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Estimations of shelf life of catfish skin crackers in polypropylene plastic packaging using the ASLT (Accelerated Shelf Life Testing) method

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ABSTRACT

This research aims to determine the shelf life of catfish skin crackers in polypropylene plastic packaging using the ASLT method. This test was conducted in the Fisheries Product Processing Laboratory of the Faculty of Fisheries and Marine Sciences, Padjadjaran University and testing the content of water content and TBA (Thiobarbituric Acid) of catfish skin crackers at the Food Technology Laboratory, Faculty of Food Science Technology, Padjadjaran University from September to November 2018. This study used an experimental method consisting of 3 storage temperature treatments at 25 ºC, 35 ºC and 45 ºC. Observations carried out include sensory (hedonic) test, water content test, and TBA (Thiobarbituric Acid) test. For the calculation, Arrhenius model was chosen with odor as a critical parameter to determine the shelf life which had the biggest R^2 value with equation Arrhenius Ln K = 1079.8 (1/T) – 5.5161, with R^2 value equal to 0.9212. The shelf life of catfish skin crackers that was saved at the room temperature (25 ºC) was 39 days or 1.3 month.

***Keywords*:** Arrhenius, catfish skin crackers, shelf life, *Pangasius pangasius*, *Pangasius jambal*, *Pangasius humeralis*, *Pangasius lithostoma*, *Pangasius nasutus*, *Pangasius polyuranodon*, *Pangasius nieuwenhuisii*, *Pangasius hypophtalmus,* Accelerated Shelf Life Testing, polypropylene plastic packaging

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1. INTRODUCTION

Areas in Indonesia that are famous as the center of catfish cultivation, are South Kalimantan, Jambi, South Sumatra, and West Java. West Java is one of the largest centers of catfish farming for the island of Java, especially in the area of the Jatiluhur Reservoir in Purwakarta. The Purwakarta region has the potential to cultivate very large catfish with a total number of 9,692.15 per year. The West Bandung region is the second largest catfish production with 3,787.60 head / year

Catfish (*Pangasius* sp., Family: Pangasiidae) is one of the fish native to Indonesian waters that has been successfully domesticated. The types of catfish in Indonesia are very numerous, among others *Pangasius pangasius* or *Pangasius djambal*, *Pangasius humeralis*, *Pangasius lithostoma*, *Pangasius nasutus*, *Pangasius polyuranodon*, *Pangasius nieuwenhuisii*, while *Pangasius hypophtalmus* known as siam jambal or bangkok catfish are the introduced fish from Thailand. One alternative to the use of catfish skin is to be processed into skin crackers. Utilization of fish skin is also in line with efforts to reduce industrial waste, by utilization of fish skin for food products. Without food, it can increase the added value of fish skin. Skin crackers on the market mostly use raw materials from cow skin, chicken intestine and chicken leg skin. Skin crackers made from fish skin are still rarely done so fish skin has a great potential to be developed. Processing fish (meat) activities cover leaving the skin of fish, head, fins, tail, thorns, and stomach contents as waste. Waste in the form of head, tail, thorns and stomach contents of fish can be used as ingredients for fish meal.

Catfish skin crackers have an easy to absorb moisture from the surrounding air. Catfish skin crackers are sluggish, the texture is more tough so it is less enjoyable to consume and easily overgrown with mushrooms. Packaging is one way to inhibit environmental water vapor absorbed by dry food products. Packaging can also prevent or reduce damage, protect materials in it from pollution and physical disturbances such as friction, impact and vibration.

Shelf life is one of the main problems often found in industries in developing and marketing products. The accuracy of the choice of packaging type is very influential on the durability of the product up to the consumer. Temperature can also affect the durability of skin crackers, because low temperatures will result in an increase in water content which causes high microorganisms to grow. The lower the storage temperature, the higher the level of water content increase, the tendency for the increase in water content is influenced by permeability.

The Accelerated Shelf Life Test (ASLT) Method, the Arrhenius model is a product shelf life estimation method using acceleration temperatures so that it can speed up reactions that cause damage to the product.

The Arrhenius model/ ASLT method is widely used for estimating the shelf life of food products that are easily damaged by chemical reactions, such as fat oxidation, Maillard reaction, protein and denaturation. The ASLT method of the Arrhenius model is generally applied to all types of food products especially in products that experience a decrease in quality due to the chemical deterioration effect.

2. MATERIALS AND METHODS

This research was conducted from September to November 2018. This test was carried out at the Fisheries and Marine Sciences Faculty of Fisheries and Marine Sciences Processing

Laboratory, as well as testing the content of water content and TBA (Thiobarbituric Acid) of catfish skin crackers at the Food Technology Laboratory, Faculty of Food Science Technology, Padjadjaran University. This study used an experimental method for 3 storage temperature treatments, that are:

A: Storage temperature at 25 ºC
B: Storage temperature at 35 ºC
C: Storage temperature at 45 ºC

Tests were carried out by means of products stored in an incubator at a temperature of 25 ºC, 35 ºC, and 45 ºC for 6 weeks (40 days). Observations were made every day 1, 10, 20, 30, and 40 days for each storage temperature. The parameters tested for the shelf life estimation of the Arrhenius model/ ASLT method are using sensory test data (texture, odor, appearance, and taste) and moisture content test.

