Available online at www.worldscientificnews.com

World Scientific News

An International Scientific Journal

WSN 133 (2019) 23-33 EISSN 2392-2192

# Characterization of Edible Film from Seaweed Flour (*Eucheuma cottonii* Weber-van Bosse, 1913) with Different Types of Plasticizer

**Farah Syifa Ramadhani***, **Iis Rostini**, **Zuzy Anna** and **Emma Rochima**

Faculty of Fisheries and Marine Sciences, Padjadjaran University, West Java, Indonesia

*E-mail address: syifaraa11@gmail.com

**ABSTRACT**

This study aims to determine the characteristics of edible film from seaweed flour (*Eucheuma cottonii*) with different types of plasticizer and to know the best type of plasticizer between sorbitol and glycerol in the manufacture of edible films. This research was conducted at the laboratory of Fisheries Products Processing, Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor, starting from 11 February 2019 – 28 February 2019. Edible films were tested namely edible film in four treatments and three replications with the addition of glycerol plasticizer 0.5%, glycerol 1.2%, and sorbitol plasticizer 0.5%. The characteristics of edible films observed were thickness, tensile strength, elongation, and transparency. The best *edible film* results are in the treatment of the addition of *plasticizer* 0.5% glycerol which is seen from the thickness parameter values of 0.029 mm, tensile strength of 7.51 MPa, percent elongation (elongation) 18.3%, and transparency value of *edible film* 64.02%. However, amongst the average values fulfilling the JIS (*Japanese Industrial Standard*) there are tensile strength and percent elongation (elongation) only.

***Keywords*****:** edible film, seaweed flour, plasticizer, sorbitol, glycerol, *Eucheuma cottonii*

( Received 19 June 2019; Accepted 05 July 2019; Date of Publication 31 July 2019 )

## 1. INTRODUCTION

Plastic packaging is the packaging most often used to extend the life of food products. However, plastic has a non-biodegradable nature, is hard to be degraded, so that the waste from this plastic can pollute the environment (soil, water, sea, and air) and it is predicted that it will decompose completely in 100 – 500 years. Therefore it is necessary to develop a package that has barrier properties such as plastic but is "environmentally friendly". Packaging that has barrier properties is an edible film. Edible films can improve barrier properties and antimicrobial activity. Edible films made from hydrocolloids have a good ability to protect products against oxygen, carbon dioxide, and lipids and have the desired mechanical properties and increase the unity of the product structure. Edible film products are a renewal of packaging products from organic ingredients. Edible films on food packaging can provide better product quality because they are made from natural ingredients that are not toxic so they can be eaten immediately and are less likely to be contaminated with food.

**Figure 1.** Seaweed *Eucheuma cottonii* Weber-van Bosse, 1913

**CLASSIFICATION:**

**Empire** Eukaryota
**Kingdom** Plantae
**Subkingdom** Biliphyta
**Phylum** Rhodophyta
**Subphylum** Eurhodophytina
**Class** Florideophyceae
**Subclass** Rhodymeniophycidae
**Order** Gigartinales
**Family** Solieriaceae
**Genus** Eucheuma
**Species:** *Eucheuma cottonii* Weber-van Bosse, 1913

**Distribution:** Indo-Pacific region

The main components in the manufacture of edible films are grouped into 3, namely polysaccharides which include hydrocolloids, lipids, and composites. Hydrocolloid components can be found from whole proteins, cellulose and derivatives, alginate, pectin, and starch. Polysaccharides that can be used as the main ingredient in making edible research films are seaweed (*Eucheuma cottonii*) in the form of flour.

The utilization of seaweed can increase added value by making seaweed flour. The process of making an edible film in this research requires additional material, namely a stabilizer which serves to stabilize, concentrate and thicken, and plasticizer which is an emulsifying material that can avoid cracking during the handling and storage process. The stabilizer commonly used is seaweed flour (*Eucheuma cottonii*), while the commonly used plasticizers are sorbitol and glycerol.

Based on this, the authors are interested in doing this research to find out the best type of plasticizer between sorbitol and glycerol in the manufacture of edible film of seaweed flour (*Eucheuma cottonii*).

