International Journal on Advanced Science Engineering Information Technology

Vol.14 (2024) No. 3
ISSN: 2088-5334

The Effect of Addition *Carrageenan* and Citric Acid on the Shelf Life of Moringa Leaf (*Moringa oleifera*) Jelly Drink

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***Abstract*—The research aims to determine the effect of adding carrageenan and citric acid on the characteristics and shelf life of Moringa leaf jelly drinks. The experimental method was a completely randomized design with two factors: carrageenan concentrations (0.2%; 0.3% and 0.4%) and citric acid concentrations (0.1% and 0.2%). The parameters tested were crude fiber, total acid, antioxidant activity, mineral content, pH, viscosity, turbidity, color, and organoleptic (aroma, taste, texture, and color). The results showed that the interaction of the addition of carrageenan and citric acid had a significant difference in total acid, pH, mineral content, and viscosity but had no significant difference in crude fiber, antioxidant activity, turbidity, and organoleptic properties. The addition of 0.4% carrageenan and 0.1% citric acid is recommended as the best quality with a crude fiber 19.66%; total acid 2.63%; pH 3.14; Ca 275.19 ppm, Zn 30.71 ppm; Fe 1.44 ppm; antioxidant activity 63.69%; viscosity 17.73 cps; turbidity 114.67 ntu; slightly sour; orange in color and has an easily aspirated or semi-solid texture. The jelly drinks were stored using hot-filled PET bottles for 12 days at 10°C and 30°C. The calculation results of the Arrhenius model selected the pH value parameter as a critical parameter to determine the shelf life of the jelly drink, and the best treatment was 23 days at 10°C and 10 days at 30°C.**

***Keywords*— Arrhenius; ASLT; jelly drink; Moringa leaves; shelf life.**

Manuscript received 6 Aug. 2023; revised 1 Nov. 2023; accepted 20 May. 2024. Date of publication 30 Jun. 2024.
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I. INTRODUCTION

Many people prefer practical foods and drinks because they are easy to consume, including jelly drinks. Jelly drink is a practical drink, not just an ordinary drink, but can be consumed as a hunger delay drink [1]. However, the nutritional content of jelly drinks circulating in the market is limited to the content of sugar, fiber, and sodium, so to increase nutritional value, such as protein content in jelly drinks, you can add or use highly nutritious ingredients such as Moringa leaves. Moringa leaves can be used as an additional ingredient for jelly drinks because Moringa leaves contain lots of nutrients, especially protein and vitamins, and can boost the body's immune system [2].

Moringa leaves (*Moringa oleifera*) are highly nutritious because they contain 11300 IU of vitamin A, 440 mg of calcium, 6.7 g of protein, and 7 mg of iron. In addition, Moringa also contains nutrients and compounds that are important for the body in the form of phytochemicals such as tannins, steroids, triterpenoids, saponins, anthraquinones, and alkaloids. To increase the nutritional value of Moringa, it can be processed into powder or flour. Moringa flour contains 25.3% protein and 24.97% dietary fiber [3]. Other research that was done by [4] found that Moringa flour has 28.41% protein, 5.21% fat, 8.72% crude fiber, 17.14 mg of Zn, 113.1 mg of Ca, 2760.84 mg of Mg, and 141.46 mg of Fe. Based on the research conducted [5], adding 40.95% Moringa extract to the instant drink can increase the antioxidant activity to 0.00039 and iron content to 5.41 µg/ml. Adding 20% Moringa extract can increase the protein content to 7.44% and vitamin C to 87.82 mg in jelly drinks [6]. Other research that was done by [7] revealed that the use of Moringa leaf extract made from Moringa leaf powder and water in comparison 1:10 indicates a carbohydrate yield of 18.97 g/100 g, fiber 3.11 g/100 g, vitamin B 0.38 mg/100 g, vitamin C 98.83 mg/100 g, calcium 213.80 mg/100 g, and potassium 112.40 mg/100 g.

A jelly drink is a beverage product in the form of a and has the characteristics of being a thick liquid and easy to drink [8]. Therefore, gelling agents are needed to form a gel in jelly drinks. The process can achieve texture criteria for jelly drinks by adding a gelling agent such as carrageenan. Carrageenan is a binder for jelly drinks because it can form gels in hot-to-cold solutions and is used in the food industry to control the water content of main food ingredients. Carrageenan is essential as a stabilizer (thickening agent), gelling agent, emulsifier, and other material.

Jelly drinks are also one of the practical and ready-to-drink packaged drinks that are popular with the public, so shelf life must be considered. The expiration date on the label is the shelf life or the time limit for the drink to be suitable for consumption. Shelf life is the time between production and consumption when the product is ideal for consumption [9]. Based on the results of observations made at one of the SMEs in Lombok, West Nusa Tenggara, Moringa leaf drinks stored at room temperature (around 25˚C-30˚C) produce drinks that have a shelf life of only 2-3 days, judging by the decrease in quality, which gives rise to an unpleasant odor, damaged texture, and brown color. At cold temperatures (around 10˚C - 15˚C), it produces drinks with a shelf life of $\leq$ 7 days, as seen from the decreased quality of the changing color and less concentrated taste.