2. 1. Sensory Test

The sensory test was carried out using the hedonic test. Scores or assessments involve 20 semi-trained panelists with observational parameters including color, odor, taste and texture. This sensory test is carried out on day 1^{st} to day 40^{th}.

2. 2. Moisture Test

Porcelain dishes are dried in an oven at a temperature of 95-100 ºC to obtain a constant weight under a pressure of <100 mm Hg for approximately 5 hours. The cup is then removed and placed in a desiccator for more than 30 minutes and left to cool down. The cup was weighed to a constant weight. The sample weighed as much as 5 g of material. The weighed sample was inserted into a cup containing the sample put into the oven with a temperature of 102-105 ºC for 6 hours. The cup was inserted into the desiccator and left to cool. The cup containing the sample was weighed to a constant. Finally, the water content was calculated.

2. 3. TBA (Thiobarbituric Acid) Test Number

10 grams of material in a beaker is weighed. Quantitatively it was transferred into a distillation flask while washing with 97.5 ml of distilled water. High heating is distilled so that 50 distillates were obtained for 10 minutes of heating. The obtained distillate is stirred evenly. The 5-ml pipette is put into a closed test tube. The test tube is closed and it is vortexed. For 30 minutes it is heated in boiling water. Using 5-ml aquadest and 5 ml reagents are made blank. The reaction tube is cooled with cooling water for approximately 10 minutes. The absorption is measured at a wavelength of 528 nm with a blank solution as a zero point. TBA numbers were calculated by being expressed in mg of malonaldehyde/kg sample.

2. 4. Data analysis

Determination of shelf life catfish skin crackers is made based on the shortest shelf life between sensory parameters (texture, odour, taste, and appearance), moisture content and determination of Thiobarbituric Acid (TBA).

3. RESULTS AND DISCUSSION

3. 1. Hedonic Test Results

Organoleptic tests performed by hedonic tests include: appearance, odor, taste and texture, carried out by 20 trained panelists. Rating scales are: 1 to 9: (1) strongly dislike: (3) dislike; (5) neutral; (7) like; (9) really like, different criteria in each sense.

Appearance

The level of receipt of food products from appearance is influenced by changes in color because changes in color will also show changes in nutritional value, so that color changes are used as an indicator of quality degradation (Table 1).

Table 1. Changes in the appearance preferences of catfish skin crackers during storage at different temperatures

Code	Appearance Parameters				
	1	**10**	**20**	**30**	**40**
K-25	9.00	7.38	6.00	4.50	3.25
K-35	9.00	7.88	6.50	5.25	4.13
K-45	9.00	8.63	7.25	5.75	4.50

The color of food is closely related to taste, because attractive food colors will arouse appetite. Five factors that cause a colored food are pigment, caramelization reaction, Maillard reaction, reaction between amino groups with reducing sugar groups, reaction of organic compounds with air and the addition of dyes.

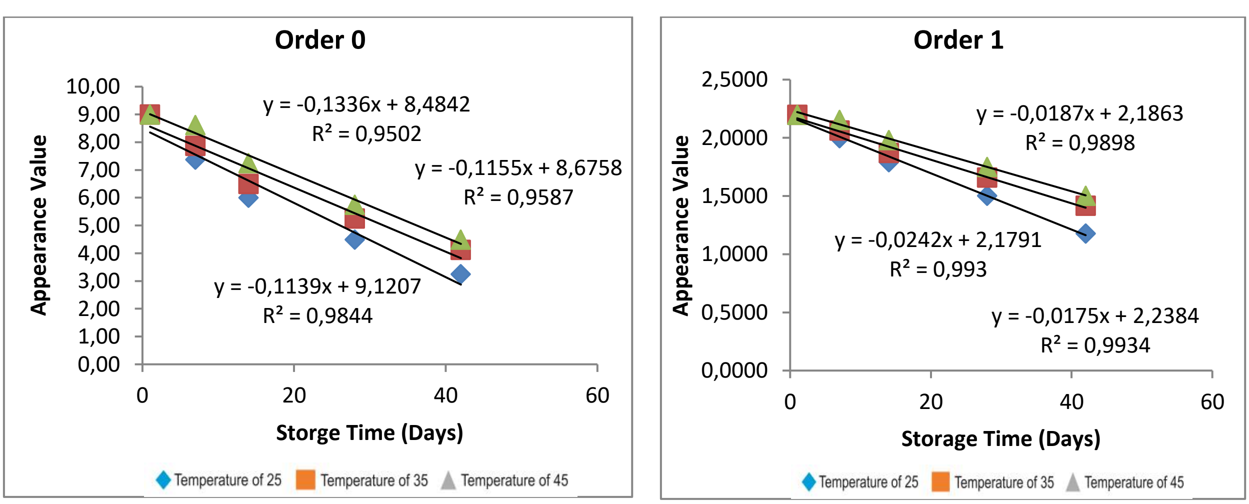

Figure 1. Relationship Graph Decreasing Appearance Score against Time

The value of R^2 (Figure 1) compared the value of R^2 of the three temperatures (25 ºC, 35 ºC and 45 ºC) order 0 is smaller than order 1; in the relationship graph decreases the score of appearance to time, so that in determining the Arrhenius equation, order 1 is chosen (Figure 2).

