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Estimation of The Shelf Life of Wedang Uwuh Ready to Drink with Blanching and Non Blanching Treatments

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Abstract – **Wedang uwuh developed into a ready-to-drink beverage which began to be produced commercially. Determination of shelf life needs to be done to determine the time span and provide quality assurance from the start of production until it is not acceptable to consumers. One of the factors that influence changes in quality is temperature. The main parameters used are pH and color which are considered to most affect the chemical and physical quality of a product. The purpose of this study was to determine changes in pH and color during storage and the shelf life of ready-to-drink Uwuh Wedang. The shelf life estimation method used is the Accelerated Shelf Life Testing (ASLT) Arrhenius approach with storage temperatures of 40°C, 50°C and 60°C thereby accelerating quality degradation. Observations every day - 0, 3, 6, 9, 12, and 15 with three repetitions. Color analysis uses two-way analysis of variance (ANOVA). The research data showed that the shelf life of wedang uwuh ready to drink blanching treatment sequentially at 40°C, 50°C, and 60°C was 18, 15, and 12 days. While wedang uwuh ready to drink non blanching sequentially, we have 10, 9, and 9 days. Storage temperature and time have a significant effect on the color change of ready-to-drink blanching and non-blanching wedang uwuh. Ready-to-drink Wedang Uwuh turns red to brownish orange and the color of Wedang Uwuh ready to drink from blanching treatment is brighter than non-blanching.**

Keywords *- Quality, Temperature, Ready to Drink, Shelf Life, Wedang Uwuh.*

INTRODUCTION

Wedang uwuh is made from various natural spices with a distinctive red color, spicy aroma, sweet and spicy taste [1]. Based on the results of an interview with one of the colors of Imogiri Bantul, the original Imogiri wedang uwuh consists of ginger, clove leaves, nutmeg leaves, cinnamon leaves, secang wood, and rock sugar. The ingredients used in the ready-to-drink wedang uwuh are ginger, secang wood, cinnamon leaves, nutmeg leaves, clove leaves and stalks [2].

The modern era requires food product manufacturers to develop food products that are fast and easy to consume, while still paying attention to product quality. Wedang uwuh is mostly sold in the form of steeping or from dry ingredients which are processed into powder. Consumers must brew the wedang uwuh first so that the development of wedang uwuh ready to drink needs to be done. However, ready-to-drink wedang uwuh easily experiences a decrease in quality so that the shelf life is not long [1].

pH and color are the main parameters used to see the decline in product quality. The pH parameter is the degree of acidity to indicate the acidity or alkalinity of a material. The degree of acidity of food products must be considered because it can affect the chemical quality of the product [3]. One of the physical attribute parameters that influence consumer acceptance of wedang uwuh ready to drink is color [4].

Changes in pH during storage indicate a reaction or damage to the constituent components of a food so that it can increase or decrease the pH value. Changes in pH during storage indicate that the food

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is less stable during storage. Changes in pH are caused by environmental factors such as temperature and poor storage. pH is one of the factors that can affect microbial growth [5].

The effect of pH on bacterial growth is related to the activity of enzymes to catalyze reactions related to bacterial growth [6]. The occurrence of the fermentation process produces alcohol (ethanol), yeast, CO2, and organic acids so that the taste of the product becomes sour as indicated by a decrease in the pH value [7]. Color change can be affected by storage temperature factors [8]. Color can be affected by pigment content, pH, temperature, oxygen and light [9]. pH affects the color change that occurs. Changes in pH and color can be affected by the ingredients used [10]. Changes in pH are influenced by environmental factors such as temperature, storage time, ingredients, and the formulation of the ingredients used [11].

The durability level of ready-to-drink wedang uwuh during storage is known by estimating the shelf life. Shelf life is the time span from manufacture to consumption of a product before the product is degraded, damaged and unfit for consumption. The shelf life test explains how long the product can last with the same quality during storage [3]. It is necessary to pay attention to the determination of the shelf life of new products in the research and development process as an effort to guarantee food quality and safety [12]. Government Regulation of the Republic of Indonesia Number 69 of 1999 Article 3 which discusses Food Labels and Advertisements that one of the food product labels must contain information on the expiry date, month and year [13].

