Indonesia International Institute for Life Sciences

ENRICHMENT PROGRAM REPORT

The Physical Properties of Plain, Coconut-flavored, and Black Grass Jelly-flavored Jelly during Storage at PT. XYZ

STUDY PROGRAM
Food Technology

GWENDA NATALIA
19010065

Jenny Halim (Field Supervisor)
Desak Putu Ariska Pradnya Dewi, S.T.P., M.Sc. (EP Supervisor)

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THE PHYSICAL PROPERTIES OF PLAIN, COCONUT-FLAVORED, AND BLACK GRASS JELLY-FLAVORED JELLY DURING STORAGE AT PT. XYZ

By
Gwenda Natalia
19010065

Submitted to

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Internship Project Supervisor: Desak Putu Ariska Pradnya Dewi, S.T.P., M.Sc.
Internship Project Field Supervisor: Jenny Halim

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CERTIFICATE OF APPROVAL

INSTITUT BIO SCIENTIA INTERNASIONAL INDONESIA

Jl. Pulomas Barat Kav. 88 Jakarta Timur 13210 Indonesia
+6221 295 67888, +6221 295 67899, +6221 296 17296
www.i3l.ac.id

Certificate of Approval

Student	: Gwenda Natalia
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Title of final thesis project	: Sifat Fisik Jelly Rasa Plain, Rasa Kelapa, dan Cincau Hitam selama Penyimpanan di PT. XYZ *The Physical Properties of Plain, Coconut-Flavored, and Black Grass Jelly-Flavored Jelly during Storage at PT. XYZ*

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Names and signature of examination committee members present:

1	Thesis Supervisor	: Desak P.A.P.D. S.T.P., M.Sc.	Approved
2	Field Supervisor	: Jenny Halim	Approved
3	Lead Assessor	: Sulkhan W.	Approved
4	Assessor 2	: Muhammad A.M. B.Sc., M.Sc.	Approved

Acknowledged by,

Head of Study Program,

Muhammad Abdurrahman Mas, B.Sc., M.Sc.

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"The Physical Properties of Plain, Coconut-flavored, and Black Grass Jelly-flavored Jelly during Storage at PT. XYZ"

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Signature: Gwenda Natalia

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ABSTRACT

Jelly products are susceptible to the occurrence of syneresis during storage. Different concentrations of carrageenan or konjac powder would impact the viscosity and texture retention of jelly at various concentrations. The significance of this topic lies in the investigation of the storage-related physical properties of plain and flavored jelly. Consequently, the syneresis, color, and pH were examined. Despite all the increase, decrease, and fluctuation values, both significant differences, and no significant differences can be found in each flavor during the two days of storage. The jelly with the highest syneresis after two days of storage was plain jelly, followed by black grass jelly-flavored jelly, and coconut-flavored jelly, with values of 2.02 ± 0.39; 1.24 ± 0.32; 0.89 ± 0.38; respectively. In addition, the syneresis observed on days 1 through 2 and within each flavor was statistically significant ($p<0.05$). Plain jelly was found to have the highest pH (7.10 ± 0.06), whereas coconut-flavored jelly had the lowest pH (5.16 ± 0.03). Coconut-flavored jelly has the highest L* value (83.68 ± 1.03), while black grass jelly-flavored jelly has the lowest L* value (3.29 ± 0.96). In conclusion, the null hypothesis was rejected since the physical attributes of each flavor and each day differ significantly. A prolonged duration of storage results in an increase in syneresis, a decrease in pH, and a degradation of brightness. Furthermore, higher carrageenan concentrations decrease syneresis and brighten the color of jelly.

Keywords: Jelly, carrageenan, syneresis, pH, color analysis

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LIST OF ABBREVIATIONS

aW	Water Activity
BGJ	Black Grass Jelly-flavored Jelly
BPOM	Badan Pengawas Obat dan Makanan
C	Coconut-flavored Jelly
CV	Curriculum Vitae
Eng Dev	Engineering Development
GMP	Good Manufacturing Practices
HAS	Halal Assurance System
P	Plain Jelly
Pack Dev	Packing Development
PDQ	Product Development Quality
PIC	Person In Charge
PD	Product Development
RTD	Ready-To-Drink
RSD	Relative Standard Deviation

I. INTRODUCTION

1.1 History of PT. XYZ

PT. XYZ, founded in 1995, is committed to the production and distribution of high-quality beverages, particularly in the form of pulverized powder, that is popular with both domestic and international consumers. XYZ's current headquarters are in Jakarta, and the company has built a large network of distributors so that it can sell its products to customers all over the country and the world.

The company is dedicated to the idea that all of its output is the result of original thought and is designed to meet the needs of its end users. The widespread success of various products such as milk powder drinks, jellies, and tea are considered as the evidence of the success of this initiative. Due in large part to its reputable products and implementation of Food Safety Management, XYZ has grown rapidly and is now one of the most influential companies in the beverage market. Several Food Safety Management that had been employed in PT. XYZ includes GMP, BPOM, HAS, ISO 9001, and ISO 22000.

1.2 Vision, Mission, and Culture

1.2.1 Vision

The vision of PT. XYZ is to become a leading company that synergizes in industry, marketing, trade, and services in packaged food and beverages that contribute to the well-being of communities and deserve recognition in Indonesia and on the worldwide market.

1.2.2 Mission

The vision will be realized through four missions on which XYZ focuses:

1. Sustainability in revenue growth and profit growth through innovation and resource development.
2. Having productive resources in accordance with XYZ value.
3. Achieve export sales contribution in accordance with company directives.
4. Developing existing brands in order to access new market segments.

1.2.3 Culture

From the beginning, seven cultures were used in PT. XYZ, which distinguishes GLITIKA. G stands for God-centered, L for loyalty, I for integrity, T for teamwork, I for innovative, K for keen to positive attitude, and A for adversity.

1.3 The Main Activity

The company specialized in powdered foods and beverages. They invented several types of foods that are classified into three categories: food, beverages, and dessert. Pasta, cake, and *perkedel* are the examples of food categories, whereas milk-flavored drinks, tea, and ginger drinks are categorized as beverages. Lastly, the desserts include jelly, agar, pudding, and pudding sauce. Besides the powdered products, the company also produces Ready-to-Drink (RTD) beverages through the toll manufacturing method.

Each product varies greatly; for example, the cake is available in chocolate, mocha, and red velvet flavors. In regards to the beverages categories, the milk-flavored drinks vary in fruit flavor which are lychee, mango, melon, taro, and vanilla blue. Other flavors that also exist for the milk-flavored drink are fusion flavors like *es teler*, *es doger*, and choco cheese. The chocolate variants for a milk-flavored drinks are as follows: chocolate, milk chocolate, and choco cream. The tea was available in apple, blackcurrant, gula tebu, grass jelly, and jasmine flavors. As mentioned before, the company also developed two RTD products which are fruit-flavored jelly drinks combined with Nata de Coco and coffee milk drink. Similarly, the jelly also varies in fruit-type flavor such as strawberry, soursop, pomegranate, kurma, and orange. Aside from the aforementioned flavor, plain and black grass jelly are also marketed. Interestingly, XYZ also develops jelly products that are more convenient or less expensive than regular ones. However, they only had a few basic flavors to choose from. Meanwhile, for agar, they also only provide a few basic flavors. Furthermore, the variant for the pudding is quite similar to jelly and agar varieties. Other than the regular pudding, XYZ also produces pudding that has a more soft texture with the variant of chocolate, peach, taro, biscuit, and avocado. Each of the products still offers a variety of flavors that cannot be described individually.

PT. XYZ operates the production process by using high-quality raw materials that have been quality-tested in a laboratory with sophisticated equipment and also through hygienic processing. As a manufacturer, XYZ follows industry standards like Good Manufacturing Practices (GMP), Food Safety Management System (FSMS), Halal Assurance System (HAS), BPOM, ISO 9001, and ISO 22000. These standards are followed by the company on a regular and responsible basis in order to be a leading manufacturer that makes high-quality products that are nutritious and safe for consumers to consume and are also favored by people all over the world. A method of distribution is important for the business to make sure that the products are always in good shape.

The company employs a multi-distribution system, which entails a distribution agreement with multiple distributors both locally and internationally. This strategy strives to ensure that XYZ's products are widely advertised and can be bought by consumers throughout the region. Locally, most

drinks can only be purchased in small traditional stores known as "warung," but jelly and pudding are widely available.