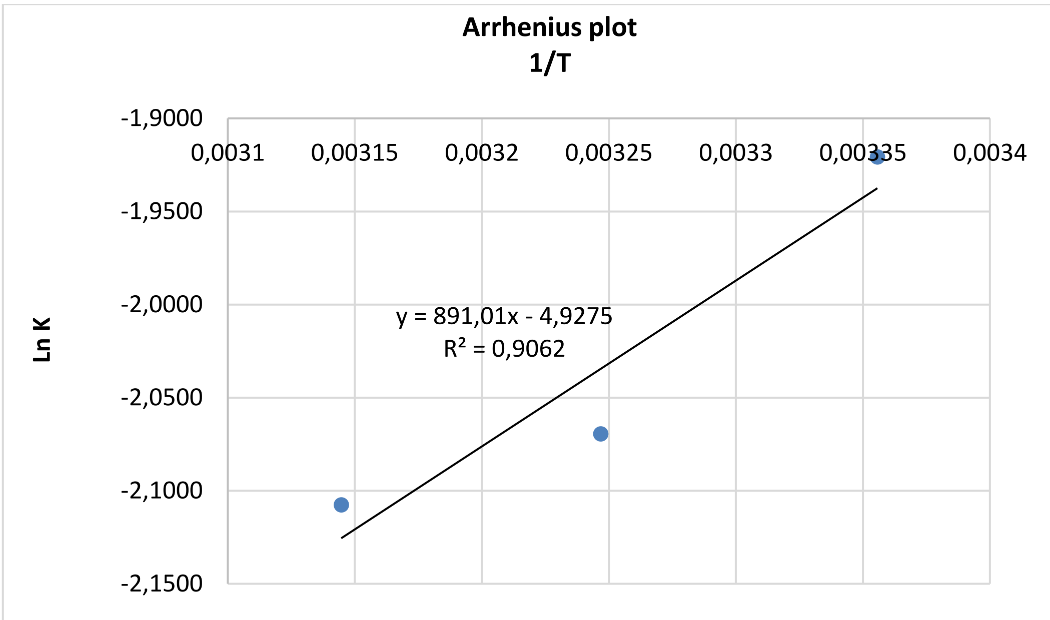

Figure 2. Graph of Arrhenius Plot Appearance

Odor

Table 2. Changes in the odor preferences of catfish skin crackers during storage at different temperatures.

Code	Odor Parameters				
	1	**10**	**20**	**30**	**40**
K-25	9.00	7.63	6.00	4.63	3.25
K-35	9.00	8.00	6.75	5.13	3.63
K-45	9.00	8.25	7.38	6.00	4.38

Odor is produced from volatile compounds contained in the ingredients that make up a food product (Table 2). The odor parameters determine consumer acceptance because of the smell or odor stimulation into impulses that will lead to the olfactory nerve and describe the characteristics of a product. The longer and the higher the temperature the sample is stored, the hedonic score on average will decrease.

The decrease in panelists' assessment of the smell of catfish skin crackers can occur due to the evaporation of volatile compounds in catfish skin crackers. The longer the time and temperature of storage, the greater the level of evaporation of volatile compounds in the product (Figure 3).

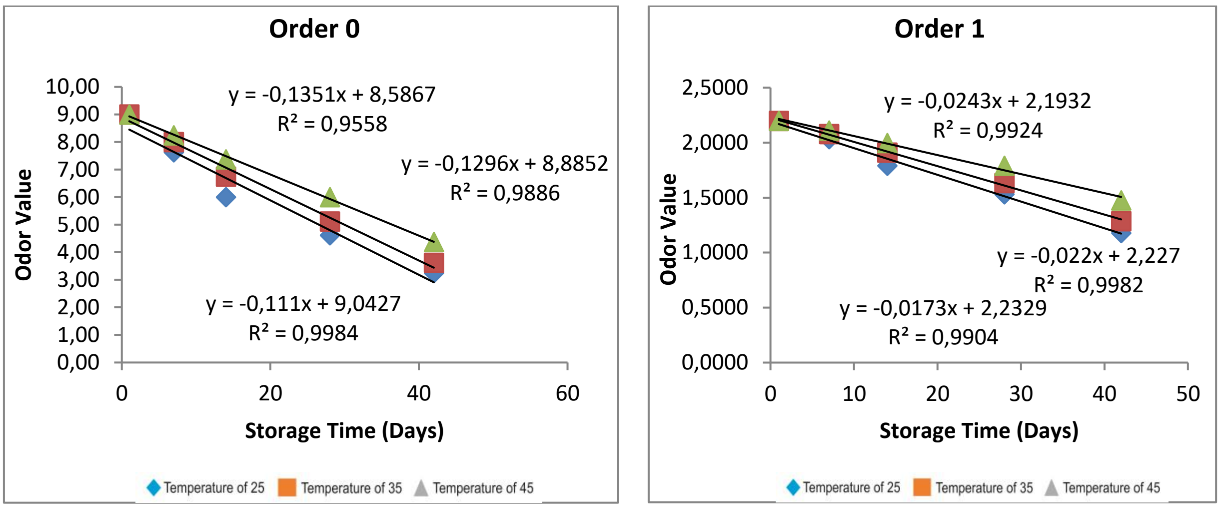

Figure 3. Graph Relationship of Decreasing odor Scores Against Time

The value of R^2 (Figure 3) compared the value of R^2 of the three temperatures (25 ºC, 35 ºC and 45 ºC) order 0 smaller than order 1 in the relationship graph decreases odor score to time, so that order 1 is chosen for Arrhenius equation (Figure 4).

