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The Characteristic of Microbial Growth on Carrageenan-Based Coated Edible Coating of Jaje Tujak

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Abstract. Jaje Tujak is a popular local food from Lombok. It has a very short shelf life as it is very susceptible to fungal growth. The use of natural and edible materials is very important for food product development. This study aims to evaluate the growth of mold and yeast on "Jaje Tujak" coated with carrageenan. The samples were either coated with 1.5, 2.5% carrageenan or not coated (control), then stored at room temperature and assessed the microbial growth at days 0, 2, 4, and 6 of storage. The parameters observed in this study were the water content, total of molds/yeasts, and texture. The results from these trials indicated that the growth of microorganisms was slightly reduced in number (preliminary research) by the coating treatments during storage at room temperature using PP plastic cup and still in the range of the maximum number of yeast/mold grow based on the SNI standard $2x10^2$ CFU/gr. In addition, packaging treatment also affects the inclination of fungal growth on Jaje Tujak. However, both treatments (with and without packaging) in both research were not able to extend the shelf life of Jaje Tujak more than two days of storage. Further research on other preservation alternatives is crucial to prolong the shelf life of Jaje Jujak.

INTRODUCTION

Jaje Tujak is a traditional snack from the Lombok region made from white glutinous rice, salt, and grated coconut. The color of this food is usually white, typical of glutinous rice. The aroma and taste of Jaje Tujak is typical of sticky rice and savory from coconut. While the texture is quite chewy and tends to be sticky. Based on the observations of researchers, for the storage of Jaje Tujak, local producers usually use plastic containers (PET). Storage using this method makes the shelf life of Jaje Tujak quite short, up to 2 days. Deterioration of Jaje Tujak is characterized by the slimy and mushy surface of Jaje Tujak, slightly sour (unusual) aroma, darkening surface color due to microbial growth, unusual taste, and hardened texture [1].

Preservation of Jaje Tujak is usually done by storage at low temperatures or processing it into Jaje Tujak chips. In addition, simple preservation often applied by the local community is coating the surface of Jaje Tujak with cooking oil. However, this method is insufficient to extend the shelf life of Jaje Tujak. Therefore, alternative preservation methods are needed to extend the shelf life and minimize the decrease in quality using carrageenan edible coating.

The edible coating is a thin layer made from edible materials, which is able to maintain product quality, has the ability to act as a barrier to the exchange of chemical and physical components that might alter food quality. It may also act as a carrier for materials such as antimicrobial compounds [2]. Substances that are often used and provide good mechanical properties as an edible coating are water-soluble hydrocolloids such as polysaccharides and proteins. These coating materials have the ability as a gas-exchange barrier due to the arrangement of strong hydrogen bonds [3], prevent texture deterioration and oxidation processes, and reduce the growth of microorganisms [4]. One of the most widely used edible coating materials is carrageenan.

Carrageenan is a type of polysaccharide in the form of phycocolloid which is primarily extracted from the seaweeds of the genus Chondrus, Eucheuma, Gigartina, and Iridaea. Carrageenan can be used as packaging materials such as coatings and films [5]. Hence, by the application of coating treatment, it is expected to be able to become a barrier

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from various factors that might accelerate the growth of molds, such as water activity (aw), relative humidity, and gaseous atmosphere.

Information about the use of edible coating on Jaje Tujak is still limited. Therefore, this paper presents research findings regarding the growth characteristics of microbes contained in Jaje Tujak which were treated with an edible coating of carrageenan.