Therefore, to extend the shelf life of the jelly drink, it is necessary to add food additives, such as citric acid, which attempt to slow down the rate of deterioration. The function of citric acid in the food and beverage industry as a preservative is preventing browning/discoloration and aroma, maintaining turbidity, and inhibiting oxidation[10].

Research conducted by [11] found that using citric acid in sheet jam affects water content, pH, and water activity; the more citric acid is added, the lower the water content and water activity. Bacteria can only grow at neutral pH (6.6-7) and not at acidic pH, below 3.5. According to [12], the parameters used to determine changes in the quality of drinks during their shelf life are influenced by temperature, one of which is pH. The pH value is considered an essential index of deterioration in beverage quality as it can indirectly indicate changes in product internals such as microbial activation. If the pH range is <5.0, the microbial activation is low, so quality drinks do not deteriorate quickly and have a long shelf life.

Several factors, such as raw materials, method of manufacture, temperature, and storage time, influence the quality of jelly drinks. During the shelf life or marketing of beverage products, the quality decreases. Temperature is a factor that affects changes in the quality of drinks. The higher the storage temperature, the faster the reaction rate of various chemical compounds. Therefore, in estimating the speed of degradation of drinks during storage, the temperature factor must always be considered [13]. According to [14], the Arrhenius model estimates shelf life by measuring the rate of handling quality parameters. It is commonly used to estimate the shelf life of temperature-sensitive food products. The study aimed to investigate the use of carrageenan as a gelling agent and citric acid as a preservative on the characteristics and shelf life of Moringa leaf jelly drinks.

II. Materials and Method

A. Materials

The tools used in this study were a blender (Philips, The Netherlands), 100 mL PET hot fill bottle, 100 ml cup, funnel, cabinet dryer, Erlenmeyer, beaker glass, measuring cup, label paper, filter cloth, gas stove, pot, water bath, spatula, analytical balance (ABJ, Germany), test tube, petri dish, pipette, oven, vortex, titration apparatus, desiccator, Whatman paper, pH meter, viscometer (Brookfield type), aluminum foil, turbidity meter, 80 mesh sieve and colorimeter apparatus (MSEZ User Manual). The materials used in this study were aquadest, citric acid (Koepoe-Koepoe brand), H_2SO_4, buffer solution, carrageenan (obtained from UD. Harkat Makmur), PP indicator, NaOH, methanol, DPPH, flavor, lemon (Red Bell), granulated sugar, and Moringa leaves (obtained from Selong, East Lombok).

B. Methods

The method was a two-factor Completely Randomized Design (CRD), namely the addition of carrageenan (P) and citric acid (K) with six treatments, namely P1K1 (0.2%:0.1%), P1K2 (0.2%:0.2%), P2K1 (0.3%:0.1%), P2K2 (0.3%:0.2%), P3K1 (0.4%:0.1%), and P3K2 (0.4%:0.2%). This research was carried out in two stages. The first stage was to determine the best product quality in leaf jelly drink, and then the shelf life was researched using the Arrhenius method.

C. Data Analysis

Observational data were analyzed by Analysis of Variance at a 5% significance level using Co-stat software and further tested by the Honestly Significant Difference (HSD) for all parameters at the same significance level.

D. Sample Preparation

1) The procedure of Making Moringa Leaf Extract: The first stage of producing Moringa leaf extract was making Moringa leaf flour. The stages of making flour were sorting, washing raw materials, draining, and blanching, carried out at 80°C for 3 minutes to inactivate enzymes, then dried at 50°C for 90 minutes in a drying cabinet, pulverized and sieved with 80 mesh sieves. The stage to produce Moringa leaf extract based on modified by [5], which was carried out using the infusion method. This method does not use a mixture of chemicals during the extraction process, so it does not affect the taste and aroma and is safe for consumption. The process begins with extracting Moringa leaf flour with a mixture of water, in a ratio of 1:10, heating at 90˚C for 15 minutes while stirring until homogeneous. After extraction, it is filtered using a cloth to obtain Moringa leaf extract.

2) The procedure of making Moringa leaf jelly drink: The procedure for making Moringa leaf jelly drink refers to [15]. All ingredients, such as 100 mL of Moringa leaf extract, 3 g of sugar, 1 mL of lemon flavor, citric acid, and carrageenan, are mixed. In the next step, the mixture is heated for 5 minutes while stirring at 70˚C until homogeneous and filtered two times until there is no fiber. For the second research, the shelf life refers to the process as studied by [9] that the prepared Moringa leaf jelly drink is poured into a

100 mL PET hot fill bottle and pasteurized for 30 minutes at 70˚C, followed by a cooling process at room temperature.