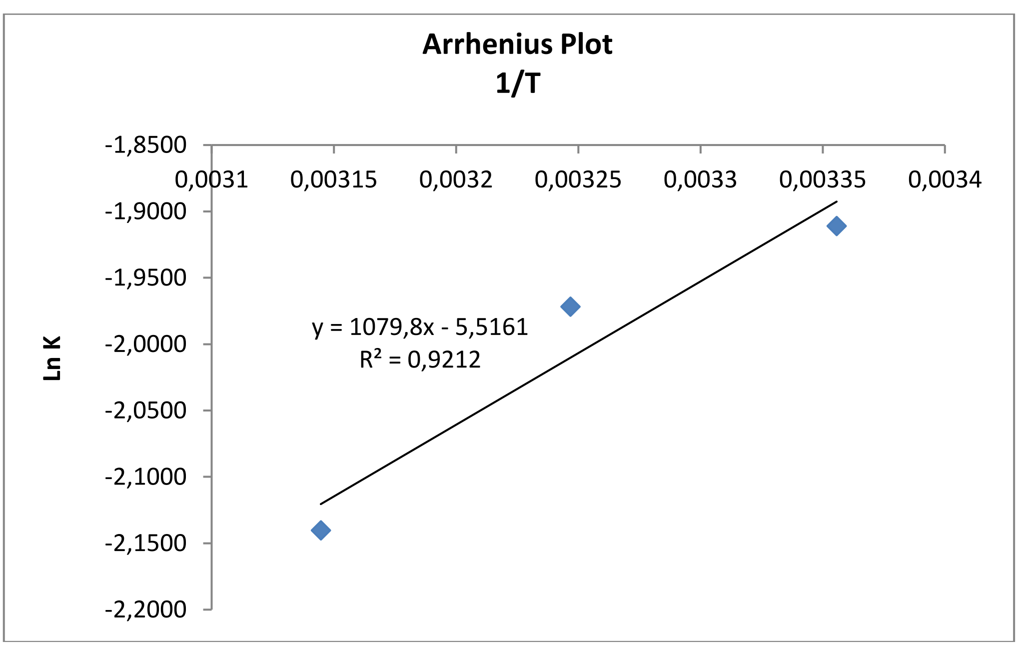

Figure 4. Chart of the Arrhenius odor Plot

Texsture

Table 3. Changes in the texture preferences of catfish skin crackers during storage at different temperatures.

Code	Texture Parameters				
	1	**10**	**20**	**30**	**40**
K-25	9.00	7.63	6.50	5.13	3.50
K-35	9.00	8.38	7.00	6.00	3.63
K-45	9.00	8.75	7.38	6.25	5.00

The level of receipt of food products from the texture (Table 3) of catfish skin crackers is influenced by the water content of the product, so that indirect changes in texture are influenced by storage time and storage temperature. The longer and the higher the temperature the sample is stored, the hedonic score on average will decrease. The level of receipt of food products from texture is strongly influenced by water content, compared to the initial quality especially in the texture parameters that are increasingly crispy. The smaller the water content of catfish skin crackers, the more crispy the texture will be (Figure 5).

