Determination of Shelf Life with Accelerated Shelf Life Testing (ASLT) in Beverage Seaweed

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***Abstract*—In this research has been made beverage seaweed from main ingredient of red seaweed type Eucheuma cottonii with added other food ingredients that serve to improve the taste. In addition to labeling and commercially produced, it is necessary to determine the shelf life in seaweed beverage. Determination of shelf life of beverage seaweed was done by Accelerated Shelf Life Testing (ASLT) method. Beverage seaweed studied there are two flavors of original taste and green tea. Based on parameters of pH value, shelf life of original taste is 17 days and the taste of green tea is 34 days. The result is for storage at room temperature 30 °C.**

***Keywords*—Beverage seaweed, ASLT, Eucheuma Cottonii, Shelf Life.**

I. Introduction

Surabaya is one of the metropolis that has a variety of social culture. Surabaya is also known as a city that has the largest localization point in Southeast Asia, which is known as Gang Dolly. Localization Gang Dolly scattered in several places, among others Putat Jaya, Distance, Bangunsari, Kremil-Tambak Asri, and Moroseneng-Klakah Rejo. The main factor behind the development of this localization is the absence of other special abilities and low educational background. So it supports the development of prostitution activities. Prostitution activities are chosen to keep jobs and support survival [1]. Prostitution-oriented activity in the economy, looks pimps view prostitution activities and activities is a granary finance that is expected to be achieved [2]. Therefore, people in the Dolly area become easy-minded and rarely pay attention to other things like education, the environment, and even diet that can result in health.

On June 19, 2104, the Mayor of Surabaya, Dr. Ir. Tri Rismaharini, M.T closed the localization area. Before this politician was made, he also made a politician that every prostitution activity in Dolly area would be given money worth Rp. 3,000,000 for capital to create new business and social minister also provide capital worth Rp. 4,200,000. But this effort did not work. To overcome this problem, some assistance from several academic and community organizations are made in the field of socio-cultural perspective, such as assistance in establishing a new education, conducting routine religious activities, community services, and economic perspective such as dolly development as a recreation center, mass media focusing on children and women [1]. None of these settlements have conducted food-related training. While the Dolly community some make the business in the field of food, among others, snack samiler "Samijali", tempe "Tempe Bang Jarwo", milk sticks and banana chips "KSM Kawan Kami", soybean milk "SME Pujaa", juice "Aneka Rasa" beverage packaging "Cool Yes" and seaweed "Orumy". Beverage seaweed "Orumy" made by UMKM INOKAM (Innovative Kampung Mandiri) Jalan Putat Jaya Gang III A RT. 03 RW. III Kec. Sawahan, Surabaya.

Food business is an activity or process of producing, preparing, processing, making, preserving, packing, repackaging, or changing the form of food. Food is a basic human need. Development of nutritious food can be done by utilizing the natural resources of the sea, including seaweed. Utilization and development of seaweed is strongly supported by the condition of Indonesian waters. Approximately 70% of Indonesia's territory consists of a rich sea with various types of biological resources [3]. As an archipelagic country with 17,504 islands, Indonesia has a long coastline of 81,000 km indicating that Indonesia has enormous potential for seaweed cultivation and development [4]. The potential area of seaweed cultivation is currently recorded 1.1 million ha or 9% of the total area of potential marine aquaculture of 12,123,383 ha. In 2015 seaweed production of 11.68 million tons [5].

Seaweeds grow and spread throughout the waters of Indonesia, and become one of the important sea commodities and high economic value. Seaweed is one of the leading commodity exports. Most of the seaweed products are exported as dried seaweed or processed [4]. Seaweed is widely used in food and non-food industries such as cosmetic, pharmaceutical, fertilizer and textile industries [3]. The benefits of seaweed as a food have long been known. Research on seaweed as a food that can be used for alternative therapies. Seaweed has therapeutic properties for health and disease management, such as anticancer, antiobesity, antidiabetic, antihypertensive, antihidperlipidemia, antioxidant, anticoagulant, antiinflammatory, immunomodulator, antiestrogenic, thyroid stimulating, neuroprotective, antiviral, antifungal, antibacterial, and in vivo tissue healing. Active compounds in seaweeds include sulfated polysaccharides, florotanin, carotenoids (eg fucoxanthin), minerals, peptides, and sulfolipids, with proven benefits against degenerative metabolic diseases [6], [7].