3) Parameters: Parameters observed in this study are crude fiber content, total acid, antioxidant activity, mineral content, pH value, viscosity, turbidity, color (˚Hue), and organoleptic, which included aroma, taste, texture, and color.

III. Results and Discussion

The research data included chemical, physical, and organoleptic parameters. The results of the analysis of these parameters are given in Table 1.

A. Chemical Parameters

1) Crude Fiber:

Crude fiber is part of carbohydrates and is defined as the fraction that remains after being digested with standard sulfuric acid and sodium hydroxide solutions under controlled conditions. Measuring crude fiber can be done by removing all dissolved acid by boiling it in sulfuric acid [15]. According to the study's results, the interaction between the adding carrageenan and citric acid had no significant effect on the crude fiber of the Moringa leaf jelly drink. Nevertheless, there was a significantly different effect on the addition of carrageenan. Table 1 shows that the higher the concentration of added carrageenan, the higher the crude fiber value. According to [16], the higher the use of carrageenan, the higher the crude fiber content. However, carrageenan can decrease the crude fiber content by simultaneously adding citric acid. It refers to research conduct [17] that adding lime, which contained citric acid, did not give results significant to the ratio. Content crude fiber in rations without lime and ration with lime juice (1.5 mL; 3 mL; 4.5 mL) were the same.

TABLE I
Data on the Results of Chemical, Physical, and Organoleptic Quality Analysis of Moringa Leaf Jelly Drink

Test Parameters	Treatment					
	P1K1	**P1K2**	**P2K1**	**P2K2**	**P3K1**	**P3K2**
1. **Chemical Quality**						
Crude Fiber Content (%)	4.17^{aB}	3.02^{aB}	5.65^{aB}	4.05^{aB}	19.66^{aA}	13.86^{aA}
Total Acid (%)	0.65^{bB}	2.34^{aB}	2.47^{bA}	2.50^{aA}	2.63^{bA}	2.68^{aA}
Antioxidant Activity (%)	63.01^{aA}	63.69^{aA}	62.25^{aA}	62.81^{aA}	63.69^{aA}	61.97^{aA}
pH value	3.57^{aA}	2.86^{bA}	3.41^{aB}	2.84^{bB}	3.14^{aC}	2.80^{bC}
Mineral Content Ca (ppm)						
Zn (ppm)	380.61^{aA}	328.57^{bA}	246.16^{aC}	111.72^{bC}	275.19^{aB}	349.05^{bB}
Fe(ppm)	23.05^{bC}	7.01^{aC}	14.79^{bB}	39.45^{aB}	30.71^{bA}	34.97^{aA}
	0.43^{bC}	1.90^{aC}	0.93^{bB}	3.03^{aB}	1.44^{bA}	3.25^{aA}
2. **Physical Quality**						
Viscosity (cPs)	13.20^{aC}	3.73^{bC}	15.63^{aB}	4.37^{bB}	17.73^{aA}	4.47^{bA}
Color (˚Hue)	128.84^{aA}	121.11^{bA}	121.52^{aA}	125.72^{bA}	127.23^{aA}	120.42^{bA}
Turbidity (ntu)	104^{aB}	87.33^{bB}	90aB	86bB	114.67^{aA}	102.33^{bA}
3. **Organoleptic Quality**						
Hedonic Quality						
Taste	3.15^{aA}	3.40^{aA}	3.05^{aA}	3.15^{aA}	3.10^{aA}	3.15^{aA}
Texture	4.40^{aA}	4.10^{aA}	3.85^{aB}	3.60^{aB}	3.25^{aC}	3.15^{aC}
Flavor	3.90^{aB}	3.10^{bA}	3.10^{aB}	2.85^{bB}	3.00^{aB}	2.65^{bB}
Color	3.60^{aA}	3.75^{aA}	3.85^{aA}	3.75^{aA}	3.45^{aA}	3.75^{aA}
Scoring Quality						
Taste	2.65^{aA}	2.60^{aA}	2.45^{aA}	2.60^{aA}	2.95^{aA}	3.00^{aA}
Texture	4.35^{aB}	4.20^{aB}	4.30^{aB}	4.55^{aB}	4.65^{aA}	4.60^{aA}
Flavor	2.40^{aB}	3.60^{aB}	2.70^{aB}	3.40^{aB}	3.30^{aA}	3.70^{aA}
Color	3.65^{aA}	3.70^{aA}	3.30^{aA}	3.35^{aA}	3.25^{aA}	3.55^{aA}