XYZ hopes that by adhering to the principle of win-win solutions, all distribution partners or distributors can work together to achieve profitable growth while also serving the larger community. Almost all of the products have been sold all over the world, including in Africa, Malaysia, Brunei Darussalam, East Timor, Hong Kong, Australia, Saudi Arabia, and South America. The distribution to other countries is consistently expanding, whether through promotion, exhibition activities held in and outside the country, product sampling, and other below-the-line activities, as a means of entering new markets in countries where they will eventually expand their distribution networks. As part of the company's global vision, XYZ has successfully formed business relationships with companies from Malaysia, Brunei, Hong Kong, the Philippines, Australia, and several African countries by supplying many of their products.

1.4 Organizational Structure

The highest position is held by the Vice President Director, with the Plant Director and Product Development Quality Manager working directly below. The Plant Director will receive a report from the Plant Development Manager through the Plant General Manager. The Packing Development Manager works closely with the Engineering Development Manager, as they both report to the Plant Development Manager. In contrast, there are four divisions that work below the Product Development Quality Manager: PDQ Manager for powder, PDQ Manager for non powder, PDQ Manager for savory, and PD Research Manager. The detailed organizational structure is depicted in **Figure 1**.

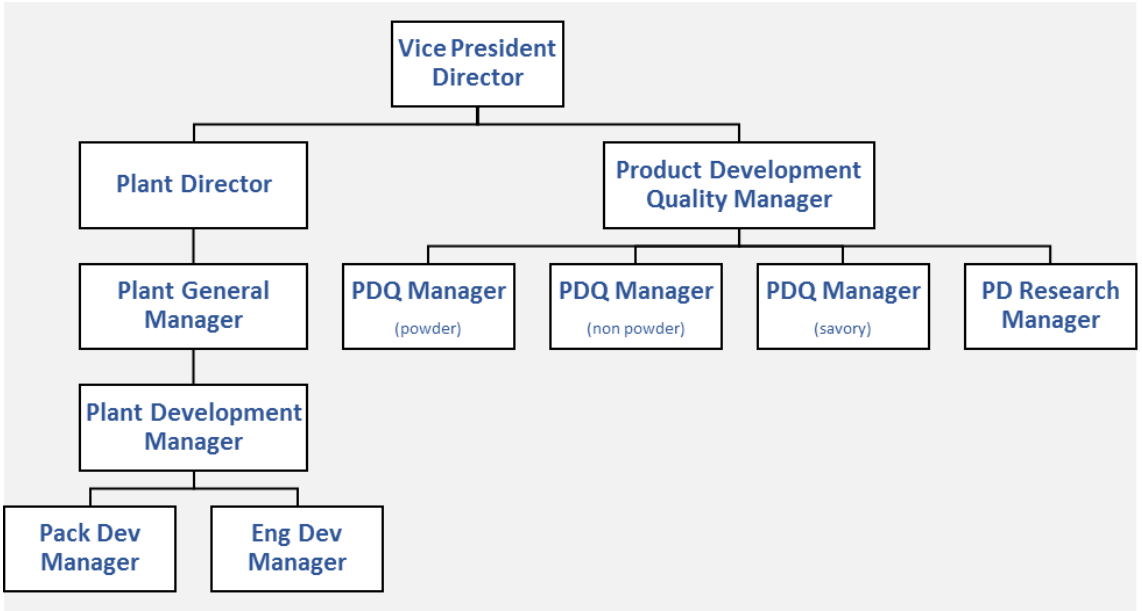

Figure 1. The organizational structure of PT. XYZ

1.5 Department Explanation

The Research and Development (RnD) division will support the Product Development (PD) team while the PD division works on the formulation. Analysis techniques, stability tests, sensory teams, consumer research, lab and pilot scale trials, etc. are all included in the support. Their duties also include the development of both new and existing products. If there is a need for reformulation, a triangle test will be conducted and samples will be distributed to the trained panelists. If the results are favorable, the next step will be to conduct a sensory test with the manager. If the manager gives his or her approval, the proposal is forwarded to marketing, and then to the Board of Directors. Nonetheless, if marketing does not approve of the products, the PD team will redo the products until marketing gives its approval.

The PD team was divided into three categories, which are powder, non-powder, and savory. Then, the powder categories would be divided into three sub-teams, dessert, sweet, and beverage. Meanwhile, the sub-team for non-powder is called new line. In addition, there are also two teams, the stability and sensory teams. As the name implies, the dessert team handles dessert products such as jelly, pudding, agar, and pudding sauce, the sweet teams handle products such as milkshake powder drink, and the beverages teams are responsible for powdered drinks (herbal powder drink, tea powder drink, fruit powder drink, and B to B product). The savory group, in contrast, will be charged for the food products which are pasta, cake, and *perkedel*. Furthermore, the new line team focuses on the formulation of RTD products and the actual product would be produced through a toll manufacturing approach. In terms of the stability team, their responsibility is to verify the stability of all the commercially available products that have been stored for a predetermined time period. Lastly, the sensory team is in charge of conducting a sensory test to maintain the sensory skills of trained panelists.

II. INTERNSHIP ACTIVITIES

2.1 Working Conditions

The intern had done her internship at PT. XYZ, located in Cikupamas Industrial Area for five months, from August 1 to December 23. The working days are from Monday until Friday. All of the employees are required to arrive on time at 8:00 a.m. and leave at 5:00 p.m. On Friday, however, the working hours began at 8 a.m. and finished at 5.30 p.m. due to an extended break for Muslim prayer. Typically, the break time is sometimes used by staff to eat and do prayer because the available time is only one hour from Monday until Thursday: 12:00 p.m.–1 p.m., while one and a half hours for Friday: 11.30 a.m.–1 p.m. If an employee fails to arrive on time, he or she must wait at the security desk and fill out the late book. The late employee must then be picked up by their supervisor before being allowed to enter the workplace.

2.2 Internship Activities

2.2.1 Consumer Insight

Consumer insight activities are centered on learning the market's thoughts on new products, whether they are acceptable or not. In other words, the goal of this action is to directly discover what the market needs in terms of food and beverage items. Typically, this activity was undertaken outside of the company, which sought responses from the general public. However, due to recent events (COVID 19), the company has decided to execute the activity internally. Therefore, all of the respondents selected for this activity are company employees. The process began with the distribution of the questionnaire to the workers in order to determine which workers would fit the study's criteria. Following the analysis of the responses, the workers would be asked to taste the products. If the workers were qualified, they would take an acceptance test called a hedonic test to see if they liked the products or not. After summarizing the results, the PIC would send this data to the formulator, who would modify the products based on market opinion; for example, if the samples were less sweet, sweetness would be added. These revised samples will then be tested on the same panelists as previously to see if the outcomes were better or not. In the end, all of the results will be given to the manager, who will decide if the statistics are good enough or if something is still missing.

In this activity, the intern almost contributed to all of the steps done from the beginning until the end: spreading the questionnaire, helping to classify the qualified employees, doing the sensory test, and analyzing the results. To be specific, the timeline of this activity can be seen on **Table 1**. This activity is expected to result in consumers liking the new products and wanting to buy them when

they are officially released. Unfortunately, the detailed results of this activity are not mentioned in this report since the corporation considers it confidential.

Table 1. Consumer Insight working schedule

Month	Activities
August	Distribute questionnaires, gather competent workers, and conduct sensory testing.
September	Analyze the data and identify the market
October	Spread out a new questionnaire, and conduct sensory testing with another sample that has been adjusted according to the market's opinions.
November	Conduct a hedonic test of similar products that are already popular in the market to compare which statistics are better according to the panelist.

2.2.2 Stability Test

The stability team monitors all marketed products on a regular basis to see whether they are still favorable after being stored in various temperature conditions and for varying periods of time. The purpose of this activity is related to the climatic conditions when the products were shipped to different countries that have different temperatures than Indonesia. The company can check whether its products are in the same condition regardless of whether they were kept in a hot or cold location. Almost all products were routinely checked by the stability staff, and the intern only had to help with the tests for beverages and desserts. Throughout the beverage stability test, the intern assisted the PIC in collecting the sample for the stability test from three different storage temperature conditions, measuring the moisture content, brewing the product, and evaluating the products to see if there were any differences between the treated and control groups. In regards to the dessert stability test, the intern cooked several samples of jelly and pudding for gel strength analysis, both by hand and with a stirrer machine.