Observation of changes in product quality during the storage process until the product is not accepted by consumers is carried out to determine the estimation of product shelf life [14]. The method used for estimating shelf life is the Accelerated Shelf Life Testing (ASLT) method. This method determines the shelf life of a product on critical parameters by accelerating the quality change reaction. The use of environmental conditions in this method can accelerate product damage. Heat affects extreme storage temperature conditions resulting in a decrease in the quality of a product's critical parameters. Environmental conditions in the ASLT method are abnormal conditions which result in faster degradation of the product so that its shelf life can be determined [15].

The temperature used for storage is a higher temperature than the normal storage temperature so that the experimental conditions for accelerating the desired shelf life can be obtained. The Arrhenius approach ASLT method is carried out by storing products in packaging at a minimum of three extreme storage temperatures [16]. In addition, three storage temperatures are used because to obtain an appropriate relationship with the storage time a minimum of five points are used, namely one point at the beginning of storage, three points in the middle of storage, and one final point where it is suspected that the product has been damaged. In general, the testing time used is more than the product estimation time after the product has experienced a decline in quality [3]. Temperature affects changes in pH, the higher the temperature, the pH value decreases with increasing heating and storage temperatures [17]. Temperature can affect color change, namely reducing color stability during storage. Each storage temperature has a different response to changes in the time range when the color change occurs [8].

Tests carried out using the Arrhenius model with an increase in test temperature aim to accelerate product damage. The product will experience a change in quality at high temperatures so that it can be seen how the effect of time and temperature is owned by the product until the product is declared damaged and unfit for consumption [18]. Therefore, in this study, we will observe the quality of wedang uwuh. Observation of ready-to-drink wedang uwuh quality parameters, namely pH and color analysis.

METHOD

Design, place and time

The research was conducted at the Food Chemistry and Food Engineering Laboratory, Food Technology Study Program, Ahmad Dahlan University. Laboratory of the Faculty of Agricultural Technology, Gadjah Mada University. The research was conducted in September 2022-January 2023.

Materials and tools

The main ingredients used in making wedang uwuh ready to drink are ginger, nutmeg leaves, cinnamon leaves, clove leaves, clove handles, and sappan wood obtained from CV. Progress Jogja. Meanwhile, other additional ingredients include rock sugar, 19 liters of mineral water (AQUA), and 250 ml of distilled water. The tools used include a 2-burner stove (Rinnai), a stainless steel pan with a

diameter of 20 cm, a plastic filter with a diameter of 18.5 cm, plastic and glass containers, PET plastic bottles (1) 150 ml, digital scales AND SJ- 5001HS and taffware digipounds i2000, 50 ml beaker (Iwaki), 100 ml measuring cup (Iwaki), alcohol thermometer S-006 (GEA), 1 door cabinet dryer, pH meter Ohaus Starter Pen Meter ST20, and Chroma meter CR-400 (Konica Minolta).

Research stages

This study aims to determine the shelf life of wedang uwuh ready to drink blanching and non blanching treatment. The stages of this research include trial and error, material preparation, manufacture, storage and sample observation. The wedang uwuh formulation in this study is presented in Table 1.

Table 1. Wedang uwuh formulation ready to drink with blanching and non blanching treatment

Material	Formulation
Ginger (g)	6,75
Cup of wood (g)	1,5
Cinnamon leaves (g)	0,225
Clove leaves (g)	0,225
Nutmeg leaves (g)	0,225
Clove algae (g)	0,225
Rock sugar (g)	5
Water (ml)	150

Making wedang uwuh ready to drink

The process of making wedang uwuh by weighing the ingredients according to the formulation in Table 1. The ingredients that have been weighed are then sorted to separate out poor quality such as dry or rotten. Furthermore, the material is washed using water to remove soil and other impurities. Peeling and size reduction were carried out on sappan wood and ginger. After all the ingredients were clean, water blanching was carried out at 100°C for 1 minute for blanching samples [19] and no treatment for non-bleaching samples. After this treatment, all materials were dried with a cabinet dryer at 55°C. The drying time for sappan wood is 12 hours, ginger 7 hours, cinnamon leaves, nutmeg leaves, clove leaves and clove handles 4 hours. All the dried Wedang Uwuh ingredients and rock sugar are then boiled in boiling water at 80-85°C for 15 minutes to produce Wedang Uwuh ready to drink. After boiling, it is cooled to low temperature and filtered to separate the ingredients from the juice. The ready-to-drink Wedang Uwuh is then packaged in a 150 ml PET bottle.