Note: The numbers followed by different lowercase letters show significantly different (significant) according to the HSD test at the 5% level
Hedonic test score: 1 = really dislike; 2 = dislike; 3 = like rather; 4 = like; 5 = really like
Scoring test score: smell (1 = not very unpleasant; 2 = not unpleasant; 3 = somewhat unpleasant; 4 = very unpleasant, 5 = very unpleasant)
Texture (1= very not easily aspirated; 2 = not easily aspirated, solid; 3 = slightly aspirated; 4 = easily aspirated, semi-solid; 5 = very easily aspirated, slightly watery)
Taste (1 = very not sour; 2 = not sour; 3 = slightly sour; 4 = sour; 5 = very sour)
Color (1 = yellow; 2 = reddish-orange; 3 = orange; 4 = dark/dark orange; 5 = light orange)

2) Total Acid:

The total acid analyzed by titration is an analysis of the amount of acid in a solution. Total acid is used to express a food ingredient's acidity level [18]. According to the study results, there was a significant difference between the interaction of the addition of carrageenan and citric acid to the total acid of the Moringa leaf jelly drink. The addition of carrageenan and citric acid had a significant effect on the total acid of the jelly drink. The total acid obtained ranged from 0.65% (0.4% carrageenan concentration and 0.2% citric acid) - 2.68% (0.2% carrageenan concentration and 0.1% citric acid).

Table 1 shows an increase in total acid and citric acid addition. Based on [19], increasing the concentration of citric acid will increase the total acid titrated. The greater the amount of citric acid added, the greater the total value of acid titrated. This is due to citric acid as a source of acid, so the difference in the amount of acid added will cause a difference in the total value of the acid being titrated. Citric acid is also a hydroxy tricarboxylic acid, which, as an acid, can function to reduce acidity. However, increasing the concentration of carrageenan with a slight increase of citric acid can decrease total acid. According to [20], this is because the OH group in carrageenan (hydrocolloid) can bind water so that it can reduce the total acid. In addition, carrageenan also has potassium, potassium, magnesium, and sodium, which react with acids to form salts. Salt is bound with carrageenan, which can reduce acidity

3) Antioxidant Activity:

Antioxidants are components of nutritional and non-nutritional content in foodstuffs and function to prevent or prevent oxidative damage in the body. According to the study results, the interaction of carrageenan and citric acid with the antioxidant activity of Moringa jelly extract showed no significant difference. Table 1 shows that the addition of carrageenan is the same as the addition of citric acid (not significant). According to [21], Carrageenan, especially kappa-type carrageenan, functions as a micro encapsulant, increasing the adhesion between the wall and core materials to protect the antioxidant compounds contained in the beverage jelly from being affected by heating or thermal processes.

The resulting antioxidant activity was 63.01%, 63.69%, 62.65%, 62.81%, 63.69%, and 61.97%, respectively. This is because Moringa leaf flour is as much as 0.2 g, so the resulting antioxidant capacity in each treatment in that range is the same. The results of the analysis obtained referred to [22] that content of the antioxidant activity of leaf extracts Moringa has an antioxidant power of 35,777 ppm while the antioxidant compounds of Moringa leaves of 239.42 ppm, such as tannins, steroids, triterpenoids, phenolics, flavonoids, saponins, and alkaloids.

4) pH:

The measurement of acidity expressed by pH is critical because it affects the occurrence of sucrose inversion in the product. According to the results of the study, it was found that the interaction between the addition of carrageenan and citric acid had no significant difference in the pH value of the Moringa leaf jelly drink. The addition of carrageenan and citric acid had a significant effect on the pH of the Moringa leaf jelly drink. The pH values obtained ranged from 2.80 (0.4% carrageenan concentration and 0.2% citric acid) – 3.57 (0.2% carrageenan concentration and 0.1% citric acid). Table 1 shows that the addition of citric acid can decrease the value of the pH.

According to [23], citric acid is acidic and has a low pH, so adding citric acid to the product can cause the resulting product to have acidic properties. The results of this study are by research from [24] revealed that the pH value obtained was around 5.80 due to the loss of volatile compounds and total acid from mulberry pectin on heating and adding a thickening agent to reduce acidity. The total gelling concentration and the proportion of pouring flour and carrageenan added to increase the pH so that the pH becomes more alkaline. According to [25] The higher concentration of carrageenan increases the pH value of the jelly drink. This is because the carrageenan extracted from the alkaline solution of seaweed sap tends to have an alkaline pH, which can increase the pH value from 9.5 to 10.5.

5) Mineral:

Analysis of mineral content using Atomic Absorption Spectrophotometry. Based on the results of the study, it was shown that there was a significant difference between the interaction of adding carrageenan and citric acid to the levels of Ca, Zn, and Fe in the Moringa jelly drink. The analysis results showed that the concentration of carrageenan and citric acid had different effects on the Ca (calcium) of Moringa leaf jelly drinks. The obtained Ca mineral values ranged from 111.72 ppm (concentration of 0.3% carrageenan and 0.2% citric acid) – 380.61 ppm (concentration of 0.2% carrageenan and 0.1% citric acid).