The usual schedule for this test is Monday through Friday, except Wednesday; however, the intern only contributed when she had free time (usually Thursday and Friday). In this case, the

activity's expected outcome is that the products showed no significant difference whether stored at a different temperature or not. Similarly to the consumer insight results, the specific data of all analyses is kept private.

2.2.3 Assisting with Product Packing

This activity is conducted after the PD team mixes the powder in huge amounts with the purpose of testing the stability of the product. Furthermore, some of the products will be tested on novel packaging materials. The expected outcome of this is that the product will be more stable when stored for longer periods. The intern assists in the packaging of the product, and as far as the intern knows, there is no set timeline for this activity; it is determined by the formulator. Usually, the intern helps on Thursday and Friday.

2.2.4 Syneresis of Jelly, Pudding, and Silky Pudding

Several measurements were often conducted to determine the stability of jelly. One of them is the analysis of syneresis. This analysis was done due to the jelly's tendency to release water from the structure. In this task, the intern helped to assist with the syneresis of trial products that the company wishes to evaluate. If there is no data available on particular products, the intern will assist with the syneresis. Occasionally, the intern will also do a syneresis on the existing product's stability after it has been stored for a particular amount of time. Syneresis was performed to see whether the results differed from the control's or not.

In total, thirteen products were analyzed for syneresis. The desired finding of this analysis is that there will be no significant difference between the control and treated samples. When conducting an ANOVA analysis of the results, it was shown that a variety of samples exhibited either non-significant and significant differences. If the sample results were significantly different, the analysis will be repeated on different day. This activity was done from August until December 2022, every Thursday and Friday. On Thursday, the intern will cooks the products and the syneresis analysis will take place on Friday. Starting in December until the end of the internship, since the analyses for the main project were already finished, the intern had time to help with the syneresis on Monday and Tuesday.

2.3 Comparison of Theory and Practice

The fundamental knowledge that the intern learned from several courses including the Food Additive course, Experimental Design, both course and laboratory classes of Sensory Evaluation, Beverage Technology Laboratory, and Food Analysis support all the activities that the intern undertakes at PT. XYZ. Since this company utilizes different kinds of additives in its products,

understanding the objectives of each ingredient that was added in the products became a simpler task. The lessons on gelling, thickening and anti-caking agents in the class on Food Additives especially help the intern to understand the definition and principle of hydrocolloids used in several products. Moreover, it also explains the effect of carrageenan and konjac powder as gelling agents that are utilized in jelly. To analyze all the results in the report, the knowledge of statistical analysis was really important. The intern learned the principles of SPSS through both course and laboratory classes on Sensory Evaluation and also Experimental Design class. Furthermore, as the intern conducts several sensory tests during the internship, the experience of becoming a panel leader in the Sensory Evaluation Laboratory Class helps the intern to properly do the triangle test.

2.4 Difficulties

Throughout the internship period, other than gaining valuable experience and knowledge, the intern also faced several challenges. In the consumer insight activity, the problem that the intern faced is the difficulty in searching for the respondents as there are several criteria for them to be eligible to participate in this consumer insight. If the workers are qualified, the next step would be to do the sensory test, specifically the hedonic test, to know whether they like the products or not. Particularly in this step, the issue that occurs is that the respondents do not come to the sensory test, although the supervisor already contacted them and they agreed to come. To overcome these problems, approaching the selected worker leaders and asking about the whereabouts of their subordinates works well. The next day, the employees began to come and do the sensory evaluation.

Meanwhile, in the stability activity, the intern had the chance to try to differentiate between the control and the treated sample. Since the differences between the samples are small, the intern had trouble telling which ones were different because she had not been trained enough to do so. The way to overcome this problem is to understand the characteristics of each product and highlight the notes of each sample. When cooking some samples, there were several samples that had a huge tendency to burn easily. This is due to the ingredients that comprise the products. Aside from the ingredients themselves, another external factor that may have an impact on this issue is the uneven heat distribution in the electric stove. As both of these causes cannot be avoided, the intern takes extra caution when making this type of product. One of the first steps in avoiding the burnt incident is to ensure that all of the ingredients are thoroughly mixed before cooking. Then, when stirring the samples, make sure that the stirring action is consistent and reaches all the parts (both the side and middle).

III. PROJECT DESCRIPTION

3.1 Introduction

3.1.1 Background

XYZ produces several products, such as jelly, pudding, and silky pudding. These types of products are susceptible to the occurrence of syneresis during storage. Syneresis is considered as one of the primary qualities of jelly because syneresis will change the composition and consistency of the jelly, decreasing its own quality (Rio, 2012). This phenomenon is also undesirable for the consumer since it would alter the appearance of the jelly by releasing water that would disrupt the display of the product. With that being said, this project exists because the company wishes to know the syneresis value of their products.

The incidence of syneresis would relate to another property of jelly, which is pH. One study stated that syneresis can rise at lower pH values because acidic environments can modify the chemical structures (Wulandari et al., 2019). It is possible for organic acids to react with the structure and chemical content of the mixed mixture. Moreover, higher syneresis can reduce the L* values of color (Wang et al., 2010). This is due to the low water content of the product, which makes the color more concentrated.

In this research, the author used three different flavors, which are plain, coconut, and black grass jelly. These flavors were selected based on the ingredients that the company intended to investigate, as no data has been collected on these three flavors. The main differences between these three samples lie in the concentration of carrageenan, which later can elaborate on several physical characteristic changes caused by higher and lower concentrations of gelling agents. Different concentrations of gelling agents will influence the product's stability, as a jelly's syneresis rate may be affected by a higher carrageenan concentration.

All of the products were stored in a chamber with a controlled temperature of 20 °C. The temperature of the chamber was adjusted to 20 °C based on previous research undertaken by the company. Initially, there is no standard, and there is no designated chamber for storing all the jellies. Due to the fluctuating (cold and hot) room temperature, the company decided to regulate the temperature for gel strength analysis. Several experiments performed by the company revealed that 20 °C is the optimal temperature for both gel strength and syneresis. The gel strength at 20 °C is greater than at 16 °C because it sets faster at that temperature. Given these points, the company conclude to use the temperature of 20 °C for the efficiency of both analysis.

According to a study, higher temperatures promote gel syneresis by disrupting the hydrogen bonding and hydrophobic interactions of the gelatin polymer (Mizrahi, 2010). The instability of gel

kept at a higher temperature was likely due to syneresis, which is the spontaneous contraction of a gel accompanied by liquid expulsion from the gel (Chittasupho & Kamkaen, 2021). It can also alter the gel's osmotic pressure, leading to a change in gel structure or possibly a phase transition (Mizrahi, 2010). Although this may be true, this research cannot be conducted at lower temperatures due to a lack of storage space in the company.

This research also focuses on the effect of storage to each flavor, to be specific for three days. Based on the preliminary trial, contamination of the jelly was likely to happen as it had a value of 0.9 for water activity. It has been discovered that values greater than 0.60 permit the formation of bacteria, and values closer to 1 increase vulnerability to microbial growth and metabolic processes that cause spoiling (Sandulachi, 2012). According to a study, jelly can be stored for up to 3 months in storage period at room temperature (30 °C) (Panchal et al., 2018). Although there is microbial activity during that period, it is found that the total microbial count does not exceed the maximum amount of microbes in jelly; hence, the jelly still remained acceptable organoleptically (Ranganna, 2010; Kumar & Deen, 2017). Another study found that the jelly's color, flavor, texture, and total soluble solids (TSS) do not change over a three-month storage period; nevertheless, the product's pH lowers after the first month and continues to decrease (Zubair et al., 2014). Although longer storage time was found to not change the physical properties of jelly, this research only observed for the storage of three days due to limited time. The importance of this topic is to investigate the different physical properties results between plain and flavored jelly also during the storage of each flavor.

3.1.2 Scope of the Project

The scope of the project includes trials on determining the appropriate storage duration and some analyses such as syneresis, color, pH, and water activity. The jelly varieties studied were only plain, coconut-flavored, and black grass jelly-flavored. Meanwhile, the water activity analysis was performed only on powder. In addition, this study focuses solely on physical attributes and excludes microbiological examination. All the ingredients and equipment were available and prepared by the PD team.