Storage of wedang uwuh ready to drink

Wedang uwuh was stored at several storage temperatures, namely 40°C, 50°C, and 60°C. Wedang uwuh ready to drink is packed in 150 ml warm PET (polyethylene terephthalate) plastic bottles. Packaging is carried out in warm conditions to minimize product contamination and suppress air in the bottle to escape thereby minimizing oxygen in the package which will accelerate product damage. PET plastic bottle packaging is a plastic polymer resin from the polyester group. PET has the general properties of being transparent, clean, resistant to temperatures up to 60°C, water vapor and gas permeability is very low [20]. PET packaging functions better to maintain the color quality of stored products than PP (polypropylene). PET polymer packaging is more economical, has lower permeability to water and oxygen and is more effective in maintaining the color quality of a product [4].

pH analysis

pH is the degree of acidity to indicates the acidity or alkalinity of a material. The degree of acidity in food products must be considered because it can affect the chemical quality of the product. The degree of product acidity during storage is used as an indicator of the growth of microorganisms in food products. Microorganisms are also identified by their degree of acidity, where bacteria generally grow faster at a pH of 6-8 [3]. The pH analysis aims to determine the pH value compared to the standard value of the herbal drink.

Testing with a pH meter tool begins with a sample of 150 ml of wedang uwuh drink placed in a beaker glass. The pH meter is turned on and then put into the distilled water, wait until the normal pH is 7. Then the pH meter is inserted into the Wedang Uwuh beverage product until the pH meter displays a number. Wait until the numbers stop, then record the pH on the digital pH meter display [21].

Color Analysis

Color as one of the parameters of physical properties influences the level of acceptance of ready-to-drink Uwuh Wedang. The color of wedang uwuh ready to drink was observed with the Minolta CR-400 chroma meter. The color change test is carried out by scanning the L* a* and b* points every 3 days of testing. The color test method using the CR-400/410 Chroma meter starts with the chroma meter calibrated with the white standard on the tool. The ready-to-drink Wedang Uwuh sample is poured as much as 5 ml in a transparent container and covered

with a lid so that there are no air bubbles. Then it is dried and done with a white and clean background. The chroma meter scanner is placed over a cup filled with ready-to-drink Uwuh Wedang. Scanning is carried out until the flash light comes out from the chroma meter scanner and the measurement value is seen on the device screen [22].

Estimation of ready-to-drink wedang uwuh shelf life using the ASLT method

Estimation of shelf life using the ASLT method is carried out after all the test data have been obtained. Estimating the shelf life of the Arrhenius approach is carried out by making data on changes in product quality over time. Data processing is done by making a graph between changes in quality over time. Next create a linear regression equation in the equation [3]:

$$y = a + bx \quad (1)$$

y is the change in product quality, x is the storage time, a is the value of the initial product quality, and b is obtained from the slope or k is the rate of change in product quality. Then determine the order of the reaction by making a graph. A graph of order 0 is made by plotting the value of k with storage time. The graph of degradation of order 0 is a constant degradation and is described by the following equation:

$$At-A0 = - kt \quad (2)$$

Information:
At = quality parameter value at time t
Ao = initial value of quality parameters
k = rate of change in quality
t = storage time

Order 1 graphs are made by plotting ln k values with storage time. The correlation of decreasing quality parameters for order 1 is described by the equation:

$$\ln At – \ln Ao = - kt \quad (3)$$

Choose the order of the most influential reaction by looking at the value of R^2, that is, choose the largest value or close to 1. After that, make a graph of the relationship between the rate of degradation of the product and the storage temperature using the Arrhenius approach. Make a graph that relates the value of ln k to 1/T first. Make a linear regression equation with the equation:

$$\ln k = \ln k0 – (E/R)\ (1/T) \quad (4)$$

Information:
ln k0 = intercept,
E/R = slope,
E = activation energy and
R = 1.986 cal/mol K (ideal gas constant)