## 2. MATERIALS AND METHODS

The materials used in this research included seaweed flour (*Eucheuma cottonii*) as a test material, 70% alcohol for sterilizing tools and research environment, aquades for dissolving seaweed flour, sorbitol as edible film plasticizer, and glycerol as edible film plasticizer. The tools used in this research are glass beaker, spatula, digital scales, measuring cups, hot plate stirrer, magnetic stirrer, white paper, thermometer, plastic mold measuring 26.7 × 18 cm, volume pipettes, and equipment for thickness testing, tensile strength, percent elongation, and transparency determination.

This research was conducted from 11 February 2019 – 28 February 2019 at the Fisheries Product Processing Laboratory using quantitative descriptive analysis method consisting of 4 treatments and 3 replications to obtain 12 experimental units. The data obtained comes from primary data taken from the results of testing in the laboratory.

### 2. 1. The Thickness of Edible Film

The thickness of the edible film was measured using a digital micrometer with an accuracy of 0.01 mm in five different places. The value of edible film thickness is determined by the average of the five measurement sites.

### 2. 2. Tensile Strength of Edible Film

The tensile strength of the film is calculated by dividing the maximum force to tear the film (F) with the cross-sectional area of the film (A).

Tensile strength is determined based on the maximum load when the film breaks. The cross-sectional area of the film is multiplication of the width of the film pieces with an average thickness of the film. Tensile strength is calculated using the formula:

$$\text{Kuat Tarik (MPa)} = \frac{F}{A}$$

### 2. 3. Percent Elongation of Edible Film

Percent elongation is the result of the percentage of length increment in the edible film when it is pulled up to break/tear it. The tools used are Digital Universal Testing Machine Auto Strain brand Instron. Edible films are cut into square pieces 35 mm wide and 50 mm long, then measured. Edible film pieces are attached to the tool handle, 1 fixed handle and 1 movable. The handle is moved up slowly until the film is torn. The maximum force value for tearing the measured film is seen on the displayed tool.

Lengthening is calculated by dividing the length of the film length when torn (b) and initial length of the film before drawing (a). Mathematically elongation is calculated using a formula:

$$\text{Pemanjangan (\%)} = \frac{b - a}{a} \times 100\%$$

### 2. 4. Transparency of Edible Film

Transparency of edible film is measured using a UV spectrophotometer at a wavelength ($\lambda$) of 550 nm. Film transparency is measured using the Bao *et al.* method (2009), that is, films that have known thickness, (x mm), are cut sufficiently then put into test cells and tested using absorbance A550. Figures displayed by UV spectrophotometers are recorded and calculated transparency of edible film using the formula:

$$T = A_{550}/x$$

where: T = Transparency
A550 = Absorbance at a wavelength of 550 nm
x = Film thickness (mm).

### 2. 5. Data Analysis

Data obtained from observations of the edible films (thickness, tensile strength, percent elongation (elongation) and transparency) have been analyzed quantitatively.

## 3. RESULTS AND DISCUSSION

### 3. 1. Recapitulation of the Research Results

Recapitulation of the results of research on the production of edible films from seaweed flour with different types of plasticizers, with the observed parameters, namely thickness characterization, tensile strength, elongation, and transparency of edible films can be seen in Table 1. Based on Table 1, it can be seen the highest thickness in the test results in treatment end of the addition of 1.2% glycerol plasticizer with a value of 0.039 mm, and the lowest is in the treatment addition of 0.5% sorbitol plasticizer with a value of 0.027 mm.

The tensile strength test results were obtained at the highest value in the treatment of the addition of 0.5% glycerol plasticizer with a value of 7.51 MPa, and the lowest value found in the treatment of the addition 0.5% sorbitol plasticizer was 4.62 MPa. The percent elongation test was obtained with the highest value in the treatment of the addition of 1.2% sorbitol plasticizer with a value of 65%, and in the treatment of the addition of 0.5% sorbitol plasticizer the value of 8.3% was obtained as the lowest value of all treatments. The transparency value obtained from the test results with the highest value was found in the treatment of the addition of 1.2% glycerol plasticizer with a value of 74.49%, and the lowest value was found in the 0.5% glycerol plasticizer treatment with a value of 64.02%