3.1.3 Objective

The main objective of this project is to investigate the physical properties (syneresis, pH, and color) of plain jelly, coconut-flavored jelly, and black grass jelly-flavored during storage.

3.1.4 Hypothesis

The null hypothesis (H0) is that there is no significant difference between the physical properties of each flavor and also within each day. Meanwhile, the alternative hypothesis (H1) of this

research is that there is a significant difference between the physical properties of each flavor and also within each day.

3.1.5 Problem Formulation

The syneresis of jelly is regarded as one of the most significant issues with jelly. Mostly, syneresis occurred after several days of storing the jellies; therefore, the observation of storage duration was observed to know whether the storing would affect the syneresis or not. Moreover, as there are multiple kinds of jellies, the question arises as to whether the syneresis value of various products would be the same. Apart from syneresis, other physical properties such as pH and color also relate to the quality characteristics of jellies.

3.2 Literature Review

3.2.1 Jelly

Jelly is the most commercially advertised product of PT. XYZ. They declared that the product was made from natural konjac tubers and seaweed, and as a result, it includes fiber that is extremely beneficial for digestion. According to its most basic definition, jelly is a type of semi-solid food that is typically served as a dessert (Eveline, Santoso, & Widjaja, 2011). The compositions of jelly are mostly fruit juice and sugar (Wachyuni, 2019). To be specific, jelly contains at least 45% by weight of fruit juice and at least 55% by weight of sugar (Wachyuni, 2019). This combination is thickened to a solute concentration of at least 65%, and coloring additives and flavorings may be added to compensate for the fruit's shortcomings. In addition to agar-agar powder, citric acid, food coloring, and vitamin C, the following components are frequently used to make jelly (Putri, Basito, & Widowati, 2013). Different ingredients will influence the explanation for each type of analysis. The expected quality characteristics of jelly are transparent, having a real fruit aroma and taste, a gel that is formed solidly, and decreased syneresis during storage time (Koswara, 2011).

3.2.2 Hydrocolloid: Carrageenan

The production of jelly necessitates the addition of a gelling agent in order to get the gel-like consistency that is characteristic of jelly products (Eveline, Santoso, & Widjaja, 2011). Several gelling agents that can be utilized in the making of jelly are alginate, agar, carrageenan, pectin, and gelatin (Widjanarko, 2009). All of the aforementioned examples of gelling agents are also known as hydrocolloids. Hydrocolloid chemicals are substances that may form colloids in water and are typically employed to avoid crystallization, as a stabilizer, or as a thickening. Carrageenan is the hydrocolloid substance that is normally utilized in the production of jelly (Williams & Philips, 2000). This is because carrageenan has the potential to create gels, dissolves easily in hot water (70 °C), is

readily available on the market, has a relatively low cost, and enhances the fiber content of the product, allowing it to be used as an alternative diet food. A gel-forming material other than carrageenan that can be used in jelly on the market is konjac powder (Rio, 2012).

Different concentrations of either carrageenan or konjac powder would affect the jelly's viscosity and preserve its texture and shape. Carrageenan and konjac have a synergistic effect on gel strength and elasticity, namely the formulation of carrageenan and konjac at a ratio of 1:1 (total concentration of 1.5%) for the production of jellies, beverages, and puddings (Sinurat, Murdinah, & Utomo, 2006). Based on the previous research, a concentration of 0.2% konjac produces a gel-like texture in jelly, however, after storage it undergoes syneresis faster than a concentration of 0.2% carrageenan. Carrageenan at a concentration of 0.2% forms a strong gel, whereas konjac at the same concentration forms a gel that is strong but more brittle, so that the gel formed does not match the expected properties of the gel in the jelly (Rio, 2012). Even though carrageenan has a strong gel structure and is a very important polysaccharide-based gelling agent, it cannot be used without other agents that can make up for its syneresis deficiencies.

3.2.3 Syneresis

According to Winarno (1997), syneresis is the occurrence of liquid leaking or seeping out of a gel, such as jelly, jelly drink, and others, because the gel system loses its activation energy, causing water that was confined within the gel system to escape. Syneresis is associated with imperfect gel formation processes. The inability of the gel system to trap water, which is impacted by the concentration of sucrose and gelling agents as well as improper pH conditions, leads to imperfect gel formation. Knowing the syneresis value of jelly is crucial since the higher the number, the more probable it is that the gel may be disrupted (Sunyoto, Suseno, & Utomo, 2017).

The use of a high concentration of sucrose in the production of jelly will result in the successful construction of a gel, whereas the use of a low concentration of sucrose will result in the formation of an incomplete gel (the gel matrix is relatively brittle). The concentration of sucrose is also related to the pH value because the presence of the alkaline OH (hydroxyl) group, which increases with increasing sucrose content, has an effect on the acid and base of the solution. The addition of sucrose in the manufacturing process serves to attract water molecules around konjac and carrageenan so that the chains connecting the gelling components are close together and form a three-dimensional network or gel.

3.2.4 pH

The degree of acidity (pH) is a measurement of the concentration of hydrogen ions in a solution to determine whether the solution is acidic or basic, with a range of 1-14 (Ophardt, 2003). It

influences the organoleptic qualities of jelly-based products. A low pH produces a softer and thinner gel (Bahar et al., 2021). Moreover, lower pH values increase the rate of syneresis because the gel has a greater potential for contraction (Jovanović, Maćej, & Denin-Djurdjević, 2004). As a result of acidic circumstances, a low pH alters chemical structures (Wulandari et al., 2019).

3.2.5 Color

To attract consumers, color is one of the characteristics of food that must be appealing (Puspita, 2021). The color of food can be determined by crushing or lowering the size of the product, followed by testing with a machine designed for color analysis. Nonetheless, if access to the necessary equipment is limited, capturing a picture and identifying the L*a*B* color can be a viable alternative. The L*a*b* color space (also known as CIELAB) is currently one of the most used color spaces for measuring object color and is utilized in almost all fields. It is one of the uniform color spaces created by the CIE in 1976 in order to address one of the primary issues with the original Yxy space: the fact that equal distances on the x, y chromaticity diagram did not correspond to equal perceived color differences (Ragain, 2016). In other words, the L*a*b color space would display a standard, nearly uniform color scale that could be used by anyone to compare color values.

The L*a*b* color space, It would generate three distinct color values: L signifies lightness, whereas a* and b* represent the green-red and blue-yellow values, respectively (Pathare et al., 2012). The L* value represents the brightness or intensity of black and white, with a greater value indicating a lighter color. This value ranges from 0 (completely black) to 100 (entirely white) and denotes image clarity (da Cunha et al., 2020). Meanwhile, the a* parameter, negative values correspond to greenish colors and positive values to red ones, whereas in the b* parameter, negative values correspond to bluish colors and positive values to yellowish ones.

3.3 Methodology

3.3.1 Water Activity (aW) of Powder Analysis

The water activity of each sample was measured using an Aqualab 4TEV Water Activity Meter. Roughly three grams of samples that have been mixed with the sugar were placed and tested for approximately ten minutes. The values for water activity were then recorded. In addition, the analysis was done with two technical replicates.

3.3.2 Experimental Design

The experimental design for this study is depicted in **Figure 2**. The first step is jelly preparation, followed by measuring the physical properties, and the last is the data analysis. In total, there were three biological and four technical replicates of each flavor of jelly. The researcher does

one biological and four technical replicates in one week. One batch of cooking yielded eighteen cups, of which six cups were kept for daily observation. This single batch represents one technical replicate of the study; therefore, the researcher cooked four batches in one week. Only sixty of the seventy-two cups were examined because the rest were deemed outliers. To be specific, on each technical replicate, the researcher only took fifteen cups to be analyzed statistically.

