The Effect of Addition Glycerol Against Nori Characterization from *Gracilaria* sp and *Ulva* sp Seaweeds

E Sinurat¹, D Fransiska¹ and Livia²

¹ Balai Besar Riset Pengolahan Produk dan Bioteknologi Kelautan dan Perikanan, Jakarta, Indonesia
² Department of Food Science, Faculty of Agriculture, Sahid of University, Jakarta, Indonesia

E-mail: ellya_sinurat@yahoo.com

**Abstract.** Nori is an edible seaweed product and is known to form a sheet. This study involves the production of nori, from a mixture of Gracilaria and Ulva Lactuca seaweeds, at a ratio of 1:1. Besides, glycerol was adopted as a plasticizing biopolymer for food packaging materials. This study, therefore, aims to evaluate the characteristics of nori, following the addition of glycerol concentration (0.4; 0.6; 0.8; 1.0 percent) as a plasticizer on the nori/edible seaweed. The parameters evaluated include elongation percentage, tensile strength, WVTR, thickness, and water content. Moreover, treatments with 0.8 percent glycerol concentration generated edible seaweed films with the following characteristics: elongation percentage of 12.15%, while the tensile strength, WVTR, thickness, and water content were 2.67 M.Pa, 2268 gr/m² day, 328.93 μm, and 12.75 %, respectively.

1. **Introduction**

Seaweeds are macromolecules that are used in the food as thickener, glazing agents, and gelling agent [1]. Seaweed as form sheet (nori) using for wrapping sushi [2]. Commercially roasted nori sheets are produced at packaging factories [3]. Nori is prepared from dried *Porphyra* sp. seaweed with high nutrients. *Porphyra* sp. is cultivated and harvested from a sea-farm, cleaned with water, cut into small pieces, formed into a sheet using a nori mat, and dried [4]. *Porphyra* sp. is grown in subtropics such as in Japan, Korea, and China, where all the cultured algal products are produced [5]. The added demand for nori is caused principally in the food market segment every year.

*Porphyra* growth and the cultivation of the most successful, but only on the development of the East Asian subtropical climates [6]. Because of the high market demand of nori, an alternative source of nori from other seaweed outside *Porphyra* which has similar properties and functions as edible packaging such as *Gracilaria* sp, *Eucheuma cottonii*, *Ulva* sp. [7].

Researchers have been studying biopolymers as one of the ways to conventional (petroleum) food packaging regarding their film-formation properties to produce biodegradable and edible films and coatings for food packaging [8]. Edible films and coatings usually use polysaccharides, proteins, and lipids [9]. These hydrocolloids provide the structural backbone of the edible films [10]. They also provide food-grade plasticizers such as glycerol, sorbitol, or polyethylene glycol are added to improve film flexibility. This research aimed to evaluate the characteristic of nori from mixture *Gracilaria* sp. and *Ulva lactuca* seaweeds with the addition of glycerol concentration (0.4; 0.6; 0.8; 1.0%) as a plasticizer on the nori/edible seaweed.
2. Materials and Methods

2.1. Preparation of Seaweeds

Fresh *Gracilaria* sp. was collected from Brebes, Center Java, Indonesia. While *Ulva lactuca* was collected from Binuangun, Banten. Fresh seaweed was under running seawater, then rinsed and gently cleaned again with distilled water then kept in a cool room before using. The ingredients seasons were salt, sesame oil, oil, oyster sauce, white rice vinegar, commercial nori was purchased from a local market.

2.2. Methods of making nori

The procedure for making Nori from *Gracilaria sp.* and *Ulva lactuca* was modified in Teddy 2009 [11], as follows in Figure 1.

![Figure 1. The flow chart of making nori](image)

2.3. Characterization of nori

The moisture content of nori is determined by gravimetry. Then the moisture content was calculated by subtracting the final weight from the initial weight of the sample [12]. The WVTR of three bag materials were determined using the wet cup method described by ASTM E96/E96M-16 [13]. Mechanical properties of nori are tensile strength and percentage of elongation at the break were measured by a tensile test using a Gotech AI-7000 -2kN testing machine 95T. The standard used for tensile testing was ASTM D882-12 (ASTM D882 - 12, 2012). All samples were conditioned speed 5mm/min at 60 ± 5%
relative humidity, grip test 50 mm, and 23.6 °C. Tensile tests were repeated five times for each sample [14]. Preparation and measurement of nori film were conducted according to Yadav et al. (2018) [15].