The value of the constant ko and the value of E=Ea is obtained from the graph of the relationship between the ln k value and 1/T. Calculate the Arrhenius constant using the equation:

$$k = k0.e\text{-}E/RT \quad (5)$$

Calculating the parameters that have the most influence on the decline in product quality by looking at the parameters that have the lowest activation energy values. Calculation of estimating shelf life with the equation [23]:

$$ts = (A0\text{-}At)/k \text{ for order 0} \quad (6)$$
$$ts = [\ln (At/A0)]/k \text{ for order 1} \quad (7)$$

Information:
ts = shelf life
A0 = initial quality characteristic value
At = final quality parameter value (critical limit)
k = value of K at storage temperature T

Estimated value of shelf life at a certain storage temperature using the reaction rate equation.

Processing and analysis of data

The shelf life estimation method used is the Accelerated Shelf Life Testing (ASLT) Arrhenius approach with the pH parameter. The obtained pH data were analyzed using Microsoft Excel. The experimental design to be used in this study was a completely randomized design with two factors, namely temperature (40°C, 50°C, 60°C) and storage time (0, 3, 6, 9, 12, 15 days) . The color data obtained were analyzed by two-way analysis of variance (ANOVA) at a significance level of α = 0.05 using SPSS Statistics 29. If there is a significant difference, then it is continued with a further test using Duncan's test at a significance level of α = 0.05.

RESULTS AND DISCUSSION

Estimation of shelf life using the ASLT method with pH parameters

Estimation of the shelf life of wedang uwuh ready to drink blanching and non blanching treatment using

the ASLT Arrhenius approach. Here wedang uwuh ready to drink blanching can be seen in Figure 1.


Blanching


Non blanching

Figure 1. Wedang uwuh ready to drink

Wedang uwuh ready to drink blanching treatment

The coefficient of determination (R^2) of order 1 is greater than order 0 so that order 1 is the reaction order in determining shelf life. The choice of reaction order is based on the highest determination coefficient of each parameter. The coefficient of determination obtained is then compared and the highest or close to 1 is selected [24]. The value of R^2 obtained from three temperatures, order 1 is greater so that order 1 is the reaction order in determining the shelf life of the Arrhenius approach.

Table 2. The relationship between ln k and 1/T order 1

Quality	Temperature (K)	Order 1		
		Slope (k)	1/T	ln k
pH	313	0,0111	0,0032	-4,5008
	323	0,0154	0,0031	-4,1734
	333	0,0158	0,0030	-4,1477

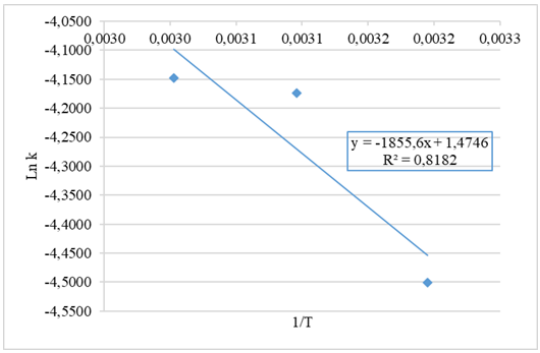

Figure 2. Link ln k with 1/T for order 1

Table 3. Arrhenius Equation Results y = -bx +a

Order 1		
Ea/R (Slope)	ln k0 (*Intercept*)	R^2
1855,6	1,4746	0,8182

The critical point for the ready-to-drink Wedang Uwuh pH chosen is pH 6 (lowest pH) based on the pH standard of Wedang Uwuh drink with the addition of the crown of the god fruit which is safe to consume is 6 – 8 [25].

