Variety of packaging and estimated shelf life of Acehnese traditional food (pliek u)

Vivi Amanda*, Ismail Sulaiman, Dewi Yunita
Program Studi Magister Teknologi Industri Pertanian, Fakultas Pertanian, Universitas Syiah Kuala, Darussalam, Banda Aceh – 23111, Indonesia

*E-mail: viviamanda@mhs.unsyiah.ac.id

Abstract. Pliek u is the result of natural fermentation in coconut meat which is separated from the oil through a pressing process. This fermentation products become an inseparable part of the daily food of the Acehnese people. Utilization of pliek u is used as additional ingredient in vegetables but some are used as rujak ingredient. This research aims to determine the shelf life of containers that are packed with a variety of packaging namely aluminum foil packaging, plastic pouches and glass bottles with acceleration (Arrhenius) method which is simulated on four storage temperature conditions in the incubator (30°C, 35°C, 45°C and 55°C). The parameters observed during storage process are moisture content, rancidity, total cell count, organoleptic (color and aroma). The results showed that the determination of product shelf life was rancidity parameter (zero order reaction) with linear $Y=0.8894x-6.5804$. The shelf life of pliek u is one year three months and four days at 35°C with a plastic pouch. The highest water content was obtained at 21 days storage in aluminum foil packaging while the total cell count and organoleptic with the color and aroma parameters produced will determine the quality of the pliek u.

1. Introduction
Coconut (Cocos Nucifera L.) is a strategic commodity that has a social, cultural and economic role in the life of the Indonesian society. The benefits of plants not only lie in the fruit flesh that can be processed into coconut milk, copra and coconut oil, but a whole part of the coconut plant have great benefits. The main reason for coconut plant is a commercial commodity because all parts or a coconut plant can be used for various purposes. In the province of Aceh itself, the coconut plant is processed into a very typical food ingredient, pliek u.

Pliek u is the result of natural fermentation in coconut meat which is separated from the oil through a pressing process. Plied u’s fermentation products become an inseparable part of the daily menu of the Acehnese society. Usually pliek u used as spice for cooking vegetables (pliek u curry), chili sauce and rujak seasoning. In nowadays, pliek u is widely known in various regions outside Aceh, which are known through salak pliek u products.

The province of Aceh has a number of pliek u producing regions, such as Great Aceh, Bireun, East Aceh, South Aceh and Pidie. The region that produces the most pliek u is Pidie Regency. Based on the result of a survey conducted in Pidie, there were 17 locations of pliek u production located spread and the production process was relatively continuous [1]. However, currently there is no packaging used for the pliek u product so it is not known how long the shelf life is in a package used.
Therefore, this study will examine the variety of packaging used for pliek u products with three types of packaging namely alufo pouches, plastic pouches and glass bottle, because the results of the research only to survey a method of manufacture and qualify testing of pliek u and also isolation and initial identification of microorganisms at the final stage of coconut fermentation in making pliek u.

2. Materials and Methods

2.1. Materials
The materials used in this study were pliek u, alufo pouch packaging, plastic pouches, glass bottles and plastic bottles, NA (Nutrient Agar), Aquades, Phosphate Buffers, glacial acetic acid, chloroform, sodium thiosulfate.

2.2. Tools
The tools used in this study were analytic scales, autoclaves, laminar air flow, electric oven, glassware (IWAKI Japan), shelves, drop pipettes, saucers, filter paper, vortex, refrigerator, centrifuges.

2.3. Research Procedure

2.3.1. Sampling
The sample used came from Meureudu market in Pidie Jaya Regency. After sampling, the pliek u will first be sorted and destroyed. Pliek u powder will be carried out by an initial organoleptic test of aroma, colour and texture, moisture content and total microbes. Then, Pliek u is inserted into packaging that will be used. The packaging will be used is alufo pouch packaging, plastic pouch and glass bottle packaging.

