory; 5 = rather like; 6 = like; 7 = very like

### Assessment of Taste Attributes

Taste of cooked rice are usually neutral and nothing strange. If there is something abnormal to the cooked rice, then there is a strange taste that arises in the cooked rice. In **Table 3**, the panelists assessed the taste attributes of 'dislikes' to 'somewhat dislikes' and their favorite levels decreased with length of storage. This was due to the possibility of the compound appearance in cooked rice that may interfere the taste

preference by the panelists, such as the improvement of acidic pH as shown in **Figure 3**. This was mainly because of the high microbial activity (**Figure 5**). However, the overall attribute of taste to packed rice was still slightly acceptable by panelists although the acceptance rate was lower than in the aroma attributes in the cooked rice.

**Table 3.** Favorite Taste Score of the ready-to-eat cooked rice product during Storage

Type of Packaging	Storage on day 1		Storage on day 4	Storage on day 7
	Room	Cold	Cold Temperature	Cold Temperature
	Temperature	Temperature		
Normal Packaging	-	-	-	-
Vacuum 5 Packaging	4.55 ± 1.23 <sup>ab</sup>	4.50 ± 1.40 <sup>b</sup>	3.75 ± 0.97	2.00 ± 1.08
Vacuum 6 Packaging	4.55 ± 1.28 <sup>ab</sup>	4.10 ± 1.29 <sup>ab</sup>	3.65 ± 0.81	2.20 ± 1.01
Vacuum 7 Packaging	3.85 ± 1.63 <sup>a</sup>	3.95 ± 1.10 <sup>ab</sup>	3.80 ± 1.11	2.45 ± 1.32



Vacuum 8 Packaging	4.75 ± 1.21 <sup>b</sup>	3.45 ± 1.90 <sup>a</sup>	3.45 ± 1.10	2.45 ± 1.50
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Score 1 = Very unlike; 2 = unlike; 3 = rather unlike; 4 = cursory; 5 = rather like; 6 = like; 7 = very like

## Conclusion

From the results, it can be concluded that the appropriate packaging method for making the ready-to-eat cooked rice product is vacuum sealing. The ready-to-eat cooked rice product has a rapid deterioration in physical properties and microbiological quality if the packaging was carried out by hand sealing packaging method at room temperature storage compared with vacuum sealing packaging method at the same storage temperature. As for storage at cold temperatures did not give a significant effect, but the results were better than the storage room temperature.

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