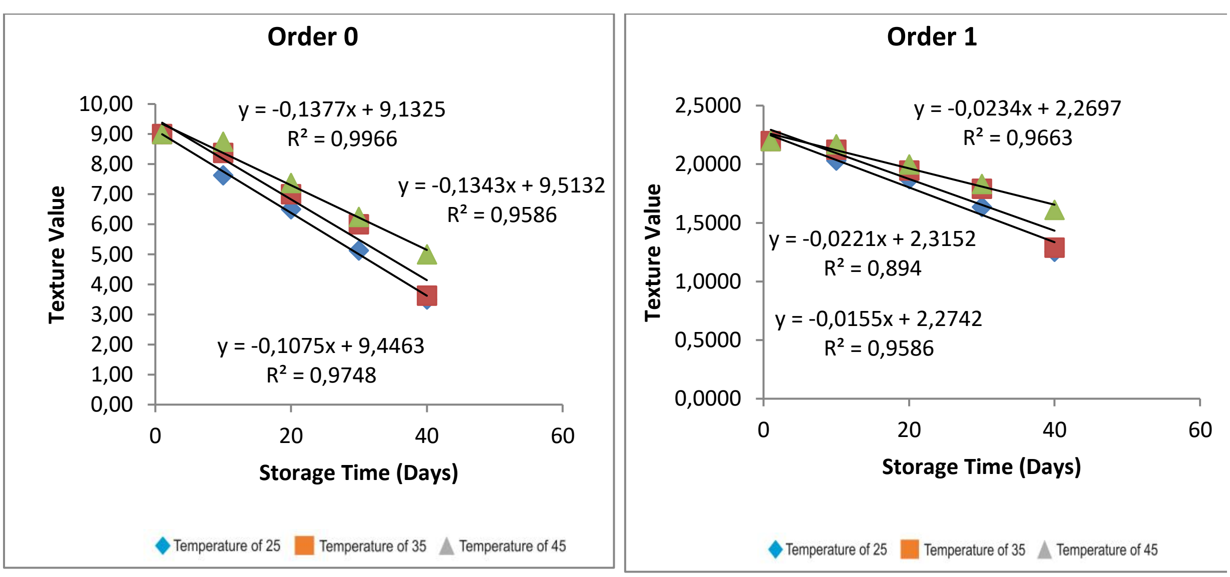

Figure 5. Relationship graph Decreasing Texture Score Against Time

The value of R^2 (Figure 6) compared the value of R^2 of the three temperatures (25 °C, 35 °C and 45 °C) order 0 is greater than order 1 in the relationship graph decreases texture score to time, so that in determining Arrhenius equation, order 0 is chosen.

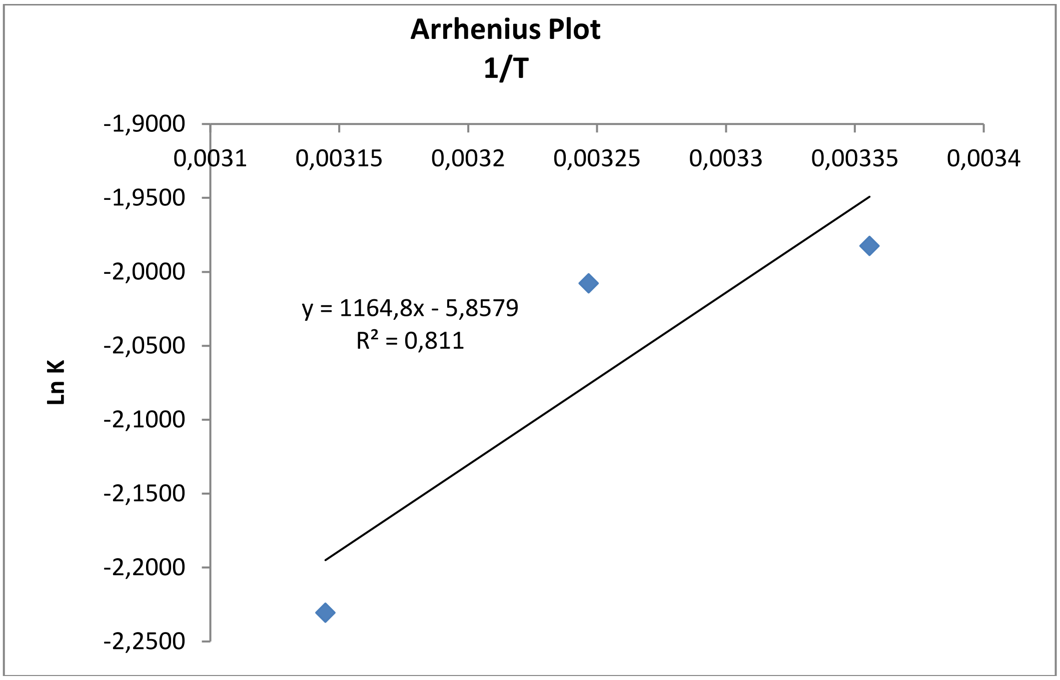

Figure 6. Graph Arrhenius Texture Plot

Taste

Table 4. Changes in the taste preferences of catfish skin crackers during storage at different temperatures.

Code	Taste Parameters				
	1	10	20	30	40
K-25	9.00	8.00	6.88	6.00	4.63
K-35	9.00	8.25	7.50	6.13	5.25
K-45	9.00	8.50	8.00	6.63	6.00

The delicious taste produced in food products (Table 4) is caused by the presence of amino acids in proteins and fats contained in food. Taste is influenced by several factors, namely chemical compounds, temperature, concentration, and interactions with other taste components. The longer the storage effects in the panelist's response to the level of preference which decreases. This is because at the 1st day storage of catfish skin crackers has not undergone physical changes, whereas on day 40, it has undergone physical changes. Organoleptic changes during storage in case of the longer stored, effect the lower the organoleptic value produced especially at the level of preference (Figure 7).