2.3.2. Water Content Analysis (AOAC, 1970)
The cup is heated in an oven at 105°C for 15 minutes, then cooled into desiccator for 20 minutes and weighed until it produces a constant weight, a sample of 2-10gr in a cup is weighed, the copper sample are heated in 105°C oven for 6 hours, cooled which contains the sample in the desiccator for 20 minutes. After cold is weighed back to produce constant weight, the put into the formula below:

\[
\text{Water content (\% wet base)} = \frac{(a-b)}{a} \times 100\% 
\]

information:
- \(a\) = initial sample weight (gram)
- \(b\) = final sample weight (gram)

2.3.3. Total cell count (Lay, 1994)
The medium is made by weighing 25g NA (Nutrient Agar) and dissolved into 500ml aquades and sterilized. Then it is stored in an oven at 46 °C. Samples are taken as much as 1 g and put into 9 ml of diluent solution (phosphate buffer). Then in vortex until it becomes homogeneous. Then it is made up to \(10^{-1} - 10^{-10}\) dilution. From \(10^{-1} - 10^{-10}\) dilution, 1ml of suspension was taken and fertilized into a petri dish and then added with 18 ml of liquid medium and shaken in rotation so that the medium was even and left until the medium coagulated. Next the sample was incubated in the incubator at 37 °C (the petri dish was placed in reserve). The number of colonies is calculated in 48 hours of incubation.

\[
\text{TCC (CFU/g)} = \frac{\text{number of bacteria that grow}}{\text{dilution}} 
\]

Because the TCC is too large, TCC is declared with the CFU/g log. For example, if the number of colonies per g = 1 000 000 CFU/g, then:

\[
\text{TCC} = \log \text{CFU/g} = 6 
\]
2.3.4. Thiobarbituric-acid (TBA) Test, (Afrianto, 2008)

The determination of TBA number is based on the reaction between 2-thiobarbituric acid and manoldehyde which forms red. The intensity of the red in shape can be measured by spectrophotometer. Malamnoldehyde is the result of lipid oxidation a hint of rancidity. The main reagents used are:
4 N HCl, TBA Reagent (0.2883g/100 ml glacial acetic acid 90%). Solvents can be accelerated by heating in a water bath.

How It Works:

Fish shredded samples were weighed 10 g carefully, put into waring blender with 50 ml of distilled water added and crushed for 2 minutes. The sample was transferred quantitatively into a distillation flask while washing with 47.5 ml of distilled water. Add 2.5 ml of 4 N HCl to pH to 1.5, Distilled with heating as high as possible for 10 minutes until a distillate of 50 ml is obtained, the distillation obtained is stirred, and transferred to 5 ml into a 50 ml Erlenmeyer which is closed and 5 ml is added TBA reagent so that a red complex is formed. Then the solution is mixed and put into the Erlenmeyer covered in boiling water for 35 minutes. Make a blank solution using 5 ml of distilled water and 5 ml of reagent, such as determining the sample. After the mixture (in closed Erlenmeyer) is boiled, then cooled with cooling water for ± 10 minutes. The absorbance is measured by spronic 20 at a wavelength of 528 nm with a blank solution as a zero point. The number of TBA expressed in mg of malonaldehyde/kg of sample. The TBA number is calculated by the following equation (Pokorny et al., 1989).

\[
\text{Number TBA} = \frac{3}{\text{sample weight (g)}} x A_{528} x 7.8
\]

2.3.5. Measuring Shelf Life with Arrhenius Age Determination with Arrhenius Approach [6]: Plek u that has been put into the packaging is stored at different temperatures, namely 0 (control) and temperatures of 45 °C, 50 °C, 55 °C [7]. All temperatures were observed every 7 days with observations made on the parameters that influence the moisture content measured by the oven method, the rancidity test with the Kreis method, total microbes, while for color, aroma and texture by organoleptic testing. From the results of the pliek u observation of the time will be plotted and obtained 4 regression equations obtained from 4 different storage temperatures. From each equation will get the slope value (b) and the constant value (k). Determination of the reaction order that will be used using a zero-order graph which is the relationship between the value of k with the storage time and the first order which is the relationship between \(\ln k\) and storage time. From these two equations, the largest R² chosen as the reaction order will be obtained. For the Arrhenius approach the k value is plotted with \(1/T\) (K-1) and \(\ln K\) which are the intercepts and slopes of the linear regression equation \(\ln k = \ln k_0 - (E/R) (1/T)\) where \(\ln k_0\) is intercept, \(E / R\) is slope, \(Ea\) is the activation energy and \(R\) is the ideal gas constant of 1,986 kcal/mol K, after getting \(k_0\) which is the preexps potential factor and the activation energy of the change reaction characteristic of the plastic where \(EA = E\), the Arrhenius equation will be obtained which is the reaction rate equation for changes in the change characteristics of fried banana flour with the equation \(k - k_0 . e^{-E/RT}\) with \(T\) is the storage temperature. With the Arrhenius equation obtained, the Arrhenius constant value with each storage temperature can be calculated, the parameter which has the lowest activation energy value is the key parameter. The shelf life is calculated using the reaction equation based on the reaction order. To determine the shelf life of the reaction is to enter the temperature value into the equation \(\ln k = \ln k_0 - (E/R) (1/T)\). The value of \(k\) obtained is included in the equation of the reaction order to get the shelf life of pliek u.