Table 1 shows this increase was due to the relatively high levels of the mineral Ca contained in each component of the materials used, for example, carrageenan and Moringa leaf powder. According to [26] Carrageenan is a galactose polysaccharide extracted from seaweed; some carrageenan contains sodium, magnesium, and calcium bound to galactose ester sulfate groups and 3,6- anhydrous-galactose copolymers. Based on research from [22] It was found that Moringa leaf flour had a Ca mineral content of 16350.58 ppm, which caused very high Ca mineral levels ranging from 111.72 ppm to 380.61 ppm. This is by research from [27] that the calcium content in crackers of 324 mg/100 g is relatively high as a mineral source, this is due to the substitution treatment of Moringa leaf flour. In the mineral content analysis, carrageenan and citric acid concentrations had different effects on the Zn (zinc) of Moringa leaf jelly drinks. The Zn values obtained ranged from 7.01 ppm (0.2% carrageenan and 0.2% citric acid) – 39.45 ppm (concentration of 0.3% carrageenan and 0.2% citric acid).

Table 1 shows the results of the analysis of the Zn content (Zinc), which is quite high in the K2 treatment, namely 7.01 ppm each, 39.45ppm, and 34.97 ppm compared to the addition of K1 citric acid (0.1% concentration). The increase in Zn mineral is caused by citric acid reducing the amount of phytic acid contained in the content of Moringa leaf powder by (0.001-0.49%) to increase the Zn content. Based on research [28], which led to a decrease in the addition of citric acid phytic acid to corn feed to increase the bioavailability of Zn because phytic acid is an anti-nutrient mineral binding compound and the acidic nature will react with minerals and will decompose. Therefore, Zn binds with phytic acid to form insoluble complexes. In the results of the Fe (Iron) mineral content analysis, both treatments had a significantly different effect on the Fe content of the Moringa leaf jelly drink. The values of Fe obtained ranged from 0.43 ppm (concentration of 0.2% carrageenan and 0.1% citric acid) – 3.25 ppm (concentration of 0.4% carrageenan and 0.2% citric acid).

Table 1 shows an increase in the mineral content of Fe (iron) in the Moringa leaf jelly drink in line with the rise in carrageenan and citric acid. This is based on research from [29] that there is an increase in ash content due to the addition of seaweed powder or carrageenan because carrageenan contains minerals contained in seaweed. The addition of these minerals, such as Ca, Cu, and Fe, as well as the ash content of a material, is related to the mineral content of the material. Another study from [30] found an increase in ash content in dairy buffalo because seaweed contained the minerals Na, K, Cl, Ca, Mg, Fe, I, and S, which were relatively high. And what is used as the main ingredient is carrageenan.

B. Physical Parameters

1) Viscosity:

Viscosity is the degree of thickness of a food product. Viscosity is a fluid property and measure of fluid viscosity, which states the size of the friction in the fluid. Viscosity describes the fluid's resistance when flowing. The higher the value of the viscosity coefficient, the higher the fluid resistance to flow. According to [31], the study's results showed a significant difference in the interaction of adding carrageenan and citric acid to the viscosity of the Moringa leaf jelly drink. The treatment of adding carrageenan had a significantly different effect.

The viscosity of the Moringa leaf jelly drink is the same as the addition of citric acid, which gives a significantly different effect. The viscosity values obtained ranged from 3.73 cPs (0.3% carrageenan and 0.2% citric acid) – 17.73 cPs (concentration of 0.4% carrageenan and 0.1% citric acid). Table 2 shows that the decrease in viscosity caused the reduction in citric acid. This is based on research from [32], that an increase in citric acid can cause a decrease in gel strength through breaking bonds in the three-dimensional matrix formed by the kappa carrageenan complex. Carrageenan gel will be stable at neutral to alkaline pH; if the pH is below 4.3, namely 3.60-anhydrous-D-galactose undergoes autohydrolysis, which decreases viscosity. However, the more carrageenan is added, the viscosity value will increase. According to [33], increasing the concentration of carrageenan will increase viscosity. This is due to the free water contained in the pineapple jelly drink, where the hydrophilic carrageenan group molecules attach to form a gel. The higher the carrageenan, the greater the amount of free water that is absorbed and bound so that the jelly becomes stronger.

2) Color:

Color is an essential quality attribute in ingredients and food products. The ˚Hue value represents the dominant wavelength determining a material's color. According to the study's results, the interactions between the addition of carrageenan and citric acid had no significant effect on the color (˚Hue) of the Moringa leaf jelly drink. Table 1 shows that the treatment of adding carrageenan (non-significant) is the same as the addition of citric acid (non-significant).

The ˚Hue value of the resulting Moringa leaf jelly drink ranges from 120.42˚ in quadrant III (Yellow) to 128.84˚ in quadrant III (Yellow Green). The non-significant difference in ˚Hue is thought to be caused by citric acid, which can stabilize the color of jelly drinks. Besides, Moringa leaf extract contains antioxidants and tannins, which, when reacted with citric acid, the color changes to brownish yellow [34], as the characteristic of condensed tannins.