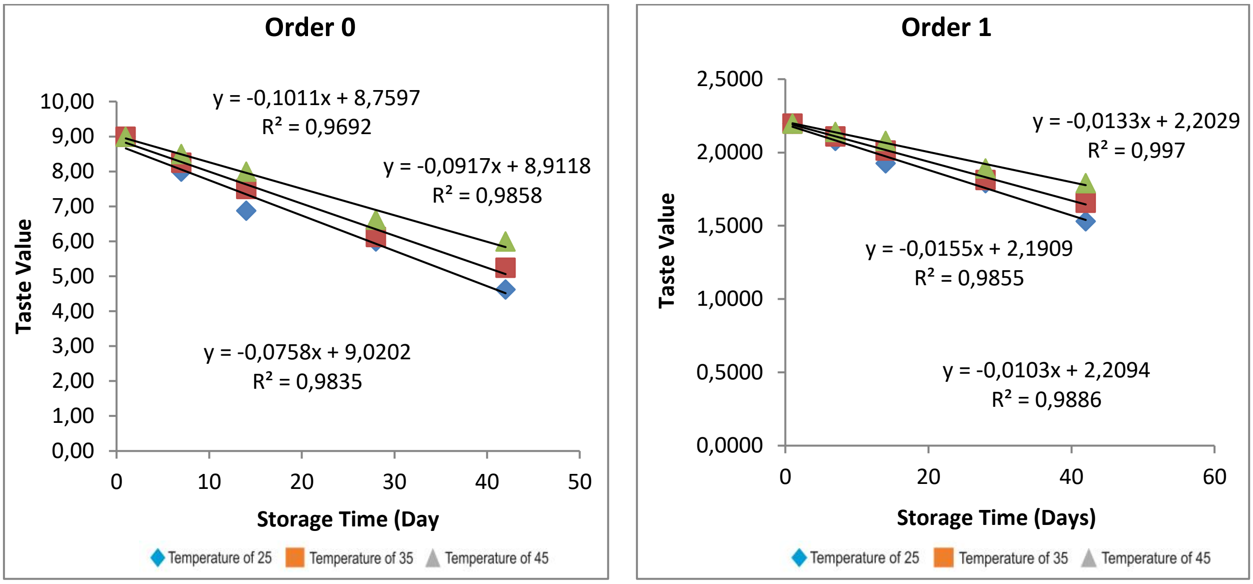

Figure 7. Relationship Graph of Decreasing Taste Score Against Time

The value of R^2 (Figure 7) compared to the value of R^2 of the three temperatures (25 ºC, 35 ºC and 45 ºC), with order 0 smaller than order 1, on the relationship graph decreases the taste score with time, so that order 1 is chosen for the Arrhenius equation (Figure 8).

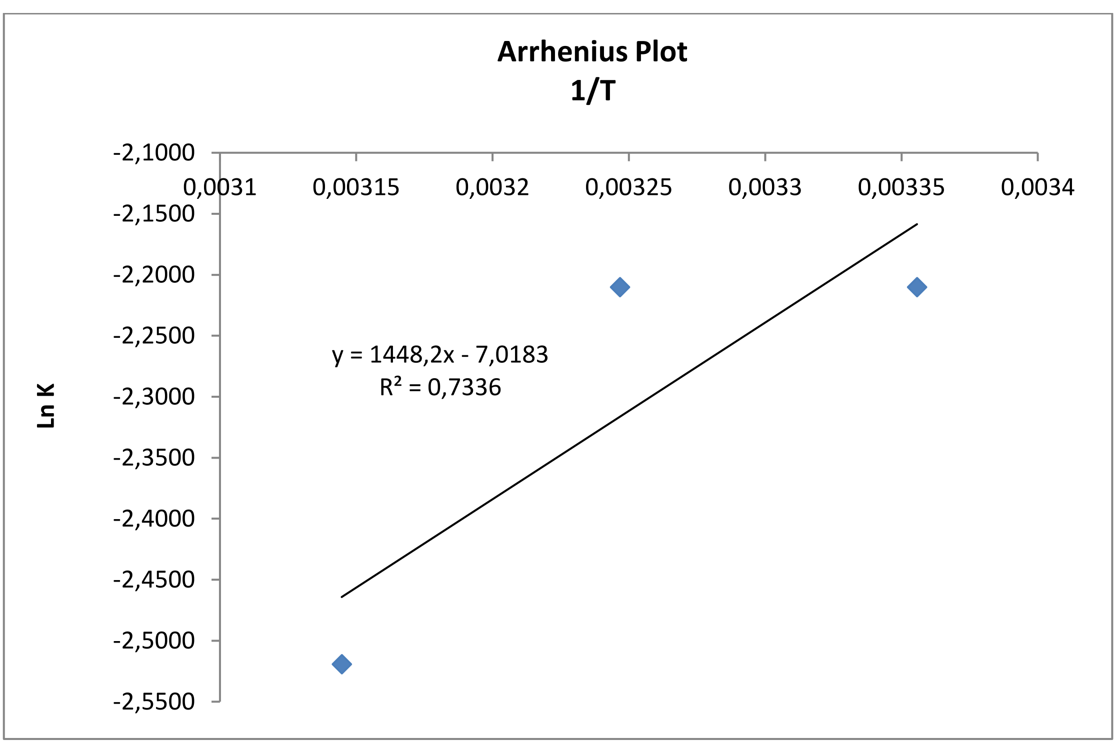

Figure 8. Arrhenius Taste Plot Graph

3. 2. Moisture Test

Based on Table 5, it can be seen that there is a decrease in water content. The product evaporation caused by temperature and storage time speeds up the evaporation process during storage. This is due to the high temperature and air velocity that will accelerate the evaporation process on the surface and parts of the particles due to differences in the vapor pressure of the liquid.

Table 5. Changes in the preferences of the water content of catfish skin crackers during storage at different temperatures

Code	Water Content Parameters				
	1	10	20	30	40
K-25	5.43	5.42	5.4	5.39	5.32
K-35	5.43	5.39	5.31	5.28	5.24
K-45	5.43	5.38	5.27	5.21	5.02

Skin crackers that are stored at different temperatures continue to experience a decrease in water content, the higher the storage temperature, the more permeability of packaging materials to water vapour. This increased permeability will make more moisture from the environment pass through the packaging material.

