Edible straw formulation from caragenant and gelatin as a solution in reducing plastic waste

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Abstract. This study has been undertaken to determine the effect of bioplastic formulations of carrageenan and gelatin on the manufacture of edible straws with water resistance. The research design used was 2 factorial complete random designs (RAL). Edible straws with 20% gelatin addition formulation have the best water resistance value of 65.18%. Based on these results it shows that there is a correlation between the gelatin added and the temperature used in the use of edible straws. Bioplastic formulations can be used as edible straws with the best formulation of carrageenan 3 grams with the addition of 20% gelatin which can be applied to 4°C cold drinks and is best applied to drinks at 25°C.

1. Introduction
Indonesia is in the second position in the world as the largest contributor of plastic waste in the ocean. 1.29 million metric tons of Indonesian plastic waste end up in the ocean each year [1]. Disposable plastic products that contribute to marine pollution are plastic straws. Plastic straw is a tube that is intended to transfer drinks from the container to the drinker's mouth, with the application of the sucking force based on disposable plastic. Plastic straws are widely used because of their high availability and low prices [2]. The basic ingredients of plastic straws are polypropylene and polystyrene that difficult to decompose by microorganisms because the carbon element forms a complex and long chemical chain [2]. Edible straws are diversified straws with flexible, lightweight, translucent, easily shaped, waterproof, impact resistant, safe to eat characteristics. Bioplastics consist of several components that can be used as edible straws. Polysaccharides are hydrocolloid sources which are the main ingredients for bioplastics. This material has complex structure and tends to have less mechanical properties than the use of hidokoloid protein [3]. Polysaccharides that are widely used as bioplastic's main ingredients are starch, cellulose and carrageenan. Carrageenan has a high gel strength of around 600-700 g/cm² and abundant availability [3]. Carrageenan has hydrophilic properties so it has the ability to bind large amounts of water [4]. Carrageenan has hydrophilic properties so it has the ability to bind large amounts of water. Gelatin is a product of the partial hydrolysis of collagen derived from bone, skin and connective tissue of animals. Gelatin contains very high protein and low fat content [5]. The addition of gelatin in carrageenan will produce a matrix consisting of gelatin-carrageenan gel complex. The addition of gelatin in carrageenan will produce a matrix consisting of gelatin-carrageenan gel complex [6].
2. Material and methods

2.1. Instrumentation
Kappa carrageenan used were obtained from PT Kappa Karagenan Nusantara, Pasuruan. Food coloring used produced by PT. Anggana Catur Prima and pure gelatin from Rousselot Gelatin Co., Ltd.

2.2. Statistics
The design used in this study was a Factorial Complete Randomized Design (CRD) with 4 treatments and 5 replications obtained 20 research units with different test temperatures namely 4°C, 25°C, and 80°C. The research flow chart can be seen in Figure 4. The repetition process in this study was carried out randomly. Randomization in research aims to provide equal opportunities in each unit of research and to avoid and/or minimize bias in the experiment.

2.3. Methods
The initial stage carrageenan is weighed as much as 3, 2.925, 2.85, 2.775 and 2.7 grams using analytical scales with the accuracy of 0.01 mg according to treatment. Furthermore, gelatin was weighed as much as 0.075, 0.15, 0.225 and 0.3 grams using the same scale. The next process is mixing ingredients. 250 ml glass beaker containing 100 ml distilled water with a room temperature of 25-30°C dissolved in carrageenan and stirred using a stirring rod. This process is followed by homogenation of the solution for 15 minutes using a magnetic stirrer.

3. Result and discussion
The addition of gelatin to the edible straw formulation influences the resistance of the water produced. The best results from the water resistance test were 65.18% at 25°C, 93.66% at 4°C and 293.96% at 80°C hot water. In accordance with Japanese Industry Standards for water resistance to bioplastics ≤ 70%. edible straws with 20% gelatin addition formulation has the best water resistance value of 65.18%. The lowest average value in the water resistance test was obtained in the P0 formulation with a test temperature of 80 °C that is (700.00 ± 70.43)% while the highest average value was obtained from the P4 formulation in the room temperature swelling test which was as many as (65.19 ± 9.96)%. Two Way Analysis of Variance (ANOVA) statistical test results showed that there were significant differences from the treatment of gelatin addition, the use of different test temperatures, and the interaction of both of them in edible straw formulations (P <0.05). This shows that the addition of gelatin and the use of different temperatures significantly affect the quality of water resistance produced by edible straws. The correlation graph or the relationship between the effect of the formulation on the results of water resistance test on edible straws in 3 different test temperatures can be seen in Fig 1.
Water resistance test (swelling test) is carried out to determine the occurrence of bonding in a polymer that is determined through the percentage of weight gain of the polymer after experiencing inflation. Water resistance testing is the main parameter in testing edible straw products. This is to determine the process of diffusion of solvent molecules (drinks) into a polymer (edible straw) which will produce a bulging gel directly proportional to the addition of weight to the polymer [7]. Bioplastic’s resistance to water is determined by swelling tests, which is the percentage of bioplastic bubbles caused by water. Edible straw water resistance test correlated with the results of bioplastic research that has been developed at this time. Based on the Japanese Industrial Standards (JIS) the value of bioplastic swelling material has a maximum value of ≤ 70%. According to Coniwanti et al. [8], the lower the swelling value, the better the plastic properties, while the higher the swelling, the bioplastic will be easily damaged [8]. This means that the water absorption process is the smallest and the resistance to water is large. Whereas the formulation without the addition of gelatin produces the greatest swelling value reaching 185% at 25ºC, 480% at 4ºC cold temperatures, and 700% at 80ºC water application. The greater the concentration of carrageenan, the greater the value of water absorption because carrageenan has more hydroxyl (OH) groups so it tends to absorb more water [9]. In addition, carrageenan contains sulfate esters which are also hydrophilic [10]. In the sulfate ester group there is sulfite (SO3-) which can bind to water.

4. Conclusion

Based on the results of the research conducted, it was concluded that there was an influence on the addition of gelatin and the temperature applied to making edible straws. Bioplastic formulations can be used as edible straws with the best formulation of carrageenan 3 grams with the addition of 20% gelatin which can be applied to 4ºC cold drinks and is best applied to drinks at 25ºC.

5. References

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