3) Turbidity:

Turbidity can be interpreted as a measure of the relative clarity of water. Turbidity is not a direct measure of suspended particles in water but a measure of the scattering effect of these particles on light [35]. According to the study's results, it was found that the interaction between the of adding carrageenan and citric acid had no significant difference in the turbidity of the Moringa leaf jelly drink. However, the addition of carrageenan and citric acid had a significant effect. The turbidity values obtained ranged from 86 ntu (0.3% carrageenan and 0.2% citric acid) – 114.67 ntu (concentration of 0.4% carrageenan and 0.1% citric acid).

Table 1 shows a decrease in turbidity with the addition of citric acid. The higher the citric acid used in the jelly drink, the lower the turbidity level will be. According to [36] that citric acid has a reasonably good resemblance because its solubility in water is high enough to maintain the turbidity and clarity of the resulting gel. Therefore, the greater the concentration of citric acid used, the more turbidity it can support and reduce in the Moringa leaf jelly drink.

However, adding carrageenan resulted in an increase in turbidity in the Moringa leaf jelly drink. The increase in turbidity level occurs because there is still a small amount of precipitate that is filtered out during the filtering process, which causes the color of the liquid to become cloudy. This precipitate comes from the hydrocolloid material in the form of carrageenan, which is used. According to [37] that the more hydrocolloid concentration added, the greater the level of solubility. This is because the number of hydroxyl groups increases with increasing hydrocolloid concentration, so the rate of water binding is easier and faster. Turbidity also occurs because of the possibility of high viscosity, so it looks more turbid. This is by research from [38] that to get a straightforward product, it must be turbid.

C. Organoleptic Parameter

1) Taste:

Taste is a subjective sensory attribute to the sense of smell because everyone has a different sensitivity. According to the study's results, the interaction between carrageenan and citric acid addition showed no significant difference in the hedonic test and scoring of the Taste of Moringa leaf jelly drink. However, the addition of carrageenan had a significantly different effect on the scoring of the aroma of the Moringa leaf jelly drink.

Table 1 shows that the results of the scoring test for the Taste of the Moringa leaf jelly drink ranged from 2.45 to 3.00 with the criteria of not unpleasant to somewhat unpleasant. According to [29], adding carrageenan and citric acid did not have a significantly different effect because the higher the carrageenan concentration, the lower the aroma value. Based on the interaction scoring test, adding carrageenan and citric acid did not significantly affect the Moringa leaf jelly drink. The aroma is due to the unpleasant aroma of the ingredients used, namely the smell of Moringa leaves. In addition, this was also because the list of panelists who conducted the aroma scoring test were semi-trained, so the panelists did not know the specific aroma of Moringa leaf jelly drinks in general.

2) Texture:

Texture is an attribute of a substance that results from a combination of various physical properties and is perceived by the senses of touch, sight, and hearing. These physical properties can be the constituent structural elements' shape, size, number, nature, and conformation. According to the study results, there was no significant difference between adding carrageenan and citric acid in hedonic testing and texture scoring of Moringa leaf jelly drinks. However, the treatment with the addition of carrageenan had a significantly different effect on the hedonic test and texture scoring of the Moringa leaf jelly drink.

Table 1 shows that the level of scoring (scoring) carried out by a list of 20 panelists had an effect that was not significantly different from the average panelist giving scores in the range of 4.20-4.65 (Slightly quickly aspirated or slightly dense – Very quickly aspirated, slightly dilute) with the highest value of 4.65. Adding carrageenan significantly affected the hedonic and texture scoring of the Moringa leaf jelly drink. The more carrageenan added, the chewier the texture of the Moringa leaf jelly drink. According to [39], at lower levels of carrageenan, it tends to produce a brittle gel so that the texture of this jelly drink is not felt when sucked.

3) Flavor:

Taste is an important parameter determining whether a product is acceptable according to consumer desires. According to the study results, there was no significant difference between adding carrageenan and citric acid on the hedonic test and scoring the flavor of Moringa leaf jelly drinks. However, adding carrageenan and citric acid significantly affected the hedonic test and texture scoring of the Moringa leaf jelly drink, with the average panelist giving a value of 2.65-3.90 (somewhat like it). The level of preference for taste in this Moringa leaf jelly drink is influenced by the addition of citric acid. According to [40] Taste is influenced by several factors, including concentration and its interaction with other taste components such as sugar or flavors. Flavors and citric acid give a sour taste while adding carrageenan and sugar can provide a sweet taste. The more carrageenan is added, the stronger the sweet taste. Therefore, the scoring test values obtained from sour to slightly sour taste are due to a mixture of citric acid and carrageenan.