Seaweed is an excellent source of polysaccharides with relatively high protein content, essential amino acids,

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essential fats, minerals, and vitamins [8][9]. But like most flora, its nutritional content is influenced by external factors such as geographic location, environment, season, and condition [7]. The type of seaweed that is owned by Indonesia is 555 types of seaweed. Seaweed production of the largest type of commodity is Eucheuma cottonii [4]. In a study conducted by Matanjun [10], based on a proximate analysis of nutritional content of seaweed Eucheuma cottonii reported to contain 9.76 ± 1.33% protein, 1.10 ± 0.05% fat, 46.19 ± 0.42% , 5.91 ± 1.21% crude fiber, 10.55 ± 1.60% water and 26.49 ± 3.01% carbohydrate [10]. Proximate analysis is not only used to determine the quality of the product raw material but also used in the final analysis of the product. Proximate analysis is a quick and accurate method to control quality, but takes a relatively long time. In this method the sample collection and preparation should be done well to ensure a homogeneous and representative sample analysis, thus obtaining accurate results [11].

Utilization of seaweed as food can be maximized by diversification of seaweed processed products. One of diversification processed seaweed is by processing the seaweed into beverage packaging to improve the economic value of the product. Currently practical packaging mimuman and ready to eat is popular by the community. Things to watch out for in beverage packaging is the issue of expiration of the beverage. For the expiration of the beverage becomes very important and dangerous information if there is no understanding specifically for the community. The expiration contained in the beverage label is the shelf life or the time limit for the beverage to be consumed. Beverages that have passed from the expiration date are harmful to health if consumed. If not observed, it can cause poisoning. The danger of poisoning will increase if the public can not get information about the expiration of a product [12], [13].

Store age of food product can be determined by 2 methods that is, conventional method and acceleration method. The conventional method is also called the ESS (Extended Storage Studies) method. This method is accurate and precise, but requires a long time and analysis of quality parameters are relatively large and expensive. While the method of ASS (Accelerated Storage Studies) or often called ASLT (Accelerated Shelf Life Testing). One advantage of the ASLT method is that the testing time is relatively short, but the accuracy and accuracy are high. So in this research used ASLT method to determine shelf life of seaweed beverage [12].

II. Experimental

A. Materials

Materials used in this study include red seaweed (*Eucheuma cottonii*), sugar, salt, mineral water, fructose, CMC-Na (Sodium-Carboxyl Methyl Cellulose), sodium benzoate, commercial phosphate buffer, and demineralization aqua.

B. Production Beverage Seaweed

Beverage seaweed used in this study were obtained from UMKM INOKAM (Innovative Kampung Mandiri) Jalan Putat Jaya Gang III A RT. 03 RW. III Kec. Sawahan, Surabaya.

C. Determination Shelf Life of Beverage Seaweed

Beverage seaweed in plastic bottles with a net weight of 350 mL stored at critical temperature variations of 10, 20, and 30 °C. The analysis was done periodically every 7 days from day 0 to day 42, to get 7 points of observation. In this research used two parameters are moisture content and pH value. Different stages of ASLT approach followed in the current research have been given in figure 1.

The result data of each parameter is plotted against time (day) and the linear equation is obtained, so that the three equations obtained for three conditions of product storage temperature with the following equation:

$$y = ax + b \quad (1)$$

The choice of reaction order for a parameter is done by comparing the regression value (R^2) of each linear equation at the same temperature. The reaction order with a larger R^2 value is the order of reactions used by that parameter.

$$\ln k = \ln k_0 - \frac{(Ea/R)}{(1/T)} \quad (2)$$

From the equation we get the constant value k0 which is the exponential factor shows the decrease of quality that kept at normal temperature and activation energy value (Ea) reaction change of product characteristic. Furthermore, it is determined that the equation model of the reaction rate with respect to temperature, the k value indicates the decrease of product quality can be calculated by the following equation:

$$k = k_0 \cdot e^{-Ea/RT} \quad (3)$$

Based on the Arrhenius equation (equation 2) and the calculation of k (equation 3), the shelf life of seaweed can be calculated by the reaction order equation as follows:

$$t \text{ zero order} = \frac{\Delta A}{k} \quad (4)$$

$$t \text{ first order} = \frac{\ln ({}^{A_0}/_{A})}{k} \quad (5)$$

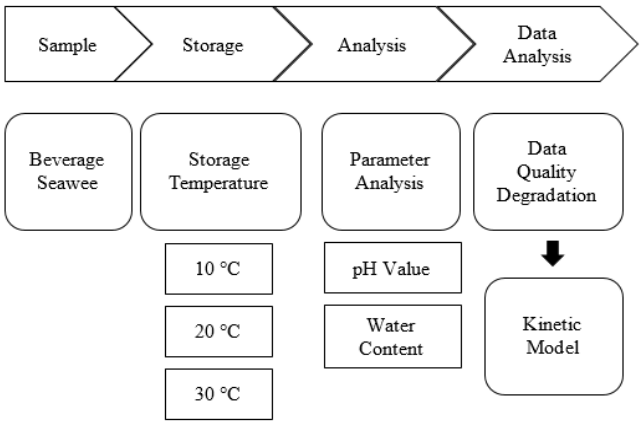

Figure 1. Research procedure to determine the shelf life of seaweed beverage.

III. Results and Discussion

A. *The Process of Production Seaweed Beverage*

Seaweed beverage made from dried red seaweed type *Euchema cottoni* which is soaked in water for 24 hours. drained, cut into pieces and blended. Blended seaweed is put into boiling water, then stirred and awaited to boil. Added food additives (BTP) sugar, salt and sodium benzoate, CMC-Na, fructose, then stirred and awaited to boil. After boiling, the seaweed beverage is removed and filtered with a stainless steel strainer. Then the seaweed beverage added flavor and kept to warm. Furthermore, seaweed beverages are packed in plastic bottles that have been sterilized with warm water and labeled. Beverage seaweed in a bottle waited until cool, then closed the bottle with a seal packing.

B. *Shelf Life of Seaweed Beverage*

Measurement of water content is done by gravimetric method. Water content is measured by removing water in seaweed beverage samples through evaporation. Evaporation of water is carried out by means of an oven at 105 °C for 3-5 hours. Measurements of water content were carried out on seaweed beverages stored at 10, 20, and 30 °C for 42 days. Based on the comparison of linear regression results, water content parameters follow zero-order reactions. The results of the determination of the water content of the original taste seaweed beverages and the taste of green tea stored at different storage temperatures each plotted against time and storage temperature can be seen in figure 2 and figure 3.

The water content of seaweed beverages undergoes varying changes in each storage temperature condition. The effect of the storage time on the water content of the original flavored seaweed beverages can be seen from the T303 samples stored at 30 °C having the greatest change in water content (figure 2).

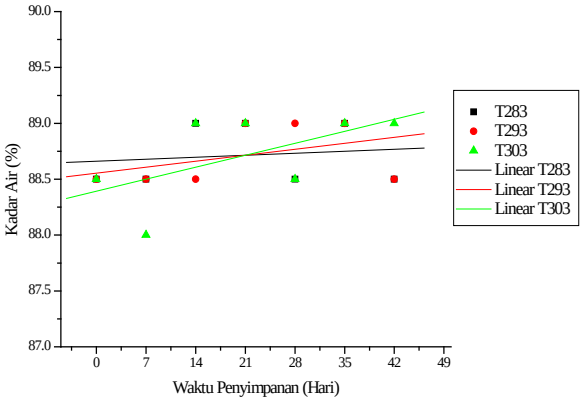

Figure 2. Changes in Water Content of Original Seaweed Beverage.

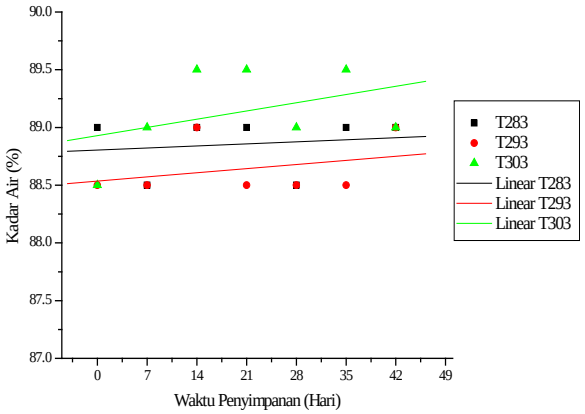

Figure 3. Changes in Water Content of Green Tea Seaweed Beverage.