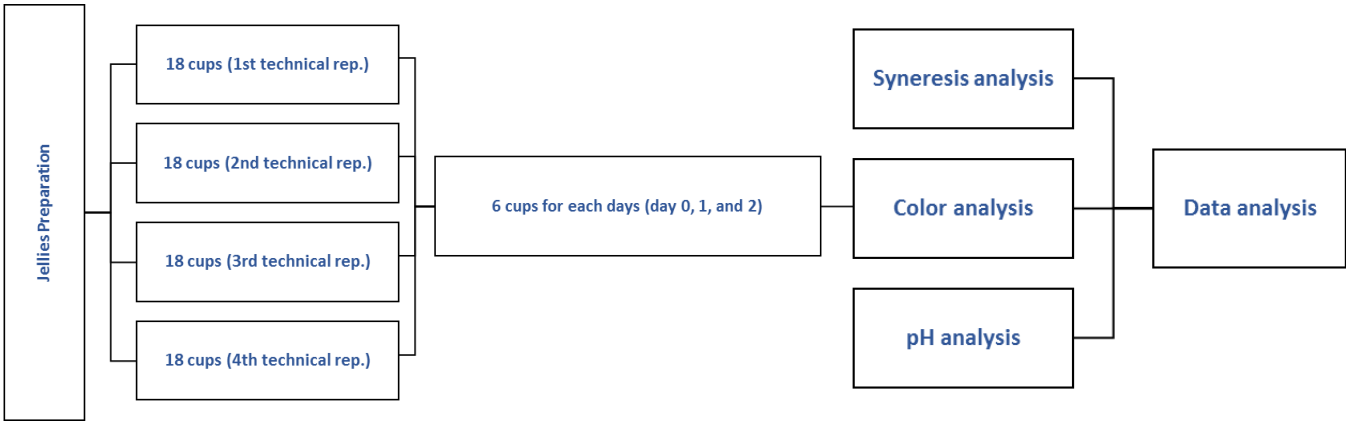

Figure 2. Experimental design for the study

3.3.3 Jellies Preparation Method

The methodology for the jelly preparation is depicted in **Figure 3**. Moreover, the detailed ingredients for each flavor can be found in **Table 2**.

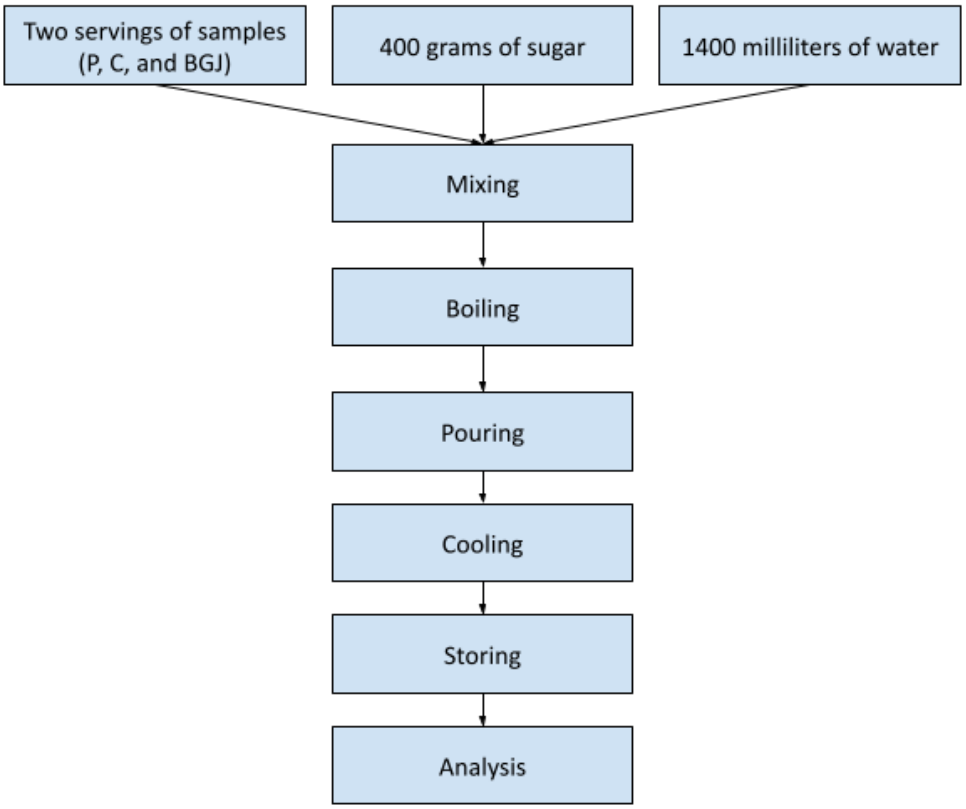

Figure 3. Flowchart of the jelly preparation method

Table 2. List of ingredients used in plain jelly, coconut-flavored jelly, black grass jelly-flavored jelly

Categories		**Plain Jelly**	**Coconut-flavored Jelly**	**Black Grass Jelly-flavored Jelly**
Flavoring agents	Sweetener	Sugar**;** fructo-oligosaccharide (FOS)	Sugar; fructo-oligosaccharide (FOS)	Sugar; fructo-oligosaccharide (FOS)
	Natural & synthetic flavors		Synthetic flavor; creamer (containing milk protein); young coconut water extract (0.1%)	Synthetic flavor; grass jelly extract (5%)
	Flavor enhancer	Salt	Salt; flavor enhancer L-Glutamic acid	Salt
Acidity regulator		Acidity regulator	Acidity regulator	Acidity regulator
Texturizing agents	Gelling	**Carrageenan (17%)**; calcium lactate	**Carrageenan (25%)**; calcium lactate	**Carrageenan (14%)**; calcium lactate
	Thickening	Maltodextrin; konjac powder; vegetable stabilizer	Konjac powder; vegetable stabilizer	Maltodextrin; konjac powder; vegetable stabilizer
	Anti caking			Anticaking
Coloring agents				Natural food color vegetable-carbon CI 77266; Synthetic food color (tartrazine CI 19140); Carmoisine CI

				14720; Brilliant blue FCF CI 42090
Nutritional additive		Vitamin D (contain tocopherol antioxidant)	Vitamin D (contain tocopherol antioxidant)	Vitamin D (contain tocopherol antioxidant)

Note. All of the information was taken from the packaging label of the marketed products.

As stated in **Table 2.**, the list showed the grouping categories for each ingredient that was used. Other than sugar, low-calorie fructooligosaccharide (FOS) was added as a sugar substitute (Cozma et al., 2012). In the texturing agents, particularly the gelling agents, calcium lactate was used to generate calcium bonds with carrageenan (Pan et al., 2017). κ-Carrageenan is to known to has one negative charge per disaccharide while calcium lactate has the positive charge (Ca^{2+}) (Sudha et al., 2014;). The addition of calcium ions (Ca^{2+}) is to improve the gelling capabilities of jelly in this study, as Ca^{2+} can improve gelling connections by forming a bridge between negatively charged carrageenan molecules (Sang et al., 2022). Adding a particular amount of calcium lactate to jelly manufacture not only improves its nutritional content, but also stabilizes the product gel system and boosts its gel strength (Rawdkuen et al., 2008).

Generally, this method was acquired by the researcher from the company. This study identified three types of jelly flavors: plain, coconut, and black grass. In general, the preparation for all jellies is identical; the only difference is the length of time required for the combinations to reach a full boil. In the beginning, two servings of samples were combined with 400 grams of sugar in a pot. After that, 1400 milliliters of water was poured gradually and stirred continuously until the mixture became homogeneous. Inability to homogenize the entire mixture results in lumpy substances. The mixture was then cooked on an electric stove with a 900-watt Modena unit. Plain jellies required 14.30 minutes to boil, whereas coconut jelly and black grass jelly took 14.10 minutes. The stirring must be done at the same rpm to avoid the mixture being easily burned. After boiling, the samples were put into the cup and left to set for at least two hours. One cooking batch would produce eighteen cups of jelly. After two hours, the weights of the sample and cup were recorded. The subsequent step involves placing the samples in the 20 °C-controlled chamber. The jelly was stored in the chamber for only one hour prior to the first observation, which is marked day 0 observation. The following observation occurred after 24 hours of storage, followed by the last observation after 48 hours.

3.3.4 Syneresis Analysis

The method was adopted from the company's method on determining the syneresis value. The observation was carried out by squeezing each jelly to expel all of its water. To absorb the water on the jelly's surface, napkin tissue was utilized. After checking that there is no water on the jelly, the researcher will reweigh the samples and cup, as well as the cup alone, using a scale AND EK-300i. The following equation calculates the percentage of syneresis (Jha, Mishra, & Tiwari, 2008):

$$\text{Syneresis (\%)} = 100\% - \left(\frac{final\ weigh-cup}{initial\ weigh-cup} x 100\%\right) \quad (1)$$

3.3.5 pH Analysis

The pH of each sample was analyzed using the pH Meter Mettler Toledo S-220-KIT that is available in the factory. Samples were smashed with a hand inside a ziplock bag until they turned into uniformly small-size jellies. Due to the jelly's robust structure, it was necessary to crush the samples to prevent the pH electrode from breaking. Then the pH results were recorded. The researcher obtained this method from the company.