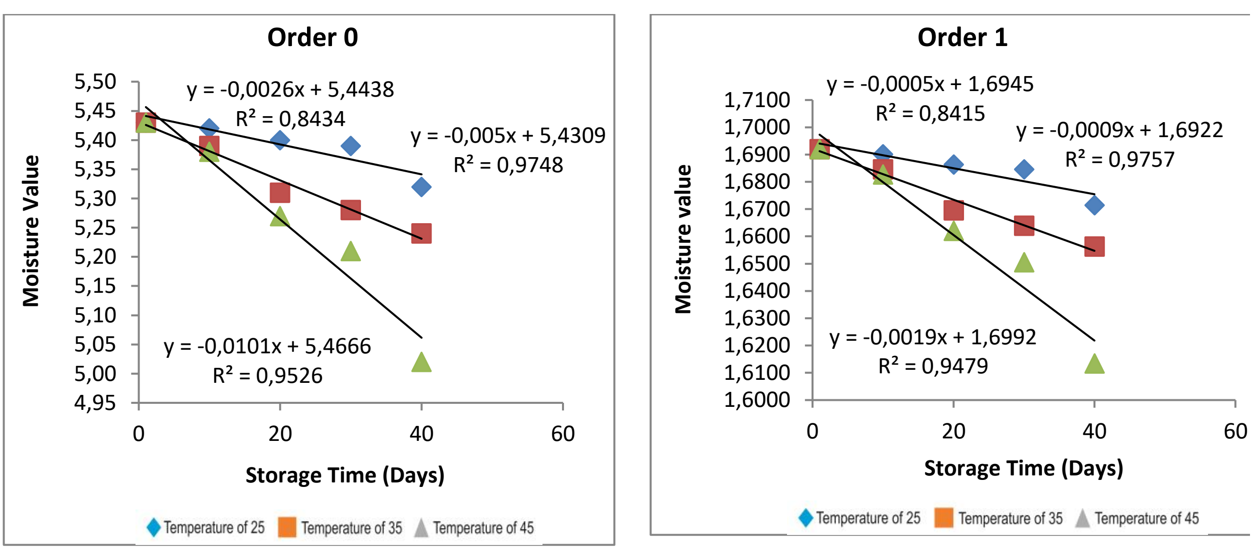

Figure 9. Graph of Relationship of Decreasing Water Content Score Against Time

The value of R^2 (Figure 9) compares the value of R^2 of the three temperatures (25 ºC, 35 ºC and 45 ºC), with order 0 greater than order 1, on the relationship graph decreases the water content score with time, so in order 0 is chosen for the Arrhenius equation (Figure 10).

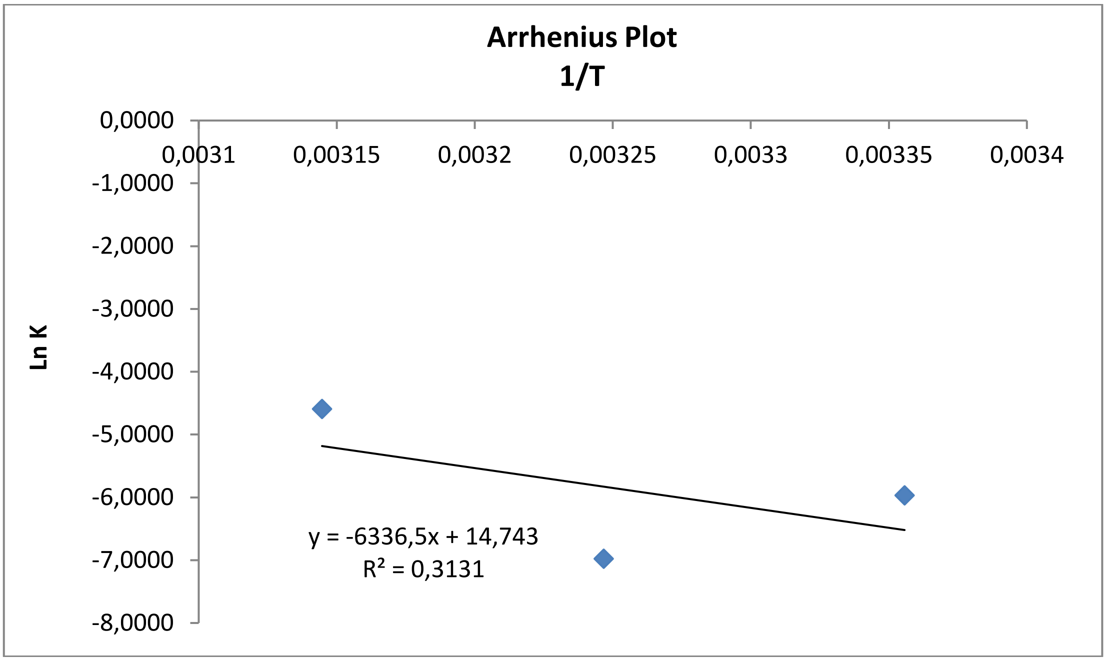

Figure 10. Arrhenius Plot Graph of Water Content

3. 3. TBA (Thiobarbituric Acid) Test Number

Thiobarbituric Acid (TBA) test is used to determine the presence of rancidity. During storage of oil and fat, they undergo an oxidation process to produce components such as aldehydes, ketones, and free fatty acids that cause rancidity.