**Table 1.** Results of the Recapitulation of Edible Film Tests.

| Treatments | | Nilai Rata-rata Ulangan *Edible Film* | | | |
|---|---|---|---|---|---|
| | | Thickness (mm) | Tensile Strength (MPa) | Percent Elongation (%) | Transparency (%) |
| *Japanese Industrial Standard* | | Max. 0.25 (mm) | Min. 3.92 (MPa) | 10 to 50% | - |
| A | T: 1.5g, S:0.5% | 0.027 | 4.62 | 8.3 | 65.23 |
| B | T: 1.5g, S:1.2% | 0.031 | 5.27 | 65.0 | 67.51 |
| C | T: 1.5g, G:0.5% | 0.029 | 7.51 | 18.3 | 64.02 |
| D | T: 1.5g, G:1.2% | 0.039 | 5.81 | 86.7 | 74.49 |

Description: T: Seaweed Flour, S: Sorbitol, G: Glycerol

### 3. 2. Thickness of Edible Film

Characterization is an important factor that determines feasibility as a packaging product in the edible film. This thickness characterization can affect the physical and mechanical properties of edible films. The thicker the surface of the edible film, the better it will be in protecting the packaged food products. This is in accordance with Agustina (2018) which states that thick edible film can provide a better protection for the food products it packs.

The thickness of the edible film is also influenced by the composition of materials and molds used when making edible films. The composition of the treated material produced a quantity of 70 ml of solids from 100 ml of the number of solids poured into a plastic mold with a mold length of 26.7 cm and a width of 18 cm. Thickness testing in this research was carried out using a digital screw micrometer that was tested on five edible film surface points and the results were averaged. This is in accordance with Supeni *et al*. (2015), the value of edible film thickness was determined from the average taken of the five measurement sites.

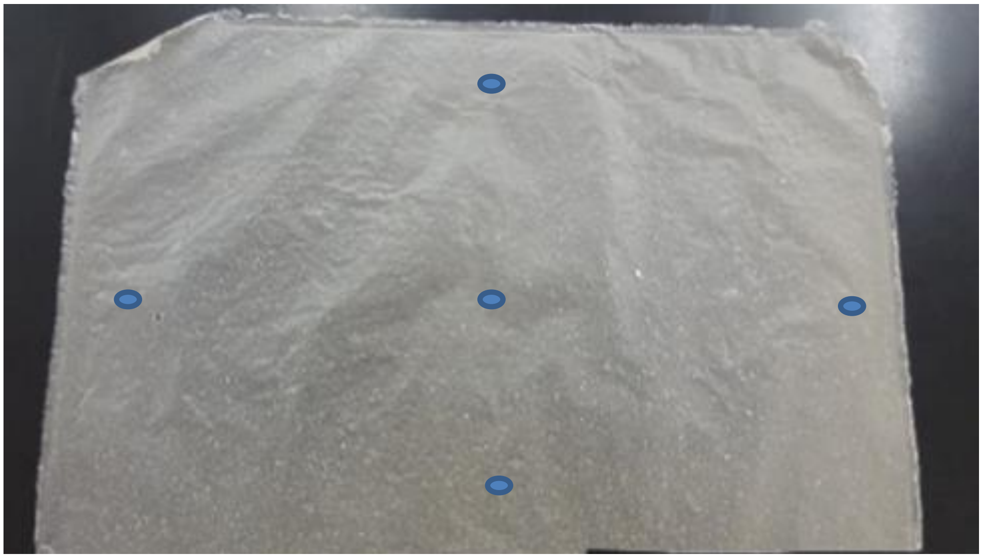

**Figure 2.** Edible film

Description: are points of thickness measured.


**Figure 3.** Edible Film Thickness Chart

The thickness of the edible film is also influenced by the composition of materials and molds used when making edible films. The composition of the treated material produced a quantity of 70 ml solids from 100 ml of the number of solids poured into a plastic mold with a mold length of 26.7 cm and a width of 18 cm. Thickness testing in this research was carried out using a digital screw micrometer. It was tested in five edible film surface points and the results were averaged. This is in accordance with Supeni *et al*. (2015), the value of edible film thickness was determined from the average of the five measurement sites.