Based on figure 2 we get the linear regression equation of T283, T293, and T303 respectively ie y = 0.0026x + 88.661, y = 0.0077x + 88.554 and y = 0.0153x + 88.393. From the linear equations obtained the slope value at each storage temperature is plotted against 1/T in the Arrhenius equation. The change in water content in the green tea flavored seaweed at different temperature storage is shown in figure 2. The greatest change in seawater beverage contents can be seen clearly in the T303 samples stored at 30 °C. Based on figure 3, we get the linear regression equation of T283, T293, and T303 respectively ie y = 0.0026x + 88.804, y = 0.0051x + 88.536 and y = 0.0102x + 88.929. From the linear equations obtained the slope value at each storage temperature is plotted against 1 / T in the Arrhenius equation.

Based on figure 2 and figure 3 shows the effect of storage time on moisture content in samples stored at different temperatures. The presence of changes in water content is possible due to water activity (a_w) which is closely related to water content, as well as the growth of bacteria, fungi and other microbes. The higher the aw in general, the more bacteria that can grow [12].

The pH value of seaweed beverage was measured by pH meter that had been calibrated with phosphate buffer pH 4, 7, and 10. Measurement of seaweed beverage was carried out on samples stored for 42 days at 10, 20, and 30 °C storage temperature. The pH value of the original seaweed pH and the taste of green tea are plotted against storage time at different storage temperatures. The pH value parameter follows the zero-order reaction. Plot of storage time to pH value can be seen in figure 4 and figure 5.

The change in pH value on the original flavored seaweed beverage (figure 4) shows that the pH value decreased during the storage process at each of the different temperatures. Results can be seen that the greatest decrease in pH values occurred in the T303 samples stored at 30 °C.

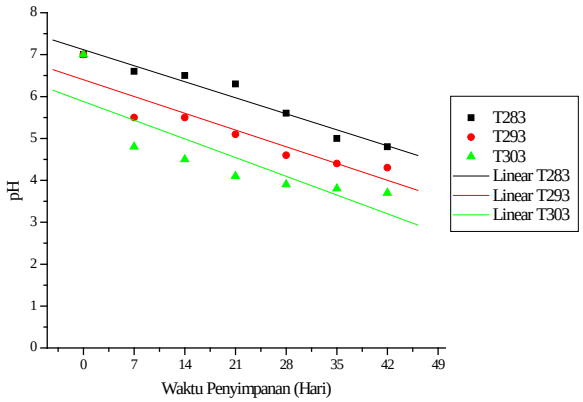

Figure 4. Change of pH of Original Seaweed Beverage.

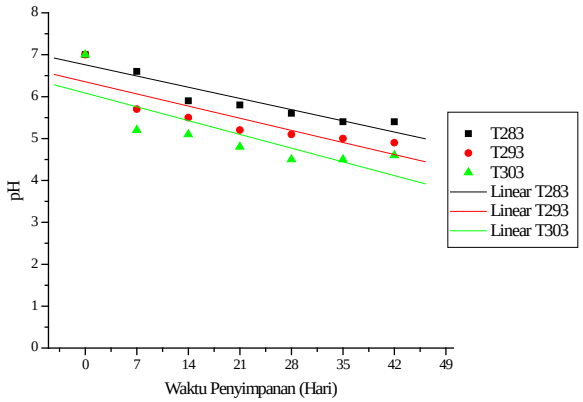

Figure 5. Change of pH of Green Tea Seaweed Beverage.

According to figure 4, the linear regression equations of T283, T293 and T303 are respectively y = -0.0546x + 7.1179, y = -0.0571x + 6.4 and y = -0.0638x + 5.8821. From the linear equations obtained the slope value at each storage temperature is plotted against 1 / T in the Arrhenius equation. Changes in pH value on the green tea flavor tea beverage can be seen in figure 5. Based on figure 5 it can be seen that the change in pH value in the seaweed beverage of green tea flavor decreased at each storage temperature. The greatest pH value change occurred in the T303 samples stored at 30 °C. Based on figure 5 we find the linear regression equation of T283, T293 and T303 respectively are y = -0.0383x + 6.7607, y = -0.0413x + 6.3536 and y = -0.0469x + 6.0857. From the linear equations obtained the slope value at each storage temperature is plotted against 1/T in the Arrhenius equation. In changes in pH values indicate the presence of decay due to microbial activity in beverages stored for 42 days under different temperature conditions [14].