METHOD

The research carried out consisted of two stages of research, (1) preliminary research (first trial) and (2) main research (second trial). Both methods were conducted the same preparation procedure which consist of; carrageenan making, Jaje Tujak making, and coating. Meanwhile, the storage condition was set to be different as will be mentioned later. Carrageenan sheets were shredded into crumbs for easier dispersing in aquadest and glycerol. Afterward, Jaje Tujak made by local producers was chopped into the same size (2cm x2cm x2cm) and coated evenly. The method used in the preliminary research was an experimental method using a Completely Randomized Design (CRD) with carrageenan concentration treatments of 0%, 1.5%, and 2.5%. The coated Jaje Tujak samples were stored at room temperature using a plastic cup (PP plastic) container, stored for 0, 2, 4, 6 days, and the total mold/yeast, moisture content, and organoleptic texture were observed. Then, complementary research was carried out using the best carrageenan concentrations obtained from the preliminary study, concentrations of 0% (control) and 2.5%, then stored for 0, 2, and 4 days under storage conditions of with packaging (thin PET plastic) and without packaging. Subsequently, only total mold/yeast was observed.

RESULTS AND DISCUSSION

Based on the results of observations and analysis that are limited to the scope of this research and supported by existing theories, a discussion for each parameter is presented as follows:

First trial

First trial or preliminary research was conducted for 6 days in a Polypropylene (PP) plastic cup with six levels of carrageenan concentration. Based on real conditions stated that Jaje Tujak started to grow mold on day 2 of room temperature storage. Six days of storage were chosen in order to testing the limit of storage condition.

Total of Mold/Yeast

The results from the preliminary study showed that the mold/yeast colony on Jaje Tujak treated with an edible coating of 2.5% carrageenan concentration on the second and fourth days were the same, counted 5.7 x 101 CFU/g, respectively (Table 1). The number was still in accordance with the maximum mold growth requirement of 2x102 for glutinous rice-based food as stated in the SNI standard [6]. In this research, the longer the storage added by the higher concentration of carrageenan leads to a higher count of mold/yeast. Edible coating basically is capable to prevent the growth of microbes and delaying microbial proliferation [7] by delaying moisture transport [8]. The reason for the contrary result was probably caused by the absence of antimicrobial agent substitution into the coating. Carrageenan might be able to delay microbial growth, but since carrageenan is a hydrocolloid matrix, thus highly hydrophilic, it presents only a limited barrier to moisture [9]. Hence, the substitution of antimicrobial agents is able to improve the ability of microbial growth prevention. Another reason was might due to the usage of tight packaging resulted in the reabsorbing of water vapor inside the packaging. Based on the result mentioned above, the concentration of 2.5% of carrageenan was chosen for further evaluation in the second trial. The chosen concentration was based on the parameter of the maximum number of mold/yeast for glutinous rice-based food in SNI standard.

TABLE 1. Total Mold/Yeast on Jaje Tujak Treated with Carrageenan During Storage

Concentration (%)	Day of Storage			
	0	2	4	6
0.00	1.80×10^1	1.80×10^2	2.20×10^2	1.10×10^5
1.50	1.50×10^1	1.20×10^2	3.70×10^1	1.20×10^2
2.50	1.30×10^1	5.70×10^1	5.70×10^1	1.00×10^4

Water Content

Based on Figure 1, the result depicted a positive regression. The water content obtained was gradually increasing by the time of storage. Water content at concentrations of 0.00 and 1.50% of carrageenan resulted in an R square value close to 1 (one), which means that the water content affects up to 80.00 and 95% on the increasing of water content, respectively (Fig.1). The percentage of water content in 0.00 and 1.50% of carrageenan were 46.00, 48.00% in day 0.00; 46.50%, 47.50% in day 2.00; 47.70%, 48.30% in day 4.00; and 48.00, 48.70% in day 6. All of the percentages were in accordance with the standard of the moderate water content of Intermediate Moisture Food (IMF) by 10.00-50.00% [10]. In contrast, the results on the treatment of 2.50% of carrageenan, the coating affected as much as 62.00% of the water content with the meaning of 48.00% of the rest were influenced by other unknown factors. However, the water content in 2.50% carrageenan slightly exceeded the standard water content of IMF with the lowest percentage was 51.38% on day 2 and the highest was 54.20% on day 6. Thus, the higher the concentration of carrageenan and the longer the time of storage, the higher the water content of Jaje Tujak obtained.