3. Results and Discussion
3.1. Water Content

Water content is an important component in food ingredients. According to [8] that changes in water content and temperature are factors that influence changes in food quality. The higher the storage temperature, the faster the reaction rate of various chemical compounds will react. In this study obtained the smallest moisture content at a temperature of 55 °C with a storage time of 7 days using a plastic pouch packaging that is 4.13% while the highest water content is 4.58% with a control temperature (room temperature) in aluminum foil packaging during storage 21 day. This is allegedly because according to [9], the increase in water content can be caused by the permeability of the product packaging material to moisture. The use of different storage temperatures can affect the permeability properties of packaging materials. The higher the storage temperature, the permeability of the packaging material to moisture will increase. Increasing the nature of this permeability will make more water vapor from the environment that passes through the packaging material. According to [10], a higher temperature will cause the packaging to expand so that the packaging pores will enlarge, so moisture absorption will occur faster.

![Figure 1. Graph of changes in water content values with Aluminium Foil Packaging, plastic pouch packaging, and glass packaging for changes in temperature and storage.](image)

The results of linear regression analysis show that the coefficient of determination (R2) varies. In Aluminum Foil packaging with a temperature of 55°C, the higher coefficient value is 0.9422 compared to the control temperature (0.8396), 35°C (0.3705) and 45°C (0.4357) while the PP value packaging a higher coefficient at 55°C is 0.9312 compared to the coefficient values at the control temperature (0.8554), 35°C (0.6661), and 45°C (0.083) but different from the glass packaging with temperature control is higher i.e. (0.9384), compared to 35°C (0.2004), 45°C (0.5318) and 55°C (0.7385) during storage.

3.2. Total Colony Counter (TCC)

Total colony counter analysis aims to determine the number of microorganisms contained in the product produced. As for the total microorganisms on pliek u can be seen in Figure 2 which states that the growth of microorganisms, the longer storage increases the microorganisms are based on the results of the study can be seen that on the 7th to 21st day microbial growth in all treatments. The total microbial growth is highest 21.63 cfu with aluminum foil packaging for 21 days storage while microbial growth is at least 6.71 cfu on the same package, namely aluminum foil packaging in 7 days storage. According to Buckle et al., (1987) in Sutaryo et al., (2008) that water activity (aw) is free water that can be used by microbes for growth. This opinion is also supported by the statement of Haftiyanti (2008), which states that pH and low water content will inhibit bacterial growth so that the total bacterial colonies are low.
Figure 2. Graph of changes in Total Colony Counter (TCC) value with Aluminum Foil Packaging, Plastic Packaging, and Glass Packaging for changes in temperature and storage.

The results of linear regression analysis show that the coefficient of determination (R2) varies. In the packaging of Aluminum Foil with a temperature of 45°C, the higher coefficient value is 1 compared to the control temperature (0.9889), 35°C (0.9998) and 55°C (0.9919) while the PP packaging with temperature control higher is 0.9981 compared to the coefficient values at temperatures of 35°C (0.9501), 45°C (0.9943) and 55°C (0.9919) but the glass packaging with the control temperature is the same as the PP packaging which is more high (0.998), compared to 35°C (0.819), 45°C (0.9772) and 55°C (0.9921) during storage.