Based on Figure 3 it can be seen that the difference in the addition of concentration and type of plasticizer influences the thickness of the edible film. The addition of 1.2% glycerol plasticizer has a higher value of 0.029 mm compared to the value of 1.2% sorbitol plasticizer used, with a value of 0.027 mm. This is because of the properties of sorbitol; this substance is not easily soluble in water, whereas glycerol has the opposite properties to sorbitol: it is easily soluble in water and can increase the viscosity of the solution. The thickness of edible film, based on the results of research that has been done, is a good thickness if used as packaging for food products such as milk candy even though the thickness value does not meet the standards of the Japanese Industrial Standard, namely max. 0.25 mm.

### 3. 2. Tensile Strength of Edible Film

The edible film's tensile strength is influenced by the composition of the material in the solution and the thickness of the edible film. The higher tensile strength indicates that edible film can withstand pressure well and is not easily brittle. This is in accordance with Saputro *et al*. (2017), edible films that have a high tensile strength value indicate that the strength in holding pressure is getting better.

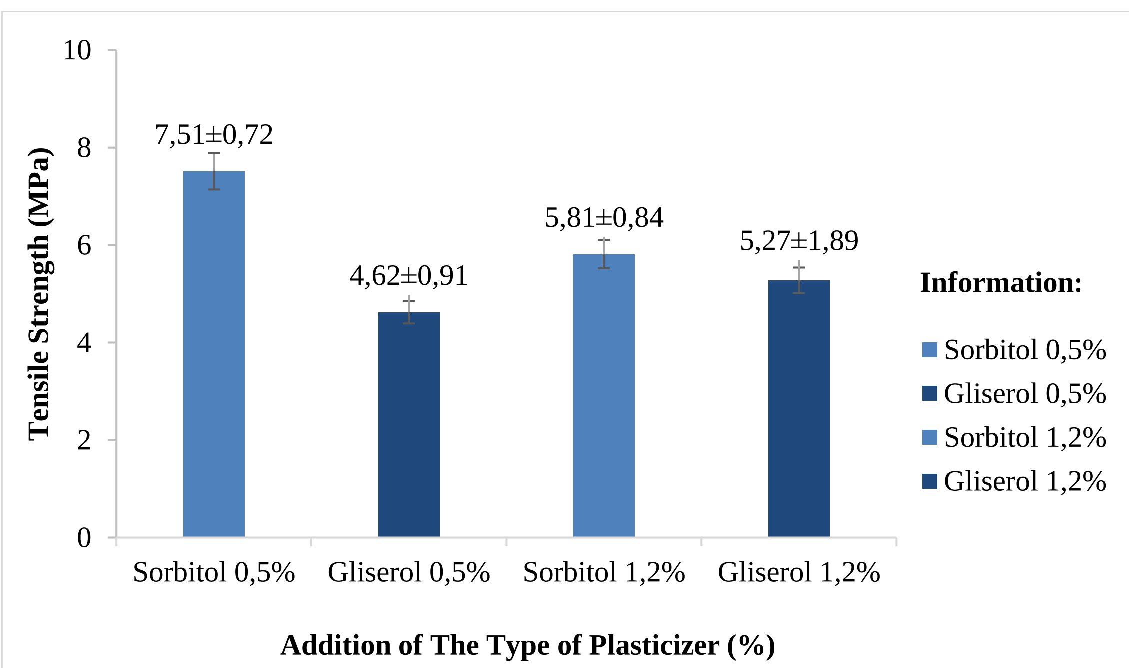


**Figure 4.** Edible Film Tensile Strength Chart

Based on Figure 4 it can be seen that the difference in addition to concentration and type of plasticizer influences the tensile strength of the edible film. The addition of 0.5% sorbitol plasticizer has a higher value of 7.51 MPa compared to 1.2% glycerol plasticizer with a value of 5.27 MPa. This is because sorbitol can trace film stiffness from reducing the energy needed by molecules in edible film solutions. Glycerol is lower in tensile strength than sorbitol due to inter-hydrocolloid interactions in hydrogen bonds which interfere with increasingly elastic molecular motion.

### 3. 3. Percent Elongation of Edible Film

Percent elongation is a measurement of the length of the film material from the initial length of the film until after the film is pulled off. Percentage characterization (elongation) is related to tensile strength and testing together with using the same tool, namely Digital Univeral Testing Machine Auto Strain brand Instron. However, the percentage elongation is inversely proportional to the tensile strength value, so if the elongation value is higher, the value of tensile strength is lower.