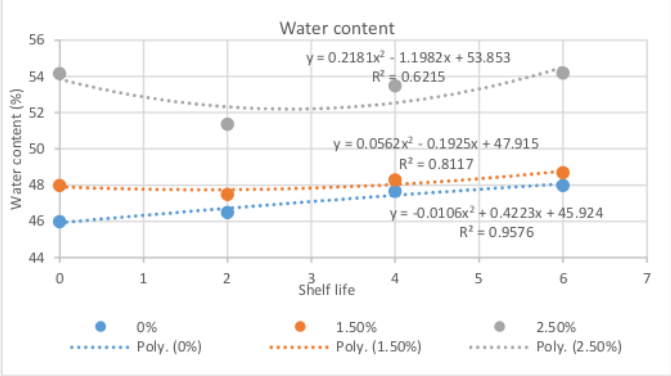

FIGURE 1. Regression of Water Content of Jaje Tujak Treated with Carrageenan During Storage

The increase in the water content of the material with the carrageenan coating treatment due to carrageenan has hydrocolloid properties that can absorb water easily so it is also easy to form a gel. With this process, the water content of the carrageenan coating itself is considered to be high so that when testing the water content, the carrageenan also contributed to the increase in the water content of Jaje Tujak [11, 12]. The nature of the hydrocolloid causes the water bound in the hydrocolloid network to increase [13]. This increase in water content supports the optimal environment for microbes to grow. To prevent the high absorbance of water by carrageenan, a composite of a hydrophobic matrix-characteristic is needed such as copper sulfite nanoparticle (CuSNP) [14].

The longer the storage, the more evaporation occurred on Jaje Tujak. In addition, high water content leads to deterioration of in Jaje Tujak. Then, the water vapor is retained in the closed container and makes the ambient pressure in the container higher than the ambient pressure of the Jaje Tujak, and causes the water vapor to be reabsorbed by Jaje Tujak according to the partial vapor pressure theorem [15].

Organoleptic test

The result indicated that the higher the concentration of carrageenan, the texture score level decreased (Fig. 2). There was a significantly different result in day 4 of storage between the carrageenan concentration treatments of 0% and 2.5%. Nevertheless, the 2.5% concentration on day 4 resulted in the texture score of 3.53 (slightly soggy state). The higher the concentration, the higher the level of panelist preferences obtained indicated by the hedonic score (Fig.3). For the hedonic scale, the higher the score, the more panelist like the sample. Meanwhile, the longer the storage, the lower the level of panelist preferences obtained. The soggy state of carrageenan was correlated with the water content result mentioned previously. Hydrophilic characteristic of carrageenan contribute to the absorbance of water and affect the texture of Jaje Tujak.

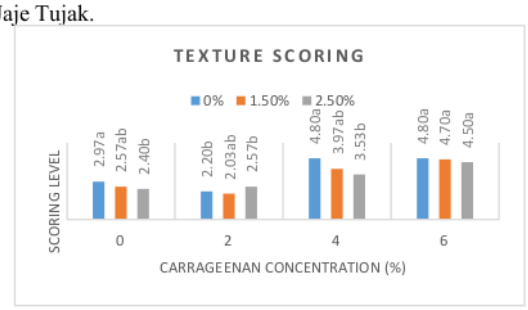

FIGURE 2. Effect of Edible Coating Carrageenan to Jaje Tujak on the Texture Scoring Value

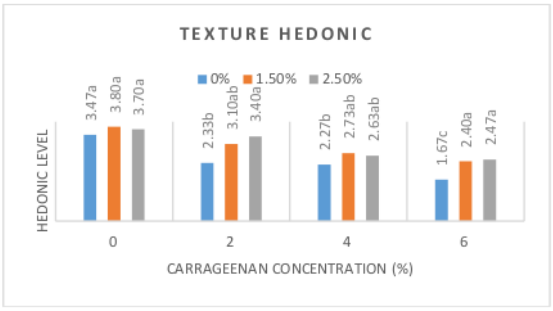

FIGURE 3. Effect of Edible Coating Carrageenan to Jaje Tujak on the Texture Hedonic Value

Second Trial

The second trial or complementary research was conducted for 4 days in thin Polyethylene Terephthalate (PET) plastic and be compared without packaging based on the real condition of Jaje Tujak sold in the market. The best carrageenan concentration was chosen (2.5%) and further be tested in four days of storage to prove whether there will be yeast/mold grow on the same day as the preliminary condition.