3.3.6 Color Analysis

Numerous analytical techniques, such as texture analyzers and UV-VIS Spectrophotometry, are available inside the company. However, the researcher is not permitted to utilize the equipment due to its overuse. The final analysis that can be performed is a color analysis. To know the color of the jelly, the researcher took a photo and then examined it using an application available on a mobile phone called Photoshop Express to identify the RGB color (**Figure 5.**). The RGB values were then transformed to the CIELAB color space (L*, a*, and b*) metric using the colormine.org web converter (**Figure 6.**). The detailed setup for the color analysis can be found in **Figure 4**. This methodology was adopted in accordance with the study taught at the researcher's university.

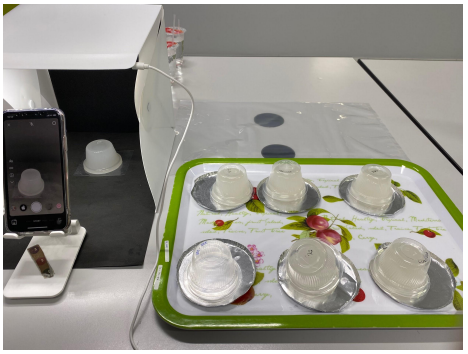

Figure 4. Arrangements of photographs for color analysis

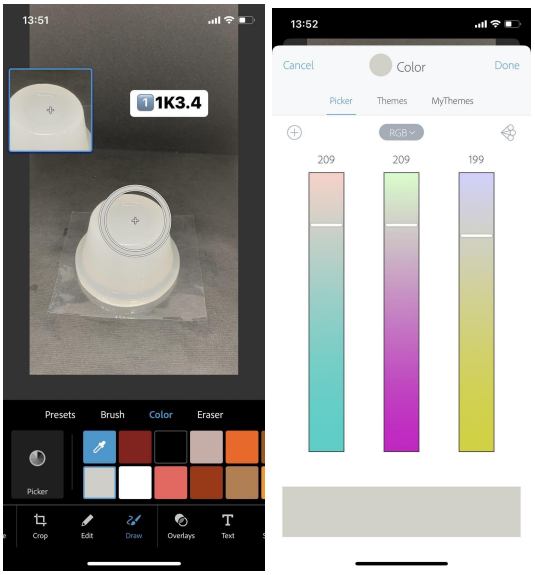

Figure 5. The appearance of the application is used to determine the RGB value

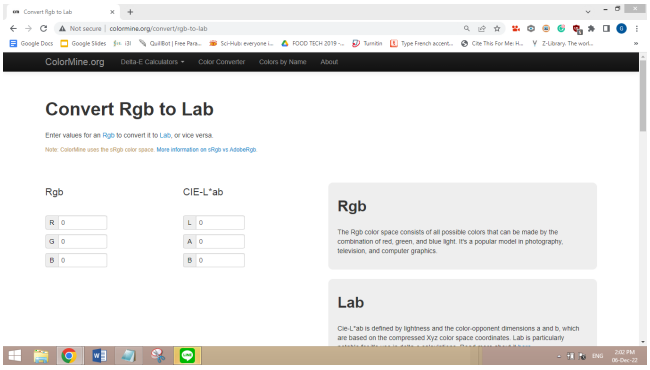

Figure 6. The appearance of the web online converter to know the L*, a*, and b* value

3.3.7 Statistical Analysis

Non-parametric measurements were used to analyze all the data because the criteria for the homogeneity and normality tests were not met. To be specific, the storage duration used the Friedman test with the Wilcoxon Signed-Rank post-hoc test to determine the significant differences. The Kruskal-Wallis test was used to understand the statistical data for both flavor analysis and water activity. **IBM SPSS Statistical 26** was used to analyze all of the data.

3.4 Results and Discussion

3.4.1 Water Activity of Powder

One of the preliminary results to support the research was analyzing the aW of the jelly in the powder form. The aW value of powdered plain jelly is 0.47, powdered coconut-flavored jelly is 0.41, and powdered black grass jelly-flavored is 0.40. Based on these results, it was indicated that the

powder itself was microbiologically stable, as it was below the minimum water activity where no microbes may thrive, which is approximately below 0.60 (Rahman, 2009).

The majority of pathogenic bacteria cannot grow below a water activity of 0.85, although most yeasts and molds are more tolerant to lower water activity, but generally, no growth happens below 0.62 (Rahman, 2009). Furthermore, the statistical analysis reveals that there is no statistically significant difference between the samples, since the significance value is more than 0.05 (p = 0.180).

Table 3. Statistical analysis of water activity

Plain	Coconut	Black Grass Jelly
0.47 ± 0.003^{a}	0.41 ± 0.015^{a}	0.40 ± 0.023^{a}

Values are means ± standard deviation (n=3)

There were no significant differences between all samples (p=0.180)

3.4.2 Syneresis

The collected data for analyzing the effect of storage duration and different flavors on syneresis can be seen in **Table 4.** The significant values were achieved from the post-hoc analysis.

Table 4. Statistical analysis of storage duration and each flavor analysis on syneresis (n=3)

Day/Sample	Plain (%)	Coconut (%)	Black Grass Jelly (%)
Day 0	0.31 ± 0.11^{ax}	0.19 ± 0.07^{bx}	0.36 ± 0.11^{cx}
Day 1	1.31 ± 0.27^{ay}	0.64 ± 0.25^{by}	0.82 ± 0.22^{cy}
Day 2	2.02 ± 0.39^{az}	0.89 ± 0.38^{bz}	1.24 ± 0.32^{cz}

Values are means ± standard deviation (n=3)

Values denoted by the different superscript $^{(a, b, c)}$ were significantly different between each flavor (p<0.05)

Values denoted by the different superscript $^{(z, y, z)}$ were significantly different between each day (p<0.05)

In regards to syneresis, the mean of all flavors increased after two days of storage. It showed that black grass jelly had the most syneresis on day 0 (0.36), whereas plain jelly seemed to have the highest syneresis at the final result (2.02). Moreover, all three flavors are statistically significant for each day. The same goes when comparing each flavor over all three days; it is found that the syneresis of different flavors is significantly different from each other.

Longer storage time results in greater syneresis, as shown in **Table 4**. This happens because, during storage, there is aggregation between continuous carrageenan polymer chains through hydrogen bonds. These formed aggregates cause the gel matrix to tighten, and the space to trap the water gets shrink, causing the previously trapped water to become loose and move away from the

matrix (Vania, Utomo, & Trisnawatia, 2017). According to the results, black grass jelly had the highest syneresis on day zero, while plain jelly had the most syneresis in the end result. Meanwhile, coconut-flavored jelly always has the lowest syneresis among the others. These can happen due to the concentration of carrageenan that was used in each product.

The storage temperature can also influence the rate of syneresis. Due to unavoidable circumstances, this study can only be conducted at a temperature of 20 °C. This might affect the stability of the jelly itself. It is found that jelly that was stored at 4 °C was more stable compared to 30 °C (Chittasupho & Kamkaen, 2021). In addition, Wulandari et al. (2019) reported that the rate of syneresis was decreased at cold storage temperatures (4 °C) compared to ambient storage temperatures (37 °C). In other words, it indicates that a higher temperature will increase the syneresis rate due to the instabilities of gel when stored at room temperature. As the temperature rises, the jelly will lose its structure and become liquid (Mizrahi, 2010).

The packaging indicates that the concentration of carrageenan in each flavor varies. In descending order, the carrageenan concentrations are 14%, 17%, and 25% for black grass jelly, plain jelly, and coconut-flavored jelly. If both the results and the information obtained from the respective packaging were combined, it means that a higher concentration of carrageenan that was used will lower the syneresis of the jelly. The increased carrageenan concentration led to the amount of matrix that was formed by double helix polymer chains that got plentiful and stronger so there is a lot of water that can be trapped, which results in water molecules in the gel that are not easily separated. Both of these findings were consistent with a 2017 study by Vania, Utomo, and Trisnawatia, which found that increased storage time causes higher syneresis and higher concentration of carrageenans resulting in lower syneresis.