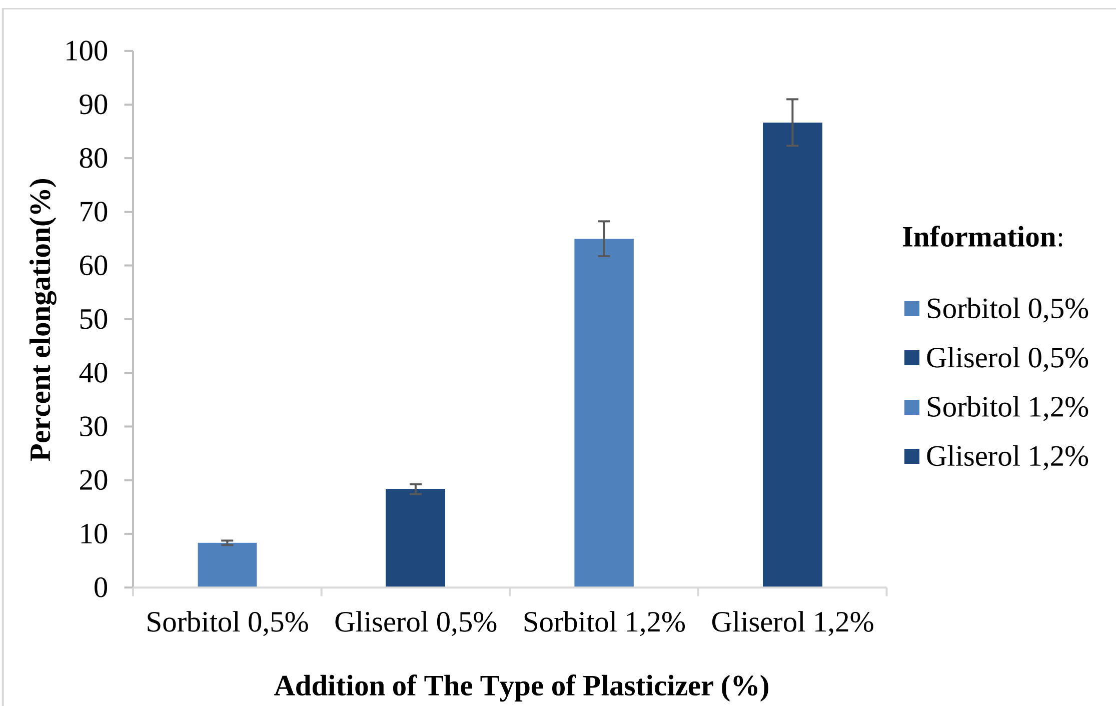


**Figure 5.** Edible Film Percent Elongation Chart

Based on Figure 5 it can be seen that the difference in the addition of concentration and type of plasticizer can affect the percentage of elongation of edible film. The addition of 1.2% glycerol plasticizer results in a higher value of 86.7% compared to the value of 1.2% sorbitol plasticizer, with a value of 65%. This is due to the influence of film thickness and different types of plasticizers. A low percentage (elongation) can cause edible films to break easily. Carrageenan contained in seaweed flour solution also affects the percentage elongation of the edible film. This is in accordance with Supeni (2012), an edible film which is more elastic and the percentage level of elongation is higher due to the interaction between carrageenan molecules.

### 3. 5. Transparency of Edible Film

Transparency is a picture of the clarity of a standard edible film material that is used usually, the standard used is the clarity of aquades which has a transparency value of 0.0683. The results of the transparency test can be seen in Figure 6.