At this stage, the Arrhenius equation is used to describe the temperature dependence of the reaction rate constants. The k values obtained from the Arrhenius equation are used to determine the shelf life of the product. Slope values of different water content and pH are plotted against 1/T. The Arrhenius plot for water content and pH parameters can be seen in figure 6 and figure 7.

Based on the Arrhenius plot (figure 6 and figure 7) on the water and pH parameters we find an equation which is then used to determine the activation energy (Ea) and the degradation constant (k). The activation energy is obtained from the slope or slope of the Arrhenius equation. Activation energy becomes an indirect quantitative way to effectively compare samples.

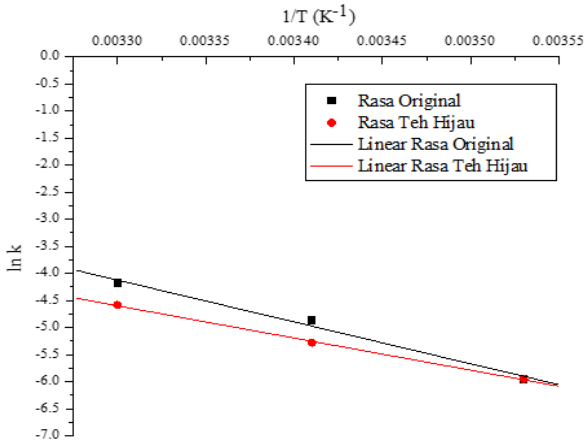

Figure 6. Arrhenius Plot for Water Content Parameters.

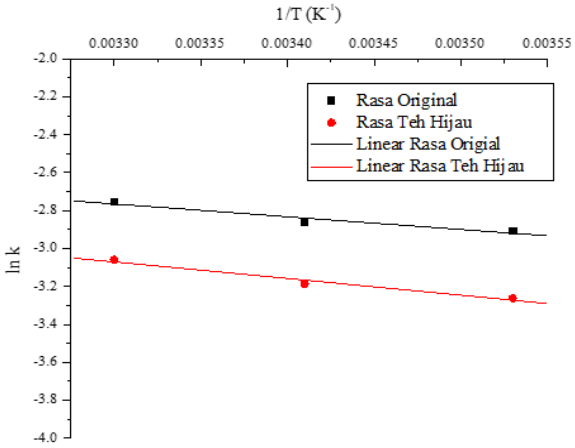

Figure 7 Arrhenius Plot for pH Parameters.

In the original seaweed beverage based on water and pH parameters obtained activation energy of 15.124 and 1.319 kcal / mol. While on the seaweed beverage of green tea flavor obtained niai activation energy equal to 11,632 and 1,719 kcal / mol. The lower the value of an activation energy means the reaction will run faster, so the faster the quality of the seaweed [15] decreases. The value of quality degradation constant is obtained from the calculation of intercept, slope and 1 / T (equation 3) for each sample and parameter. The quality deterioration constant (k) of the original sea-flavored beverage is based on the water content and pH parameter of 0.016 and 0.198. In the beverage on the seaweed beverage, the taste of green tea was found in the quality decreasing constant of 0.010 and 0.071.

Furthermore, to determine the shelf life of seaweed beverage used parameter with the lowest activation energy value that is pH parameter. Determination of shelf life is done by zero order reaction (equation 4). The shelf life can be determined from the value of the quality degradation constant with the initial and final quality of the beverage stored at 30 ° C. Results of determination of shelf life of original seaweed taste for 17 days and taste of green tea for 34 days. The shelf life can be extended by lowering the

temperature of the product storage. At storage temperature 0 ° C shelf life of seaweed with value of constant of quality decrease equal to 0,15 for original taste and 0,052 for flavor of green tea respectively got shelf life for 26 and 46 days.

IV. Conclusion

Based on research that has been done can be concluded that shelf life of seaweed is obtained through pH parameter because it has lower activation energy than water content parameter. Based on the calculation result, the age of the original taste seaweed storage store is 17 days at 30 °C storage temperature and 26 days at 0 °C. Seaweed tea flavored green tea is 34 days at 30 °C storage temperature and 46 days at 0 °C. The lower the storage temperature can extend the shelf life of the product.

Acknowledgement

The financial supports from the Institute for research and community services *(LPPM, Lembaga Penelitian dan Pengabdian Masyarakat*) ITS, and the facilities supports from Chemistry Department, Faculty of Mathematic and Natural Sciences, Institut Teknologi Sepuluh Nopember Surabaya (ITS) are acknowledgement.

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