Table 4. Calculation results of k values at storage temperatures of 40°C, 50°C and 60°C

	Order 1		
Temperature (°C)	40°C	50°C	60°C
Temperature (K)	313	323	333
1/T	0,0032	0,0031	0,0030
ln k	-4,4538	-4,2703	-4,0978
k	0,0116	0,0140	0,0166
t	17,7553	14,7780	12,4363
Shelf life (day)	18	15	12

Wedang uwuh ready to drink non blanching

The coefficient of determination (R^2) order 1 is greater than order 0 so that order 1 is the reaction order in determining shelf life. The choice of reaction order is based on the highest determination coefficient of each parameter. The coefficient of determination obtained is then compared and the highest or close to 1 is selected [24]. The value of R^2 obtained from three temperatures, order 1 is greater so that order 1 is the reaction order in determining the shelf life of the Arrhenius approach.

Table 5. The relationship between ln k and 1/T Order 1

Quality	Temperature (K)	Order 1		
		Slope (k)	1/T	ln k
pH	313	0,0213	0,0032	-3,8490
	323	0,0214	0,0031	-3,8444
	333	0,0248	0,0030	-3,6969

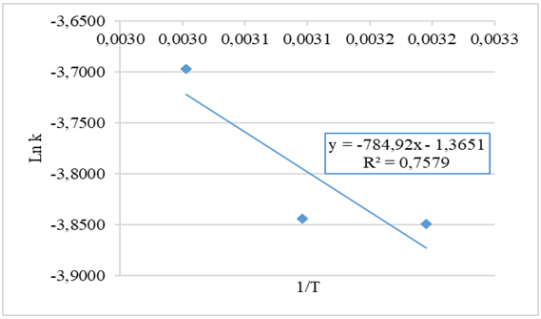

Figure 3. Link ln k with 1/T for Order 1

Table 6. Arrhenius equation results y = -bx +a

Ordo 1		
Ea/R (*Slope*)	ln k0 (*Intercept*)	R^2
784,92	-1,3651	0,7579

The critical point for the ready-to-drink wedang uwuh pH chosen is pH 6 (lowest pH) based on the standard pH of wedang uwuh drink with the addition of the crown of the god fruit which is safe to consume is 6 – 8 [25].

Table 7. Calculation results of k values at storage temperatures of 40°C, 50°C, and 60°C

	Ordo 1		
Temperature (°C)	40°C	50°C	60°C
Temperature (K)	313	323	333
1/T	0,0032	0,0031	0,0030
ln k	-3,8728	-3,7952	-3,7222
k	0,0208	0,0225	0,0242
ts	9,9312	9,1893	8,5426
Shelf life (day)	10	9	9

Estimation of the shelf life using storage temperatures of 40°C, 50°C, and 60°C obtained the results sequentially; the blanching treatment had a shelf life of 18, 15, and 12 days. While wedang uwuh non-blanching has a shelf life of 10, 9, and 9 days. From the Arrhenius equation, the results of the activation energy (Ea) of ready-to-drink wedang uwuh blanching treatment were 3685.2216 cal/mol K while non blanching were 1558.8511 cal/mol K.

Comparison of the results of estimating the shelf life of wedang uwuh ready to drink blanching and non blanching treatment

Shelf life estimation obtained showed that blanching uwuh drink has a longer shelf life than non blanching ready to drink uwuh drink. Based on the activation energy results, wedang uwuh ready to drink blanching treatment requires more energy to carry out the reaction to lower the pH than non blanching. So the ready-to-drink Wedang Uwuh product without blanching is more easily damaged than the blanching treatment.

The blanching treatment of raw wedang material before drying the material can minimize the loss of bioactive compounds and their activities and provide values close to fresh samples. Blanching before drying and hot air drying can be an efficient and low-cost alternative approach to crop preservation [26]. The lower the activation energy, the faster the reaction so that it contributes to a decrease in the quality of the drink [27].

The color change of wedang uwuh is ready for the drinking blanching treatment during the storage process

The effect of temperature and storage time on the overall L* (lightness) value shows a significant decrease in the L* value. Decreased value of L* in the blanching treatment of wedang uwuh. As the storage time and temperature increased, the color of the wedang uwuh changed from red to brownish orange. In accordance with the statement, the higher the L* value of the sample means that the sample has a lighter color [8]. The opposite also applies, the lower the L* value, the darker the color.