3.3. TBA (Thiobarbituric Acid) Test

The results of the analysis of TBA numbers of pliek u in aluminum foil packaging, plastic Pouch, and glass during storage tends to be unstable at all four temperatures, namely control, 35°C, 45°C, and 55°C because according to Velasco (2004) Rancidity is damage or change smell and flavor in fat or fatty ingredients. Rancidity affects the quality of food products, causing consumers to reject the product. Damage or rancidity in fat, can be caused by 4 factors, namely absorption of odor by fat, action by enzymes in tissues containing fat, microbial action and oxidation by air oxygen, or a combination of two or more of the causes of damage.

Figure 3. Graph of changes in TBA values with Aluminum Foil, plastic pouch, and Glass packaging for changes in temperature and storage.

During storage, TBA value of pliek u at each temperature and treatment tends not to differ much. The results of linear regression analysis show that the coefficient of determination (R2) varies. In the packaging of Aluminum Foil with temperature control, the coefficient value is higher 0.8986 that is...
compared with the temperature of 35°C (0.1558), 45°C (0.6573) and 55°C (0.2133) while the PP packaging with the temperature of 45°C is higher than that is 1 compared to the coefficient value at the control temperature (0.3968), 35°C (0.0087), and 55°C (0.9964) but the glass packaging with the control temperature is the same as the aluminum foil packaging which is more high (0.9139), compared to 35°C (0.0041), 45°C (0.7567) and 55°C (0.3652) during storage.

3.4. Organoleptic Test

3.4.1. Color

Color is one of the sensory factors visually which is sometimes very decisive in the assessment of food quality. According to Winarno (1997) in Saragih (2018), consumers will not receive a food if they have unsightly colors or give the impression that they have deviated from the usual color. Observations were made because of the influence of storage on the color changes of the plek u. During storage for 21 days in all treatments and temperature, there was a decrease in plek u color from brown to blackish brown. The results of color organoleptic analysis stated that the level of preference of aluminum foil packaging was 3.74 with a temperature of 35°C for 7 days of storage, while with PP 4.03 with a temperature of 35°C for 7 days as well as glass packaging the highest level of preference was also obtained at the temperature 35°C for 7 days which is 3.78 by untrained panelists.

The results of linear regression analysis show that the coefficient of determination (R²) varies. In the packaging of Aluminum Foil at a temperature of 35°C, the higher coefficient value is 0.9988 compared to the control temperature (0.997), 45°C (0.5192) and 55°C (0.9926) while in PP packaging with temperature control higher is 0.9912 compared to the coefficient value at temperatures of 35°C (0.3927), 45°C (0.8421) and 55°C (0.9578) and higher value glass packaging that is 45°C (0.9959), compared to the control temperature (0.3343), 35°C (0.7788), 55°C (0.75) during storage.

From the results of the study it can be concluded that the higher the storage temperature, the faster the color changes in the plastic. This is consistent with the statement from Wasono., et al. (2014), the increasingly dark color changes are suspected because fried banana flour during storage can be caused by non-enzymatic browning reactions, namely the occurrence of Maillard reaction. When aldose/ketose is exposed to heat and reacts with the amine group, production of various components occurs such as flavor, aroma, and dark colored polymers.

![Figures 4. Graph of changes in color of organoleptic values with Aluminium Foil packaging, plastic pouch packaging, and glass packaging for changes in temperature and storage.](image-url)

3.4.2. Aroma

The results of organoleptic aroma analysis stated that the level of preference of aluminum foil packaging was the highest of 3.36 with a temperature of 35°C for 7 days of storage, while with PP
packaging of 3.65 with a temperature of 35°C for 7 days but different from glass packaging that is the highest level of preference obtained at temperature 35°C for 14 days which is 3.58 by untrained panelists. According to Arpah (2001) in Putri (2016), change in aroma is a sensitive problem in food products. This is due to the detection by the smells cells in the nose that are able to smell the formed even at very low concentrations. The formation of several off-flavor molecules in the product will damage the overall flavor. One of the most common is the occurrence of rancidity both due to hydrolysis and oxidation.

Figures 5. Graph of changes in aroma of organoleptic value with Aluminum Foil, Plastic pouch packaging, and Glass packaging for changes in temperature and storage.