3. Results and Discussion

3.1. Moisture content

Moisture content is very important for product processing and handling in the food industry. The moisture content of nori commercial (9.73%) was found to be lower than the nori analog containing glycerol 0.4%, 0.6%, and 0.8% (Figure 2). The increase of glycerol concentration contributes to the addition of moisture content of nori. The increase in the moisture content of nori could be attributed to the hydrophilic nature of glycerol.

3.2. Water vapor transmission rate (WVTR)

Controlling moisture migration is vital for retaining packaging quality. The initial and critical moisture contents of food and the humidity gradient between the inside and the outside of the package, the shelf life of the product could be predicted to a fair degree by conducting the WVTR sample [16]. The WVTR of the packaging material is usually determined by the course method. The sheet nori containing glycerol (2,643.65 g/m²/day) showed the highest water vapor transmission for all treatments including commercial nori (Figure 3). This indication can be explained by the upgrade of intermolecular forces of attraction between the polymer chains because of the increase of plasticizer concentration. The effect was observed in our nori analog at a glycerol concentration of 0.8%. Process of making nori analog with a press manual maybe the intermolecular, not homogenous. The permeability of the tested bag materials is affected by environmental conditions and treatments. The results showed that the increase in glycerol will increase the value of WVTR. This is due to the tendency of glycerol to modify the polymer structure which causes its density to decrease, then causes water molecules to diffuse more easily and gives a higher WVTR [17].

![Figure 2. Moisture Content of Nori with Various Glycerol Concentration](image-url)
3.3. **Tensile strength (TS) and Percentage elongation**

Edible films must have high TS to be used as food packaging. This parameter is important to protect food during handling, transportation, and marketing [18]. TS and percent elongation increased with the addition of plasticizer glycerol concentration (Figure 4), but after additional concentration, 1.0% glycerol tended to decrease. The result in this study was also observed by Venugopal (2011) that the addition of glycerol in edible film production can reduce TS due to a decrease in the interaction between water molecules and agar [19]. The decrease in TS with the increase in plasticizer concentration has also been reported in other studies [18][20]. The percent is the ability of the nori to extend before breaking. It describes the nature of the nori plasticity. To maintain the ability of the material to protect food products, high elasticity is required [21]. The increase in elongation and flexibility of nori was due to reduced interactions between polymer chain molecules, this occurred from increasing the plasticizer up to glycerol concentration 10% [22][23]. The same phenomenon percent elongation with TS, after addition glycerol 1.0% the percentage of elongation to decrease.

![Figure 3. Water vapor transmission rate of Nori with Various Glycerol Concentration](image)

![Figure 4. Tensile strength and percentage of elongation of nori with various glycerol concentration](image)
3.4. Thickness

Thickness describes the feasibility of edible films as packaging materials for meal products. It affects other film characteristics, such as percent elongation, gas transmission rate (GTR), tensile strength, and vapor transmission. The GTR is reverse to characteristic of the thickness. The thickness of the sample is dependent on both the material of the sample and step processing conditions [24]. The commercial nori sheet had 163.2 µm thick, the thinnest compared to all treatments. The addition of glycerol increased the thickness of the film. Similar results are also observed in other studies [25]. Krochta (1994) reported that the film thickness correlated to the number of three-dimensional networks that are formed [26].

![Figure 5. The Thickness of Nori with Various Glycerol Concentration](image)

4. Conclusion

Glycerol concentration affected the physical and mechanical properties of nori. Increasing concentrations of tensile strength, percentage elongation, and thickness, however after addition glycerol were 1% to decrease. The optimum glycerol concentration in this study was 0.8% to get the best TS, percent elongation, and thickness.