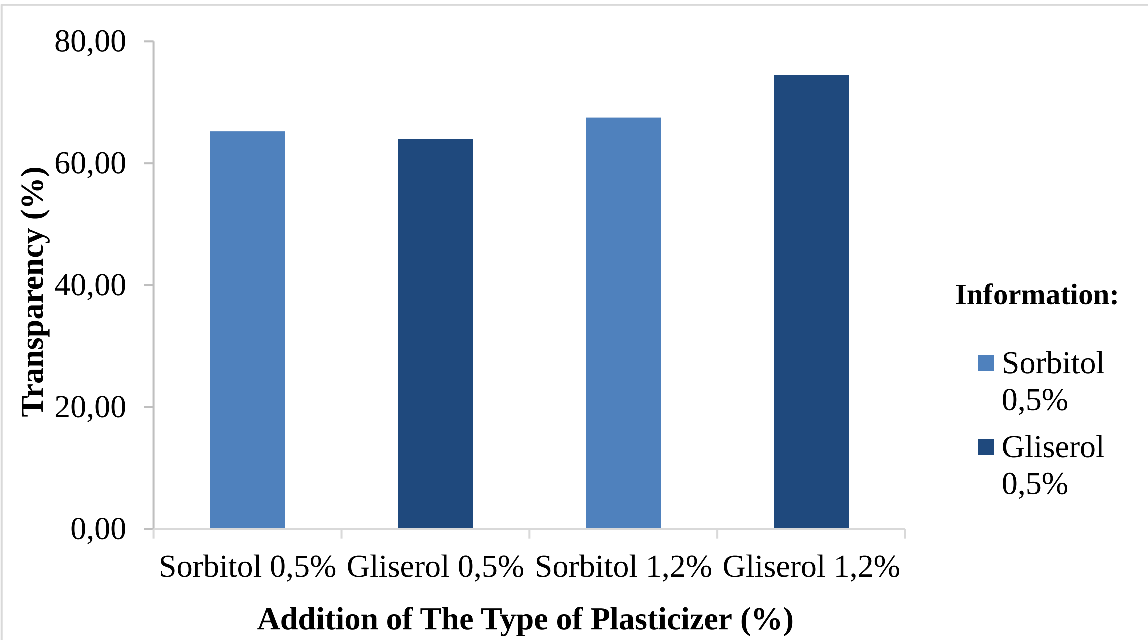


**Figure 6.** Edible Film Transparency Chart

Based on Figure 6 it can be seen that the difference in the addition of concentration and type of plasticizer influences the transparency value of an edible film. The addition of 1.2% glycerol plasticizer has a higher value of 74.49% compared to the value of 1.2% sorbitol plasticizer, with a value of 65.23%. This is due to the influence of film thickness and different types of plasticizers. Warkoyo *et al*. (2014) stated that the degree of clarity decreased due to increased material concentration and high film thickness.

The transparency value of edible film, based on the results of research that has been done. has a good clarity when used as the food product packaging because the absorbance value meets aquades (0.0683) standard which is a clarity standard, while the clarity value is around 0.95-1.00.

## 4. CONCLUSIONS

Based on the results of research performed, it can be concluded that edible film is the best in case of the treatment with the addition of 0.5% glycerol plasticizer, as seen from the tensile strength parameters, and the elongation of edible films that have an average value fulfilling the standard JIS (Japanese Industrial Standard); for each parameter the tensile strength value is 7.51 MPa, the percent value of elongation is 18.3%, while the transparency value is 64.02% and the thickness value is 0.029 mm, which does not meet the standards of JIS (Japanese Industrial Standard) that is 0.25 mm.

## References


[1] Maher Z. Elsabee, Entsar S. Abdou. Chitosan based edible films and coatings: A review. *Materials Science and Engineering: C* Volume 33, Issue 4, 1 May 2013, Pages 1819-184

[2] Mochamad R. Ismail, M. Wahyudin Lewaru, Donny J. Prihadi, Microplastics Ingestion by Fish in The Pangandaran Bay, Indonesia. *World News of Natural Sciences* 23 (2019) 173-181

[3] Muthukumarasamy Thillaivasan, Kaliyamoorthy Kumar, Kathiresan Silvakumar, Seasonal variation in elemental composition of certain seaweeds from Mandapam and Kilakarai coast, Gulf of Mannar biosphere reserve**.** *World Scientific News* 129 (2019) 147-160

[4] Carmen A. Campos, Lía N. Gerschenson, Silvia K. Flores. Development of Edible Films and Coatings with Antimicrobial Activity. *Food and Bioprocess Technology* August 2011, Volume 4, Issue 6, pp 849–875

[5] Bao, S., S. Xu, and Z. Wang. 2009. Antioxidant activity and properties of gelatin films incorporated with tea polyphenol-loaded chitosan nanoparticles. *Journal of the Science of Food and Agriculture* 89 (15): 2692-2700