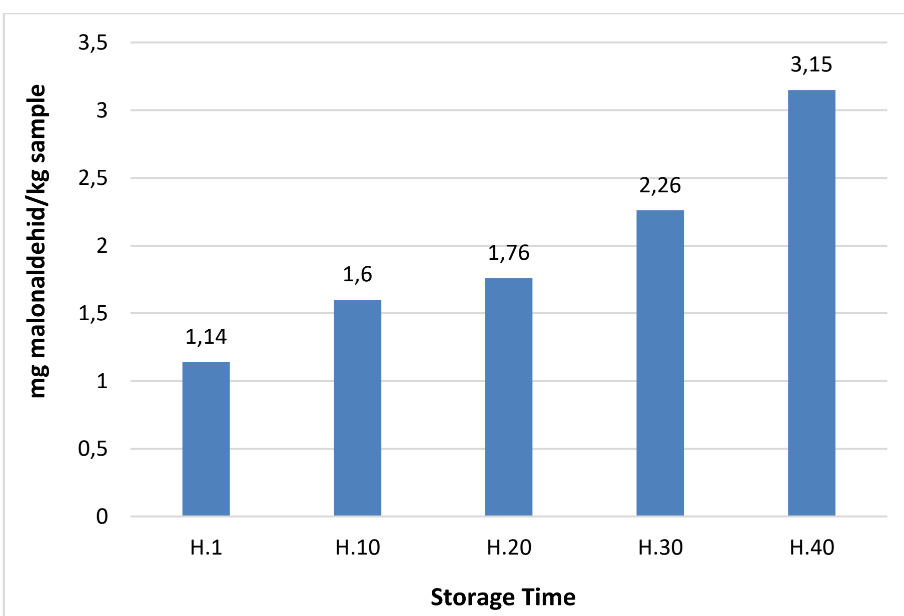

Figure 11. Graph of TBA Number of Patin Skin Crackers

Based on Figure 11, the results of the determination of the number of TBA with a wavelength of 528 nm on day 1 were 1.14 mg malonaldehyde / kg and increased to the 40th day of 3.15 mg malonaldehyde / kg sample. Oil or fat with a higher TBA value indicates that the oil is getting rancid or damaged. This shows that the greater the level of TBA produced, the quality of catfish skin crackers decreases.

The longer the storage time, the TBA number increases. An increase in the value of TBA during storage occurs because of the destruction of fat that causes rancid odors and taste due to oxidation reactions between unsaturated fatty acids contained in food products with air. Free fatty acids are formed due to the process of oxidation and hydrolysis of enzymes during processing and storage. High content of free fatty acids will affect the quality of fried products.

3. 4. Shelf Life Determination

Shelf life is the time until the product experiences a certain level of quality degradation so it is not suitable for consumption or no longer in accordance with the criteria stated on the packaging (quality is no longer in line with the promised quality level), due to deterioration reactions that take place. Deterioration reactions cause a decrease in quality and deliver the product to a low quality condition that is not suitable for consumption. Deterioration reaction will cause changes to the products of catfish skin crackers in terms of appearance, odor, texture and moisture content of the product.

Determination of critical values in catfish skin crackers is obtained from the hedonic test and water content evaluation parameters. The choice of reaction order is done by plotting the data of quality degradation following the zero and reaction order one and then making the linear regression equation.

Table 6. R^2 value of each parameter.

Number	Parameters	R^2	Ea (Kj/mol)
1	Appearance	0.9062	7408.75
2	Odor	0.9212	8978.54
3	Texsture	0.8110	9685.31
4	Taste	0.7336	12041.78
5	Water content	0.3131	52688.00

The parameter that has the greatest correlation coefficient (R^2) on catfish skin crackers is the odor parameter. R^2 value of cracker products means 92% of odor changes are affected by storage time (Table 6). Catfish skin crackers have an Arrhenius equation Ln K = 1079.8−5.5161 (1/T). Calculation of shelf life of catfish skin cracker products is based on data of quality degradation on odor hedonic test evaluation parameters with the Arrhenius model ASLT method, if it is assumed the temperature during distribution and storage is room temperature 25 ºC or 298 K for 39,82001 (39 days or 1.3 months). The critical point in the storage of catfish skin crackers temperature of 25 ºC, 35 ºC and 45 ºC, is odor. So that at a temperature of 25 ºC catfish skin crackers are lower in shelf life than at 35 ºC and 45 ºC.

4. CONCLUSIONS

The shelf life of catfish skin crackers stored at 25 ºC has a shorter shelf life than at 35 ºC and 45 ºC. The shelf life of catfish skin crackers stored at room temperature (25 ºC) is 39 days or 1.3 months. The shelf life of catfish skin crackers (temperature 35 ºC) is 44 days or 1.4 months, and at (temperature 45 ºC) the shelf life is 50 days or 1.6 months.

Catfish skin crackers at a temperature of 35-45 ºC have a longer shelf life because the storage at the quality of the dry temperature of fish skin crackers will be maintained, especially in water content. The higher the storage temperature, the lower the water content stored in the product.

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