The different concentrations of carrageenan in each flavor also influence the results of the significant differences between the three different flavors. It indicates that each flavor will have a different value of syneresis. There is no published research that defines the standards for syneresis, so the researcher is unable to determine whether the syneresis value is still within the acceptable range. Additionally, the host institution does not adopt any standards, as they have only ever compared their samples to the standards they have.

However, when compared with other studies, the syneresis values of this research were lower. The 2011 study by Eveline, Santoso, and Widjaja reveals that gelatin and kappa carrageenan-based jelly has a value of 1.20% after one day of storage. In another study, Prangdimurti et al. (2014) found that syneresis of green grass jelly happens on the first day, with a value of about 1%. After 15 days of storage, the syneresis of the green grass jelly reaches 4.90 % (Prangdimurti et

al., 2014). Based on these studies, it can be said that the syneresis of plain jelly, coconut-flavored jelly, and black grass jelly-flavored jelly still has reasonable values.

In the syneresis method, all of the jellies were placed upside down and covered with a cup prior to being placed in the chamber since air can cause the jellies to shrink; therefore, the actual syneresis cannot be determined because it evaporated altogether. Specifically, the company has conducted multiple trials on this issue, and because they focused on Relative Standard Deviation (RSD), they discovered that the jelly covered with a cup had the lowest RSD. Consequently, they began investigating jelly syneresis using this approach.

3.4.3 pH

The collected data for analyzing the effect of storage duration and different flavors on pH values can be seen in **Table 5**. To know the significant values of each data, a Post-hoc analysis was done. It was found that there was a significant difference between all three days for plain jelly. However, the pH of coconut-flavored jelly on day 0 was significantly different from day 1 and day 2, while there was no significant difference between day 1 and day 2. In regards to black grass jelly-flavored, there is no significant difference between day 0 and day 1, whereas day 2 was statistically significant with day 0 and day 1.

When comparing between flavors, there was a significant difference between coconut-flavored and plain, as well as black grass jelly-flavored on day 0 and the first day of observation, but not between coconut-flavored and black grass jelly-flavored in regards to pH. However, on the last day of observation, all results turned into a significant difference. The highest pH was observed in plain jelly from the beginning until the end of the observation, whereas the lowest pH was found in coconut-flavored jelly. Overall, the pH was decreasing after two days of storage.

Table 5. Statistical analysis of storage duration and each flavor analysis on pH (n=3)

Day/Sample	Plain	Coconut	Black Grass Jelly
Day 0	7.16 ± 0.07^{ax}	5.19 ± 0.03^{bx}	7.15 ± 0.05^{ax}
Day 1	7.12 ± 0.07^{ay}	5.16 ± 0.03^{by}	7.13 ± 0.06^{ax}
Day 2	7.10 ± 0.06^{az}	5.16 ± 0.03^{by}	7.05 ± 0.07^{cy}

Values are means ± standard deviation (n=3)

Values denoted by the different superscript $^{(a, b, c)}$ were significantly different between each flavor (p<0.05)

Values denoted by the different superscript $^{(z, y, z)}$ were significantly different between each day (p<0.05)

The addition of higher concentrations of carrageenan can cause a higher pH of jelly (Vania, Utomo, & Trisnawatia, 2017). This can happen because carrageenan is considered as an ingredient with a basic pH. Based on FAO (2000), the pH of carrageenan solution (1 gram in 100 gram solution) is 8-11. Moreover, carrageenan is also an extraction result from seaweed with an alkaline solution which supports the alkaline characteristic of carrageenan. With that being said, the more added carrageenan will increase the pH of the jelly. However, this theory does not align with the experiment's results. The pH of the highest concentration of carrageenan which is found in coconut-flavored jelly is the lowest among the others, whereas both plain and black grass jelly-flavored have neutral pH values. This can happen due to the addition of other ingredients in each flavor. The coconut-flavored jelly contains 0.1% extract of young coconut water, as stated on the packaging. Although this ingredient was listed last, indicating that it had the lowest concentration among the others, it was discovered that young coconut water has a pH of 4.78 (Coconut Handbook Tetrapak, n.d.). In other words, the low pH of coconut-flavored jelly is due to the acidic pH of young coconut water.

The pH value changed during the storage period. Two days of storage resulted in a decrease in the pH of the jelly. This decreased incidence happens because of the possibility of the activity of microorganisms. Although the process of making jelly involves heating, the step following the heating can be less sterile. The cleanliness of the cup, the plate to place the jelly on, as well as accidentally touching the surface of the jelly when weighing, are several things that should be taken into account. This is what spurs the activity of microorganisms. Microorganisms will metabolize to break down sucrose and produce organic acids such as malic acid, oxalic acid, and other acids, thereby lowering the pH of the jelly. This was aligned with a study by Vania, Utomo, and Trisnawatia in 2017.

According to **Table 5**, there is no significant difference between the plain jelly and the black grass-flavored jelly because both have a pH of around 7. This can be due to the fact that the ingredients are more or less the same, only differing in the food coloring. Nonetheless, when compared to coconut-flavored jelly, these two flavors are noticeably different. This occurs because the coconut-flavored jelly contains several ingredients that neither plain jelly nor black grass jelly-flavored has, such as creamer and young coconut water extract.

3.4.4 Color

On **Table 6.**, **Table 7.**, and **Table 8.**, it displays the data obtained for studying the influence of storage length and different tastes on three color values (L*, a*, and b*). A post-hoc analysis was performed to determine the significance of each set of data.

Table 4. Statistical analysis of storage duration and each flavor analysis on L* value (n=3)

Day/Sample	Plain	Coconut	Black Grass Jelly
Day 0	71.20 ± 1.47^{ax}	83.06 ± 1.04^{bx}	4.36 ± 1.79^{cx}
Day 1	68.25 ± 2.08^{ay}	83.17 ± 0.96^{bx}	5.34 ± 2.90^{cy}
Day 2	67.02 ± 2.35^{az}	83.68 ± 1.03^{by}	3.29 ± 0.96^{cz}

Values are means ± standard deviation (n=3)

Values denoted by the different superscript $^{(a, b, c)}$ were significantly different between each flavor (p<0.05)

Values denoted by the different superscript $^{(z, y, z)}$ were significantly different between each day (p<0.05)

Table 7. Statistical analysis of storage duration and each flavor analysis on a* value (n=3)

Day/Sample	Plain	Coconut	Black Grass Jelly
Day 0	-1.51 ± 0.51^{ax}	-1.10 ± 0.46^{bx}	-0.47 ± 0.49^{cx}
Day 1	-1.90 ± 0.84^{ay}	-1.10 ± 0.57^{bx}	-0.02 ± 0.52^{cy}
Day 2	-0.21 ± 0.66^{ay}	-1.47 ± 0.48^{by}	-0.24 ± 0.42^{cy}

Values are means ± standard deviation (n=3)

Values denoted by the different superscript $^{(a, b, c)}$ were significantly different between each flavor (p<0.05)

Values denoted by the different superscript $^{(z, y, z)}$ were significantly different between each day (p<0.05)

Table 8. Statistical analysis of storage duration and each flavor analysis on b* value (n=3)

Day/Sample	Plain	Coconut	Black Grass Jelly
Day 0	4.49 ± 2.54^{ax}	3.55 ± 1.12^{ax}	2.69 ± 1.14^{bx}
Day 1	5.20 ± 2.91^{ay}	3.66 ± 1.27^{bx}	2.43 ± 0.95^{cx}
Day 2	3.29 ± 1.72^{az}	3.90 ± 1.18^{bx}	1.84 ± 0.84^{cy}

Values are means ± standard deviation (n=3)

Values denoted by the different superscript $^{(a, b, c)}$ were significantly different between each flavor (p<0.05)

Values denoted by the different superscript $^{(z, y, z)}$ were significantly different between each day (p<0.05)

After two days of storage, the plain jelly has a decreased value of L*, while the a* and b* values fluctuated. This indicates that there is a significant difference from day to day for L* result. In contrast, the L* and b* values of the coconut-flavored jelly have increased, whereas the a* value has decreased. Although both the L* and b* values increased, it was found that there is no significant difference between day 0 and day 1 results. When it came to the last flavor, which was black grass

jelly-flavored, the L* and a* values fluctuate while the b* value dropped. Comparable to the L* value of plain jelly, the sample of BGJ demonstrates a significant difference between days.