References

[1] Debeaufort F 2014 Hydrocolloids as edible or active packaging materials. In Gums and Stabilisers for the Food Industry (17): 271-286
[2] McHugh T 2015 Producing Edible Films. Food Technology, 69(4), 120-122.
[3] Levine I A, & Sahoo D 2009 Porphyra: harvesting gold from the sea. IK International Pvt Ltd.
[4] Bito, Teng, T F & Watanabe, F 2017 Bioactive compounds of edible purple laver Porphyra sp. (Nori). Journal of agricultural and food chemistry, 65(49): 10685-10692
[5] Blouin NA, Brodie JA, Grossman AC, Xu P Brawley SH 2011 Porphyra: a marine crop shaped by stress. Trends Plant Sci. 16: 29–37.
[6] Susyiana E 2014 Nori sheet imitation in form edible film with materials of protein myofibrillar tilapia. Jurnal Pengolahan Hasil Perikanan Indonesia, 17(3):262-279.
[7] Aguirre J A, De Leon ZMA, Alvarez PB, Torres L C, Nieto D E, Ventura J M, & Aguilar CN 2018 Basic and applied concepts of edible packaging for foods. In Food packaging and preservation Academic Press (p 61).
[8] Azeredo H M, Mattoso H C, Wood D, Williams T G, Avena R J, & McHugh TH 2009 Nanocomposite edible films from mango puree reinforced with cellulose nanofibers. *Journal of food science*, 74(5): N31-N35.

[9] Espitia J P, Du W X, Avena D J, Soares D F, Mc Hugh T H 2014 Optimal antimicrobial formulation and physical–mechanical properties of edible films based on Açai and pectin for food preservation. *Food Hydrocoll*. 35 287.

[10] Praseptiangga D 2017 Development of seaweed-based biopolymers for edible films and lectins. In *International Conference on Food Science and Engineering* p.012003-1

[11] Teddy M 2009 Pembuatan Nori Secara Tradisional dari Rumput Laut Jenis Glacilaria sp. *Thesis* (IPB, Bogor: Fakultas Perikanan dan Ilmu Kelautan)

[12] ASTM E96/E96M - 16 2016 Standard test methods for water vapor transmission of materials: ASTM International, West Conshohocken, PA, USA.

[13] ASTM D882 -12-2012 Standard Test Method for Tensile Properties of Thin Plastic Sheeting. In American Society for Testing and Materials.

[14] ASTM d6988-03-2004 Standard guide for determination of thickness of plastic film test specimens. astm international. DOI: 10.1520/d6988- 03

[15] ASTM d6988-03 2004 Standard guide for determination of thickness of plastic film test specimens. astm international. DOI: 10.1520/d6988- 03.

[16] Rangana S 1999 Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill Education, p: 450-475

[17] Khazaei N, Esmaili M, Djomeh Z E, Ghasemlou M, & Jouki M 2014 Characterization of new biodegradable edible film made from basil seed (*Ocimum basilicum* L.) gum. *Carbohydrate Polymers*, 102: 199‒206.

[18] Rusli A 2017 Physical and mechanical properties of agar based edible film with glycerol plasticizer. *International Food Research Journal* 23(4): 1669-1675

[19] Venugopal V 2011 Marine Polysaccharides: Food Applications. *Boca Raton*: CRC Press

[20] Saremnezhad S, Azizi M H, Barzegar M, Abbasi S and Ahmadi E 2011 Properties of a new edible film made of faba bean protein isolate. *Journal of Agriculture Science and Technology* 13: 181-192

[21] Galus S, and Lenart A 2013 Development and characterization of composite edible films based on sodium alginate and pectin. *Journal of Food Engineering* 115: 459-465

[22] Zhong Q P, and Xia W S 2008 Physicochemical properties of edible and preservative films from chitosan/cassava starch/gelatin blend plasticized with glycerol. *Food Technology and Biotechnology* 46(3): 262-269

[23] Katili S, Harsunu B T, and Irawan S 2013 Effect of plasticizer concentration of glycerol and chitosan compositions in the solvent on the physical properties of chitosan edible film. *Jurnal Teknologi* 6(1): 29-38

[24] Arham R, Mulyati M T, Metusalach M, Salengke S 2016 Physical and mechanical properties of agar based edible film with glycerol plasticizer. *International Food Research Journal*, 23(4): 1669-1675

[25] Upasana Y U, Pushparaj A, Anchal A, & Verma Y Effect of Carom Seed Oil on the Antimicrobial, Physicochemical and Mechanical Properties of Starch Based Edible Film. *International Journal of Environment, Agriculture and Biotechnology*, 3(4): 1258-1263

[26] Krochta 1994 Edible Coating and Film to Improve Food Quality; CRC Press: New York.