[6] Adnan, H. & Porse, H. (1987). Culture of Eucheuma cottonii and Eucheuma spinosum in Indonesia. *Hydrobiologia* 151/152: 355-358

[7] Nurindra. P., A. Alamsjah. M., A. and Sudarno. 2015. Characterization of Edible Films from Lindur Mangrove Propagule Starch (Bruguiera gymnorrhiza) with Addition of Carboxymethyl Cellulose (CMC) as Plasticizer. *Fisheries and Marine Scientific Journal* 7 (2): 125-132

[8] Son, D., A. et al. 2017. Addition of Sorbitol as Plasticizer in the Manufacture of Edible Film Pati Breadfruit. *Student Online Journal* 4 (2): 1-15

[9] Saputro, B., W., Nurcahya, E. Susanto, E. 2017. Characteristics of Edible Films from Mixed Semirefined Carrageenan Flour by Adding Tapioca Starch and Glycerol. *Journal of Fishery Products Processing and Biotechnology* 6 (2): 1-6

[10] Tarun Pal Singh, Manish Kumar Chatli, and Jhari Sahoo. Development of chitosan based edible films: process optimization using response surface methodology. *J Food Sci Technol.* 2015 May; 52(5): 2530–2543. doi: 10.1007/s13197-014-1318-6

[11] Abdulaal Farhan, Norziah Mohd Hani. Characterization of edible packaging films based on semi-refined kappa-carrageenan plasticized with glycerol and sorbitol. Food Hydrocolloids 01 Mar 2017, 64: 48-58. DOI: 10.1016/j.foodhyd.2016.10.034

[12] Supeni, G. 2012. Effect of Edible Films from Carrageenan on Mechanical and Barrier Properties. *Chemical Packaging Journal* 34 (2): 281-285

[13] Supeni, G., Cahyaningtyas, A. A., Fitiriana, A. 2015. Characterization of Physical and Mechanical Properties of Chitosan Addition in Modified Edible Carrageenan and Tapioca Films. *Chemical Packaging Journal* 37 (2): 103-110

[14] Warkoyo. Rahardjo, B. Marseno, Dj., W. and Karyadi, J., N., W. 2014. Physical Properties of the Mechanical and Barrier Edible Film Based on Starch Bulbs (Xanthosoma sagittifolium) which are Incorporated with Potassium Sorbate. *Journal of Agrotechnology* 34 (1): 72-81

[15] Patricia Cazón, Gonzalo Velazquez, José A. Ramírez, Manuel Vázquez. Polysaccharide-based films and coatings for food packaging: A review. *Food Hydrocolloids* Volume 68, July 2017, Pages 136-148. https://doi.org/10.1016/j.foodhyd.2016.09.009

[16] Jinping Lai, Lidya Abune, Nan Zhao and Yong Wang, Programmed Degradation of Hydrogels with a Double-Locked Domain, *Angewandte Chemie*, 131, 9, (2846-2851), (2019).

[17] Jinping Lai, Lidya Abune, Nan Zhao and Yong Wang, Programmed Degradation of Hydrogels with a Double-Locked Domain, *Angewandte Chemie International Edition*, 58, 9, (2820-2825), (2019).

[18] Yong Lv, Ci Song, Qiuqian Xu and Yusheng Yu, Preparation of a Surface Sizing Agent of Dialdehyde Chitosan/Cationic Starch and Barrier Property, Advances in Graphic Communication, Printing and Packaging, 10.1007/978-981-13-3663-8_95, (704-709), (2019).

[19] Adriane Cherpinski, Sergio Torres-Giner, Luis Cabedo, Jose Alberto Méndez and Jose M. Lagaron, Multilayer structures based on annealed electrospun biopolymer coatings of interest in water and aroma barrier fiber-based food packaging applications, *Journal of Applied Polymer Science*, 135, 24, (2017).

[20] Leire Urbina, María Ángeles Corcuera, Arantxa Eceiza and Aloña Retegi, Stiff all-bacterial cellulose nanopaper with enhanced mechanical and barrier properties, *Materials Letters*, 10.1016/j.matlet.2019.03.005, (2019).