4) Color:

Color is an important parameter because of the physical or sensory properties that consumers first see. Color involves the sense of sight more and is one of the indicators that determine whether or not food is accepted by consumers. According to the study's results, the interaction between adding carrageenan and citric acid had no significant difference on the hedonic test and scoring the color of Moringa leaf jelly drinks. Table 1 shows that the treatment of adding carrageenan (non-significant) is the same as the addition of citric acid (non-significant). The highest value was 3.70. The results of the color preference test based on the level of judgment (hedonic) gave an effect that was not significantly different. The level of color preference in the Moringa leaf jelly drink is influenced by the color of the additional ingredients, namely the added lemon flavor. According to [41], the yellowish-white color of carrageenan and white crystalline citric acid have no effect on the resulting product because it is dominated by the color of the additional ingredients used, namely lemon flavor.

The main research stage is on quality chemical, physical, and organoleptic properties. Moringa jelly drink produces the best P3K1 treatment with carrageenan addition concentration of 0.4% and citric acid 0.1%. This can be seen from the results the research obtained is fiber content 19.66%; total acid 2.63%; pH 3.14; minerals Ca 275.19 ppm; mineral Zn 30.71 ppm; mineral Fe 1.44 ppm, activity antioxidants 63.69%; viscosity 17.73 cPs; color 127.23 (yellow-green); turbidity 114.67 ntu; slightly sour taste; not flavorful unpleasant; orange in color and has a texture easily aspirated or semi-solid.

D. Shelf-Life Research Results

The process of storing Moringa leaf jelly drink with P3K1 treatment (added concentration of 0.4% carrageenan and 0.1% citric acid) was carried out for 12 days using hot filled PET bottles. Then stored at 2 different temperatures, namely 10˚C and 30˚C.

1) Critical Parameters of Moringa Leaf Jelly Drink:

In this study, the critical parameters of Moringa leaf jelly drink were determined by involving 20 panelists to select essential parameters that were considered critical parameters of damage to Moringa leaf jelly drinks, such as aroma, texture, taste, and color. The crucial point observations showed that the longer the storage, the lower the level of preference of the panelists for the Moringa leaf jelly drink. This is by research conducted by [42], which states that the longer and higher the sample temperature is stored, the lower the average hedonic score will be. The hedonic test was set on the panelist's preference score for aroma, texture, taste, and color, namely a score of 2 "dislike." This was due to the condition of the Moringa leaf jelly beverage product, which was considered to have been rejected for consumption by the panelists.

2) Changes in pH:

Figure 1 shows changes in pH values stored at various temperature variations. The longer the storage time, the higher the pH value of the product. The pH value in PET hot fill bottles during storage tends to increase at both temperatures, namely 10˚C and 30˚C. It is suspected that the longer the shelf life of the jelly drink, the more water components will come out. With increased water components in this drink, the pH value increases. The increase in pH is due to the large number of water components in the jelly drink during the shelf life, and the longer the osmosis time, the more water is extracted from the cells [29].

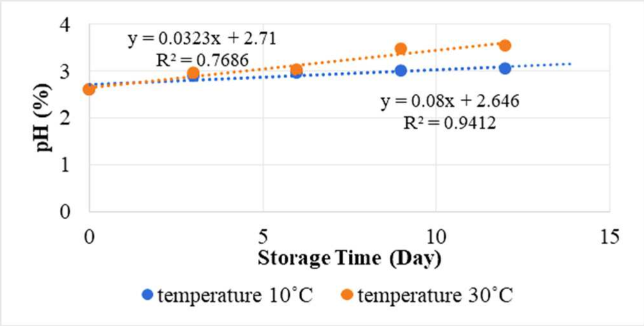

Fig. 1 Curve of relationship between storage time and pH value of Moringa Leaf Jelly Drink

TABLE II
PH VALUE OF MORINGA LEAF JELLY DRINK DURING STORAGE

Storage Time (Days)	Storage Temperature 10˚C	30˚C	Tipping Point
	pH value		
0	2.61	2.61	2.61
3	2.90	2.96	3.24
6	2.96	3.03	3.26
9	3.01	3.48	3.90
12	3.04	3.55	3.91

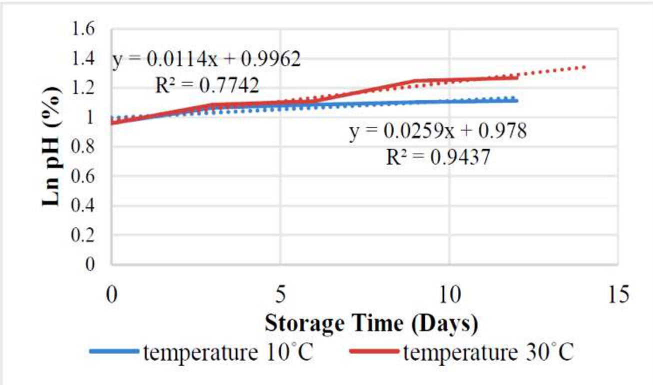

Fig. 2 Curve of relationship between storage time and Ln pH value of Moringa Leaf Jelly Drink