The effect of temperature and storage time on a* (redness) values as a whole showed a significant decrease in a* values. The a* value decreased on the 3rd and 9th day and then increased until the 15th day during the storage process. There was a decrease in the value of a* (redness) of wedang uwuh ready to drink non blanching. These results are in accordance with the temperature and storage time which increases resulting in a decrease in the value of a*. The a* value at low temperatures lasts longer than at high temperatures. The color a* increases when the color of the sample is reddish and decreases when it is yellowish [8].

The effect of temperature and storage time on the overall L* (lightness) value shows a significant increase in the decrease in a* value. The b* (yellowness) value increased on the 3rd and 9th day and then decreased until the 15th day during the storage process. The lowest b* value occurred on day 15. The increased storage temperature, light and storage time could cause the average b* (yellowness) value after storage to increase compared to before storage [8].

The color change of wedang uwuh is ready for non-blanching drinking during the storage process

Color analysis was also carried out on samples of non-bleached wedang uwuh which would be used as a comparison for blanching treated uwuh wedang samples. When viewed based on the results of the analysis and visually, changes in the values of L*, a*, and b* cause the color of wedang uwuh is ready to drink from red to brownish orange. These results indicate that the value of wedang uwuh ready to drink blanching and non-blanching during storage generally decreased at all temperatures. The highest

changes in L*, a*, and b* values were in the non-blanching Uwuh Wedang sample, indicating that the sample underwent discoloration faster than the blanching Uwuh Uwuh ready-to-drink treatment. Storage at a certain temperature affects changes in color intensity due to the stability of the dye, namely sappan wood brazilein in wedang uwuh which has shifted its equilibrium. Factors that affect brazilein are pH, temperature and storage time. The level of acidity in accordance with the increase in storage time is the effect of pH on the color change [28].

The color change during storage is caused by the brazilein pigment found in sappan wood [4]. The results of the study were in accordance with the color stability test on the pH of brazilein secang wood extract pH 6-7 (neutral) producing a deep red color, whereas at pH 5 it is pink or brownish red [10]. Changes in the pH of the drink affect the resulting color. Increasing the pH of the drink produces a more intense red color. The pigment of sappan wood, namely brazilin, is red at pH 6-7 and at pH 8 and above it is purplish red, while at pH 2-3 the resulting color is yellowish [29]. Secang wood has a brazilin pigment which produces a red color. The color pigment affects the a* value in the sample. The addition of sugar in each treatment resulted in a caramelization process of sugar during cooking, causing the color to get darker [30].

Wedang uwuh ready to drink blanching and non-blanching treatment compared to packaged wedang uwuh which is stored at a cold temperature of 8-10°C, there is a change in the value of a* getting lower, L* and b* getting higher along with the length of storage time, which is 21 days. The color of wedang uwuh ready to drink packaging becomes brownish in color [4]. Based on the results of the analysis as a whole, there was an increase and decrease in the values of L*, a*, and b* caused by sample instability due to the influence of temperature and storage time causing the sample to become cloudy and sediment at the bottom of the bottle. These results also occurred in studies with samples of Dayak onion herbal drink, the precipitate formed during storage is probably a compound that does not contribute to antioxidant activity in Dayak onion herbal drink [31]. The difficulty in making ready-to-drink traditional drinks on a business scale is the formation of sediment during storage. The precipitate is a solid particle that is not suspended in water. In the research on dragon fruit juice drinks, the problems that occur in stored dragon fruit juice drinks also contain sediment [32].

CONCLUSION

The shelf life of wedang uwuh ready to drink blanching treatment using the ASLT method with the Arrhenius approach at 40°C, 50°C, and 60°C were 18, 15, and 12 days respectively. While wedang uwuh ready to drink non blanching sequentially, we have 10, 9, and 9 days. Changes in the pH of the ready-to-drink blanching treatment and the non-blanching ready-to-drink broth during storage were the blanching treatment-ready-to-drink wedang had a higher final pH than the non-bleaching ready-to-drink wedang. The effect of temperature and storage time had a significant effect on the color change of wedang uwuh ready to drink blanching and non-blanching treatment.

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