The results of linear regression analysis show that the coefficient of determination (R²) varies. In the packaging of Aluminum Foil with temperature control, the coefficient value is higher 0.9643 which is compared with the temperature of 35°C (0.5811), 45°C (0.0357) and 55°C (0.4102) while in the PP packaging value also higher coefficients at the control temperature are 0.9912 compared to temperatures of 35°C (0.9409), 45°C (9643) and 55°C (0.4743) but are different from glass packaging where the temperature control coefficient value lower at 0.0819, compared to 35°C (0.3351), 45°C (0.9826) and 55°C (0.6575) during storage. From the observations taken from the average of each test and the aroma parameters from pliek u and obtained the results tend to decrease due to the temperature and storage time.

3.5. Shelf life calculation of pliek u

The Arrhenius model is an approach that quantifies the effect of temperature on the value of quality degradation and determination of shelf life. According to Nirwana (1994), the data analyzed was carried out by simple linear regression analysis to determine the relationship between variables measured by the length of storage. Among the parameters used in measuring the quality of pliek u using Aluminum Foil, PP, and Glass packaging, water content values, TBA and TCC are critical parameters for estimating shelf life. This is according to Singh (1994) in Saragih (2018) that the organoleptic test cannot be used to measure the results of determining the product expiration time because it cannot explain the rate of change in quality so that the values of kinetic parameters cannot be obtained.

From the values of water content, TCC, TBA and descriptive test (color, aroma and texture) obtained during the storage period are plotted against the storage temperature of each reaction order so that the slope value is obtained which is the value of the reaction velocity constant at each temperature (Table 1).