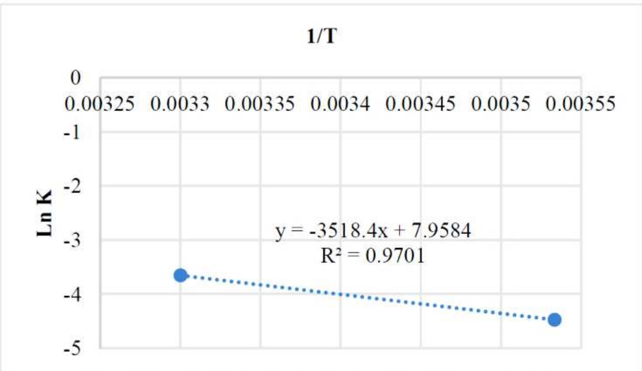

Fig. 3 Graph of Arrhenius Equation Determination

TABLE III
DETERMINATION OF THE SHELF LIFE OF MORINGA LEAF JELLY DRINKS

Temperature (˚C)	Critical Point	Initial pH Value	K	Shelf life (Days)	Shelf life (Months)
10˚C	3.91	2.61	0.0114	114. 035	4 months
30˚C	3.91	2.61	0.0259	50.193	1 months

3) Estimation of Shelf Life:

In determining the shelf life of Moringa leaf jelly drink products using the Arrhenius model, Table 2 shows the linear regression equation parameter of the pH value of Moringa leaf jelly drinks at various storage temperature variations. Reaction order 0 shows a linear relationship between pH value data and storage time (days). In contrast, reaction order 1 shows a linear relationship between Ln pH value at each storage temperature and storage time (days). The curve used to make the Arrhenius graph can be seen from the value of the correlation coefficient (R2). The most considerable R2 value will be used to determine the Arrhenius equation.

According to the calculation results of the shelf life of the Moringa leaf jelly drink in (Table 3), the longest shelf life was obtained at 10˚C, which was 23 days, then at 30˚C, which was 10 days. This shows that the increase in temperature causes a faster rate of reaction which causes the Moringa leaf jelly drink to spoil quickly so that its shelf life is getting shorter. According to [43] that storage temperature is related to shelf life. Temperature affects the acceleration of damage or a decrease in product quality, where the higher the storage temperature, the greater the speed of deterioration resulting in shorter shelf life. The use of hot fill PET bottles is one of the factors that extends the shelf life of Moringa leaf jelly drinks. Packaging is a process of packaging, container, or packing a product using certain materials so that the product inside can be accommodated and protected, while product packaging is part of the packaging of a product that is inside. This packaging is one way to preserve or extend the life of the food or food products contained therein. Of the several types of packaging, some of which are plastic and glass packaging. Types of plastic packaging include HDPE and PET. For PET plastic packaging, which is also used increasing in the packaging of fruit juices and beverages, it has the properties of being resistant to high temperatures, translucent, strong and not easily torn and has low permeability to water vapor and gas. This is because the lower the permeability to water vapor and gas. This is because the lower the permeability of the packaging, the longer the shelf life of the product.

The processing process is also a factor in a product's quality so that it affects its shelf life. The shelf-life factor of Moringa leaf jelly drinks besides using hot filled PET bottles, can be affected by the pasteurization process. According to [44] pasteurization is a thermal process with a temperature of <100ºC to kill certain vegetative microbes, namely pathogens, and deactivate enzymes. Pasteurization does not kill all vegetative microorganisms and spore-forming microorganisms. To extend shelf life, pasteurized products must be combined with storage at low temperatures, addition of preservatives, modification of packaging, adjustment of pH and aw to control microbial growth... Based on research conducted [14] that for hot fill PET bottle products after cooking the product is also pasteurized after it is in the package, namely pasteurization 70˚C - 90˚C for 15-30 minutes. The luo han guo jelly drink product using hot fill PET bottles which is pasteurized for 30 minutes at 90˚C has a shelf life of 42 days when viewed from microbiological and color criteria.

IV. Conclusion

The treatment with the addition of carrageenan and citric acid produced the best quality Moringa leaf jelly with a crude fiber of 19.66%, total acid of 2.63%, pH 3.14, Ca 275.19 ppm, Zn 30.71 ppm, Fe 1.44 ppm; antioxidant activity, viscosity 17.73 cPs, color 127.23 (yellow-green); turbidity 114.67 ntu, slightly sour taste, not smell bad, orange in color, and has an easily aspirated or semi-solid texture. Based on the analysis of the estimation of shelf life for the best treatment, it was found that the shelf life was packaged using hot-filled PET bottles with a temperature of 10˚C and 30˚C, twenty-three days, and ten days, respectively.

Acknowledgment

We gratefully acknowledge the Ministry of Education, Culture, Research and Technology of the Republic of Indonesia for research funding through the Matching Fund Scheme Program and the Faculty of Food Technology and Agroindustry, University of Mataram, for the technical support.

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