Total of Yeast

The amount of yeast counted in Jaje Tujak with both treatments (without and with packaging) in general was distributed at log 5 (Table 2). There was a decrease in the number of yeast at 0% treatment during storage, whereas the total yeast on Jaje Tujak treated 2.5% carrageenan tends to fluctuate. The high number of yeasts on day 0 of storage may be due to the abundance of carbohydrates that may act as the main substrate for yeast growth.

Furthermore, packaging treatment (with packaging or without packaging) did not cause a significant reduction in yeast growth. This might due to the abundant source of carbohydrates in Jaje Tujak as a main substrate of yeast growth. For longer storage, a fermentative deterioration might have occurred due to the abundance of yeast, thus further affecting the texture and aroma of the product [16]. In addition, the traditional method of Jaje Tujak processing such

as the use of sack coating on the pounder utensils, and also gloveless producer on grating the coconut, implemented by local producer where the samples were obtained may cause high yeast contamination in the samples.

TABLE 2. Total Yeast on Jaje Tujak Treated with of Edible Coating Carrageenan and Packaging During Storage.

Concentration (%)	Shelf Life (days) 0 (x 10^5)	2 (x 10^5)	4 (x 10^5)
			without packaging
0.00	8.10	7.00	7.80
2.50	6.70	3.60	8.10
			with packaging
0.00	8.10	7.00	5.00
2.50	6.70	5.70	6.00

Total of Mold

There was a decrease in the number of mold on day 2 of storage in unpacked Jaje Tujak for both concentrations of carrageenan but increased again on day 4 of storage (Table 3). The decrease in the number of mold may be related with condition that in the unpacked Jaje Tujak, the carrageenan coating was completely dry and effectively worked as a barrier for water that can support fungal growth. However, the total mold increased on day 4 of storage. This might be due to an insufficient amount of antimicrobial agent in the coating material that can prevent the growth of mold during 4 days of storage. On the other hand, the number of mold on packed Jaje Tujak treated with 0% and 2,5% of carrageenan increased after 4 days of storage. In general, the level of mold in packed Jaje Tujak samples exceeded the SNI standard for glutinous rice-based food by 2 x 102 CFU/g.

TABLE 3. Table of Total Mold of Edible Coating Carrageenan on Jaje Tujak.

Concentration (%)	Shelf Life (days) 0 (x10^2)	2 (x10^2)	4 (x 10^2)
			Without Packaging
0.00	3.50	0.45	38.00
2.50	3.20	0.11	2600.00
			With Packaging
0.00	3.50	11.00	7.80
2.50	3.20	4.80	1700.00

CONCLUSION

Mold growth was slightly reduced in day two of storage by the concentration of 2.5% carrageenan and Jaje Tujak treated without the packaging. The dry condition of storage may contribute to the reduction of mold growth and may also be due to the suitable dryness condition of the coating. Meanwhile, when Jaje Tujak was treated with packaging, the mold growth was slightly reduced on day 4 of storage by the concentration of 0% carrageenan. In addition, yeast growth was slightly reduced on days 2 and 4 by the concentration of 0% and 2.5% carrageenan and packaging treatments. Overall, the results indicate that the treatment of carrageenan coating was still lacking inefficacy of suppressing the microbial growth and shelf life of Jaje Tujak in room temperature storage. Further research on the use of antimicrobial agents is needed to solve the problem since as stated above coating without antimicrobial agents was insufficient to prolong the shelf life of Jaje Tujak.

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7