Next, according to the Arrhenius equation, \( \ln k = \ln k_0 - \frac{E_a}{R} \frac{1}{T} \), then each \( \ln k \) value is plotted against 1/T for each parameter. The plot of 1/T can be seen in (Table 2).
| Parameter                  | Temperature (1/T, K) | Temperature (°C) | Order zero | Order one |
|---------------------------|----------------------|------------------|------------|-----------|
|                           |                      |                  | Slope (ko) | Intercept (ko) | Determination (R²) | Ln ko | Slope (ko) | Intercept (ko) | Determination (R²) | Ln ko |
| Water Content             | 0.0033               | 30               | 0.029      | 3.932      | 16.041        | -3.554 | 0.007      | 1.374        | 15.687        | -5.031 |
|                           | 0.0032               | 35               | 0.010      | 4.200      | 62.954        | -4.633 | 0.002      | 1.435        | 62.291        | -6.088 |
|                           | 0.0031               | 45               | 0.004      | 4.201      | 56.432        | -5.586 | 0.001      | 1.435        | 56.654        | -7.038 |
|                           | 0.0030               | 55               | 0.013      | 4.044      | 5.778         | -4.357 | 0.003      | 1.398        | 5.559         | -5.801 |
|                           | 0.0033               | 30               | 0.021      | 3.974      | 14.455        | -3.886 | 0.005      | 1.382        | 14.165        | -5.343 |
|                           | 0.0032               | 35               | 0.020      | 4.017      | 23.977        | -3.894 | 0.005      | 1.393        | 23.943        | -5.363 |
|                           | 0.0031               | 45               | 0.000      | 4.215      | 99.489        | -8.380 | 0.000      | 1.439        | 99.484        | -9.817 |
|                           | 0.0030               | 55               | 0.001      | 4.131      | 83.585        | -6.602 | 0.000      | 1.419        | 83.471        | -8.022 |
|                           | 0.0033               | 30               | 0.018      | 4.010      | 6.155         | -3.998 | 0.004      | 1.391        | 5.842         | -5.454 |
|                           | 0.0032               | 35               | 0.006      | 4.223      | 79.964        | -5.169 | 0.001      | 1.440        | 79.491        | -6.617 |
|                           | 0.0031               | 45               | 0.007      | 4.131      | 46.824        | -4.954 | 0.002      | 1.419        | 46.531        | -6.390 |
|                           | 0.0030               | 55               | 0.005      | 4.142      | 26.154        | -5.217 | 0.001      | 1.421        | 26.143        | -6.654 |
| TBA                       | 0.0033               | 30               | 0.005      | 0.148      | 10.136        | -5.257 | 0.023      | -1.840       | 8.416         | -3.771 |
|                           | 0.0032               | 35               | 0.002      | 0.179      | 84.416        | -6.315 | 0.008      | -1.709       | 87.333        | -4.808 |
|                           | 0.0031               | 45               | 0.006      | 0.218      | 34.266        | -5.044 | 0.020      | -1.464       | 35.847        | -3.920 |
|                           | 0.0030               | 55               | 0.001      | 0.200      | 78.665        | -6.822 | 0.005      | -1.611       | 76.835        | -5.247 |
|                           | 0.0033               | 30               | 0.002      | 0.265      | 60.317        | -6.309 | 0.006      | -1.329       | 58.574        | -5.040 |
|                           | 0.0032               | 35               | 0.001      | 0.204      | 99.132        | -7.394 | 0.003      | -1.604       | 99.411        | -5.962 |
|                           | 0.0031               | 45               | 0.008      | 0.164      | 0.002         | -4.863 | 0.029      | -1.720       | 0.282         | -3.547 |
|                           | 0.0030               | 55               | 0.016      | 0.081      | 0.359         | -4.118 | 0.056      | -2.012       | 2.704         | -2.880 |
|                           | 0.0033               | 30               | 0.006      | 0.197      | 8.607         | -5.124 | 0.022      | -1.586       | 10.195        | -3.820 |
|                           | 0.0032               | 35               | 0.000      | 0.219      | 99.591        | -8.646 | 0.001      | -1.519       | 99.648        | -7.189 |
|                           | 0.0031               | 45               | 0.003      | 0.258      | 24.326        | -5.862 | 0.010      | -1.349       | 24.369        | -4.628 |
|                           | 0.0030               | 55               | 0.000      | 0.220      | 99.819        | -7.846 | 0.002      | -1.544       | 99.707        | -6.176 |
| TCC                       | 0.0033               | 30               | 0.345      | 1.360      | 0.019         | -1.065 | 0.059      | 0.947        | 1.033         | -2.836 |
|                           | 0.0032               | 35               | 0.337      | 1.460      | 0.007         | -1.087 | 0.058      | 0.962        | 1.499         | -2.854 |
|                           | 0.0031               | 45               | 0.337      | 1.473      | 0.008         | -1.088 | 0.057      | 0.970        | 1.074         | -2.861 |
|                           | 0.0030               | 55               | 0.338      | 1.415      | 0.000         | -1.085 | 0.058      | 0.951        | 1.261         | -2.848 |
|                           | 0.0033               | 30               | 0.341      | 1.413      | 0.004         | -1.077 | 0.058      | 0.956        | 1.162         | -2.847 |
|                           | 0.0032               | 35               | 0.340      | 1.407      | 0.031         | -1.078 | 0.058      | 0.956        | 0.934         | -2.849 |
|                           | 0.0031               | 45               | 0.628      | -1.269     | 6.651         | -0.465 | 0.086      | 0.700        | 1.224         | -2.459 |
|                           | 0.0030               | 55               | 0.501      | 2.065      | 0.001         | -0.692 | 0.058      | 1.336        | 1.361         | -2.843 |
|                           | 0.0033               | 30               | 0.509      | 2.005      | 0.002         | -0.675 | 0.059      | 1.334        | 1.222         | -2.834 |
|                           | 0.0032               | 35               | 0.503      | 2.112      | 0.013         | -0.687 | 0.058      | 1.347        | 1.538         | -2.846 |
|                           | 0.0031               | 45               | 0.504      | 2.066      | 0.004         | -0.686 | 0.058      | 1.339        | 1.443         | -2.841 |
Based on the results of Table 2, the parameter that produces the greatest correlation value is used as a parameter for determining the quality of the pliek u, which is obtained from the water content value and TBA with a regression pattern of order one. Then the values applied in the Arrhenius equation with y are ln k and x are 1/T, then the equation can be written as follows: 
\[ \ln k = \ln k_0 - \left( \frac{E_a}{R} \times \frac{1}{T} \right) \]
So that it can be written on the order one, water content can be written in Aluminum Foil packaging \( k = 0.223 \times \left( \frac{1}{T} \right) \times -5.2387 \), PP packaging is \( 0.3166 \times \left( \frac{1}{T} \right) \times -5.5507 \) and Glass packaging \( 0.3497 \times \left( \frac{1}{T} \right) \times -5.6609 \) while for TBA it can be written in Aluminum Foil packaging \( k = -0.3539 \times \left( \frac{1}{T} \right) \times -3.5518 \), PP packaging is \( 0.8894 \times \left( \frac{1}{T} \right) \times -6.5804 \) and Glass packaging \( -0.6571 \times \left( \frac{1}{T} \right) \times -3.9821 \). If it is assumed that in the market storage is carried out at a control temperature, 35 ° C, 45 ° C to 55 ° C, then the calculation of shelf life of Pliek u can be seen in Table 3 and Table 4.
Table 2. The plot ln k against 1/T for parameters of water content, TBA and TCC

| Parameter | Order Zero | Order One |
|-----------|------------|-----------|
|           | Treatment  | Slope (Ea/R) | Intercept | Correlation | Slope (Ea/R) | Intercept | Correlation |
| WC        | Aluminum Foil | -0.4431 | -3.5141 | 0.4725 | 0.223 | -5.2387 | 0.894 |
|           | PP          | 0.3844  | -4.052  | 0.8062 | 0.3166 | -5.5507 | 0.8798 |
|           | Glass       | 0.4181  | -4.1643 | 0.7913 | 0.3497 | -5.6609 | 0.8641 |
| TBA       | Aluminum Foil | -0.3425 | -5.003  | 0.2712 | -0.3539 | -3.5518 | 0.4166 |
|           | PP          | 0.9104  | -7.9472 | 0.6434 | 0.8894 | -6.5804 | 0.6728 |
|           | Glass       | 0.0003  | -6.4217 | 6E-0B | -0.6571 | -3.9821 | 0.2622 |
| TCC       | Aluminum Foil | 0.1698  | -0.849  | 0.0667 | 0.3435 | -1.7176 | 0.0667 |
|           | PP          | 0.1767  | -1.2695 | 0.5685 | 0.04  | -2.8497 | 0.0713 |
|           | Glass       | -0.0023 | -2.8351 | 0.3301 | -0.0037 | -0.6748 | 0.6096 |

Table 3. Calculation of Pliek u shelf life based on analysis of Water Content on order zero and order one.

| Order | Parameter | Temperature 1/T,K | Equation | Ln K | K | (Ao-At) | Ln (Ao-At) | Shelf Life |
|------|-----------|-------------------|----------|------|---|---------|------------|------------|
| 0    | WC        | 0.0033            | y = -0.4431 x -3.5141 | -3.5156 | 0.0297 | 0.6244 | 21 |
|      |           | 0.0032            |          | -3.5155 | 0.0297 |        | 21 |
|      |           | 0.0031            |          | -3.5155 | 0.0297 |        | 21 |
|      |           | 0.0030            |          | -3.5155 | 0.0297 |        | 21 |
| 1    | WC        | 0.0033            | y = 0.223 x -5.2387 | -5.2380 | 0.0053 | 0.4710 | 89 |
|      |           | 0.0032            |          | -5.2380 | 0.0053 |        | 89 |
|      |           | 0.0031            |          | -5.2380 | 0.0053 |        | 89 |
|      |           | 0.0030            |          | -5.2380 | 0.0053 |        | 89 |

| Order | Parameter | Temperature 1/T,K | Equation | Ln K | K | (Ao-At) | Ln (Ao-At) | Shelf Life |
|------|-----------|-------------------|----------|------|---|---------|------------|------------|
| 0    | WC        | 0.0033            | y = 0.3844 x -4.052 | -4.0507 | 0.0174 | 0.3656 | 21 |
|      |           | 0.0032            |          | -4.0508 | 0.0174 |        | 21 |
|      |           | 0.0031            |          | -4.0508 | 0.0174 |        | 21 |
| 1    | WC        | 0.0033            | y = 0.3166 x -5.5508 | -5.5498 | 0.0039 | 1.0062 | 259 |
|      |           | 0.0032            |          | -5.5498 | 0.0039 |        | 259 |
|      |           | 0.0031            |          | -5.5498 | 0.0039 |        | 259 |
|      |           | 0.0030            |          | -5.5498 | 0.0039 |        | 259 |
Based on the calculation of the Arrhenius model acceleration method (Table 3) from the analysis of Water Content obtained that the shelf life of the pliek u packaged with Glass has a longer shelf life of 321 days (10 months 7 days) compared to pliek u which is packed with PP and aluminum Foil. The rate of decline in Pliek u quality is also influenced by the type of packaging used because each type of packaging has different permeability. Sembiring and Hidayat (2012) in Putri (2014) state that, the permeability capability of each package varies and will affect the rate of water vapor transmission, the lower the rate of water vapor on a package, the less amount of moisture that can penetrate the packaging.

References
[1] Sulisma. 2010. Survei Cara Pembuatan Dan Uji Mutu (Kimia dan Sensorik) Pliek U Di Kabupaten pidie. Universitas Syiah Kuala, Banda Aceh.
[2] Baihaqi. 2011. Isolasi dan Identifikasi Awal Mikroorganisme Pada Tahap Akhir Fermentasi Kelapa Dalam Pembaruan Pliek U. Universitas Syiah Kuala, Banda Aceh.
[3] Dewi, Gunadnya dan Pudja. 2015. Penentuan Umur Simpan Bumbu Rujak Dalam Kemasan Botol Plastik Menggunakan Metode Arrehenius. Universitas Udayana, Bali.
[4] Herawaty, H. 2008. Penentuan Umur Simpan pada Produk Pangan. JurnalLitbang Pertanian. 27(4).
[5] Hermanianto, J., Arpah, M., dan Jati, W. K. 2000. Penentuan Umur SimpanProduk Ekstrusi Hasil Samping Penggilingan Padi (menir dan bekatul)dengan Menggunakan Metode Konvensional, Kinetika Arrhenius danSorpsi Isothermis. Bul Teknol dan Ind Pang. 11 (2):33-41.
[6] Labuza, T.P. 1982. Shelf Life Dating of Food and Nutrition Press, Inc., Westport Connecticut.
[7] Syarief, R dan H. Halid. 1993. Teknologi Penyimpanan Pangan. Penerbit ARCAN bekerja sama dengan PAU Pangan dan Gizi. Institut Pertanian Bogor, Bogor.
[8] Wijaya, C. H. 2007. Pendugaan Umur Simpan Produk Kopi Instan Formula Merk-Z dengan Metode Arrhenius. Skripsi. Fakultas Teknologi Pertanian, IPB. Bogor.
[9] Wigelar, O. T. 2013. Pendugaan Umur Simpan Susu Skim Serbuk dengan Metode Foam-mat Drying dengan Berbagai Suhu Penyimpanan yang Dikemas dalam Alumunium Foil. Skripsi. Jurusan Teknologi Pangan, Fakultas Teknik, Universitas Pasundan. Bandung.
[10] Winarno, F.G. 1983. Gizi Pangan, Teknologi dan Konsumsi. Penerbit Gramedia. Jakarta.
[11] Sumparno, B. 2008 didalam Murniyati, 2009. Penggunaan Resort Pouch Untuk Produk Pangan Siap Saji. Squalen Vol 4 No. 2
[12] Page D S. 1997. Prinsip-prinsip Biokimia. Jakarta, Erlangga.
[13] Palungkun, R. 2005. Aneka Produk Olahan Kelapa. Penebar Swadaya, Jakarta.
[14] Arpi, N., M. I. Sulaiman, Z., A. Pian, S. Hariadi, dan Y. Adli. 1998. Perbaikan dan
Pengembangan Teknologi Minyak Pliek U (Minyak Kelapa) Hasil Fementasi, Spesifik Aceh. Laporan Hasil Penelitian Kerjasama World Bank dan LPTP (Loka Pengkajian Teknologi Pertanian), Banda Aceh.

[15] Putri A I., Hervelly., dan Ina S N. 2016. Artikel Pendugaan umur simpan keripik tempe yang dikemas dengan berbagai jenis kemasan dan disimpan pada suhu penyimpanan berbeda. Universitas Pasundan. Bandung

[16] Saragih M R A. 2018. Pengaruh kemasan plastik polietilen dan polipropilen terhadap umur simpan abon ikan tongkol (katsuwonus pelamis) dengan menggunakan model arrhenius. Universitas Syiah Kuala. Banda Aceh.

[17] Syarief.R., S. Santausa dan Isyana. 1989. Teknologi Pengemasan Pangan, PAU Pangan dan Gizi. Institut Pertanian Bogor, Bogor.