Similar to the findings of syneresis, all three color values (L*, a*, and b*) of all three flavors exhibited a significant difference from the beginning to the end of the experiment, with the exception of the b* color on day 0, which indicates that there is no significant difference between plain and coconut-flavored jelly. In comparison with each flavor, the highest L* value can be found in coconut-flavored jelly (83.68 ± 1.03), whereas the lowest L* value lies on BGJ samples (3.29 ± 0.96). As stated in the study by da Cunha et al. in 2020, the higher the L* value, the lighter the color. This shows that the coconut-flavored jelly is lighter in color compared to the plain and BGJ samples.

Two-day storage color changes may also be influenced by the syneresis that occurs. One study stated that syneresis would decrease the L* values due to the low water content of the product (Wang et al., 2010). In principle, jelly would hold the water, and when syneresis happens, the water would escape, leaving the coloring agents behind. Observation reveals that the tissue utilized to adsorb water from the surface of the jelly is colorless. This implies that the color of the jelly was retained. It further indicates that the jelly's color has become more concentrated than previously. It can explain why the color of BGJ samples became darker as they utilized a variety of colorings to create BGJ's color. To be specific, the coloring agents that were used in BGJ are carbon CI 77266, tartrazine CI 19140, carmoisine CI 14720, and Brilliant blue FCF CI 42090. In regards to plain jelly, although the jelly does not contain any coloring agents, the color got darker after two days of storage. This could be explained by the possibility that the color that was captured was the reflection of the background when taking the picture of the jelly. Since the author used a black background, it can reflect on the sample because it has an almost transparent color.

A higher percentage of carrageenan and sucrose will produce a strong jelly consistency, which may diminish the color's intensity compared to before the gel was formed (Sumartini, 2021). It is also consistent with Estiasih and Ahmadi's (2009) study, which stated that carrageenan can dissolve in water to generate a thick solution and can influence the gel's color. Another study also discovered that jellies with higher concentrations of carrageenan have a more transparent appearance (Pamungkas, Sulaeman, & Roosita, 2014). In addition, as carrageenan has a white color, a high proportion of it can influence the jelly's hue to become lighter (Ahmad & Mujdalipah, 2017). Hence, all of these studies would then match the results of the experiment, since the coconut-flavored jelly has the brightest color from the beginning until the end of observation (L* value).

3.5 Conclusion and Recommendations

In conclusion, the null hypothesis was rejected as there is a significant difference between the physical properties of each flavor and also within each day. This happens because there is a

change in the physical properties of each flavor of jelly depending on how long it has been stored. After two days of storing, plain jelly, coconut-flavored jelly, and black grass jelly-flavored have an increased syneresis and decrease in pH. The color values of both plain jelly and BGJ samples got darker while coconut-flavored jelly became lighter. Moreover, as the composition of each jelly differs, it also influences the syneresis, pH, and color values. Among the three samples, it is concluded that a higher concentration of carrageenan will lower the syneresis of the jelly and turn the jelly into lighter color. Moreover, higher syneresis also leads to a decrease in color. In regards to pH, the basic pH of carrageenan will turn the product's pH into neutral and alkaline. With the exception of coconut-flavored jelly, as it contains other ingredients that influence the overall pH of the product.

It is suggested to evaluate other parameters, including gel strength, as it is also regarded as a key quality characteristic of jelly. The applications of other types of gelling agents could also be analyzed further to investigate the most suitable ingredients for making jelly. As the project's scope was restricted to physical properties, it would be more effective for a future study to analyze the microbial activity of the product to determine whether or not the storage length affects the characteristic. Furthermore, future research should include the observation of jelly at a lower temperature, such as 4 °C, to determine whether the storage temperature affects the physical properties or not. In addition, the utilization of more proper machines and methods to analyze the physical properties of jellies is also recommended to avoid any possibility of human error.

IV. SELF REFLECTION

Throughout the internship period, the author gained a lot of skills that will benefit her working adventures after she graduates. Adapting to the new environment and gaining hands-on experience were two of the biggest experiences that she achieved. Several soft skills, such as communication, problem-solving, and time management, also flourished during the process of her internship, from the beginning until the end. Furthermore, she improves her decision-making skills in order to process all of the information provided and interact with the appropriate person in a given situation. All of these skills are very important, as she can apply them in any working condition. The author realized her weaknesses during the internship. She struggles to prioritize working on her report and presentation. The report is completed as the deadline draws closer since the author believes there is still plenty of time. As a result, it appears that the report was made together hurriedly.

The author is able to attain all of the aforementioned competencies since she had previously acquired the fundamental ideals from i3L, which she can apply to her internship activities. The values of Grit, Role-Model, and Integrity significantly contributed to all the experiences and obstacles she encountered. All the courses offered in i3L, particularly the Food Additive and Sensory Evaluation classes, have helped her comprehend some core theories and ideas.

In addition to lessons, i3L gave additional BRIGHT sessions that contributed to the author's development of soft skills. The "Learning Style and Personality" BRIGHT sessions greatly assisted the author in understanding herself and her surroundings. This session increased the author's awareness of her communication preferences, which will help her communicate with others during her internship. Additionally, it strengthens relationships with PT. XYZ's employees. As a result of determining her learning type through this session, the author is able to apply the lessons from her internship because she remembers several fundamental theories linked to the work she performed there. "Internship Preparation" is another BRIGHT session that helped her prepare for and execute her internship. In this session, the CSD highlighted the differences between a cover letter and a CV or resume and also provided the author with various examples. With the skills she gained from this session, the author was able to compose a cover letter and resume that helped her land this internship position.

Although the author's impact on the workplace is moderate, she was able to assist in various divisions. She supported the consumer insight division by assisting the PIC and lightening the workload when collecting over two hundred questionnaires from the employees. In addition, she was able to do multiple syneresis studies on samples that lacked data. In addition, she gives instructions to the PIC in the dessert section on how to conduct color analysis using Adobe

Photoshop and another color picker tool on a smartphone. The PIC can comprehend explanations of the CIE LAB color space, notwithstanding the inaccuracy of this color analysis.

V. CONCLUSION & RECOMMENDATION

The primary objective of doing the internship is to experience real hands-on activity in a reputable factory, as well as to expand the connection to a future professional career. The author obtained valuable insights into working in the food industry and also sharpen her personal skills that can be beneficial for the future. During the internship, the author also hones her spirit of inquiry and learns from the experts that already dwell in this type of work for more than 10 years. To improve future internship experience, the author should interact with other divisions that were not directly related to PD such as marketing and HR. It is also recommended to broaden the knowledge that might be useful when communicating with other professionals.

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APPENDICES

Appendix 1. Homogeneity Test for Storage Duration Analysis

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Syneresis	Based on Mean	64.682	2	537	.000
	Based on Median	61.181	2	537	.000
	Based on Median and with adjusted df	61.181	2	411.166	.000
	Based on trimmed mean	66.262	2	537	.000
pH	Based on Mean	3.961	2	537	.020
	Based on Median	.979	2	537	.376
	Based on Median and with adjusted df	.979	2	179.001	.378
	Based on trimmed mean	.979	2	537	.377
L	Based on Mean	52.972	2	537	.000
	Based on Median	43.195	2	537	.000
	Based on Median and with adjusted df	43.195	2	397.696	.000
	Based on trimmed mean	50.258	2	537	.000
a	Based on Mean	14.854	2	537	.000
	Based on Median	13.766	2	537	.000
	Based on Median and with adjusted df	13.766	2	522.633	.000
	Based on trimmed mean	14.658	2	537	.000
b	Based on Mean	88.873	2	537	.000
	Based on Median	73.128	2	537	.000
	Based on Median and with adjusted df	73.128	2	346.288	.000
	Based on trimmed mean	84.819	2	537	.000

Appendix 2. Normality Test for Storage Duration Analysis

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Day	Statistic	df	Sig.	Statistic	df	Sig.
Syneresis	0	.077	180	.012	.959	180	.000
	1	.061	180	.096	.977	180	.005
	2	.073	180	.020	.980	180	.012
pH	0	.386	180	.000	.650	180	.000
	1	.369	180	.000	.652	180	.000
	2	.516	180	.000	.056	180	.000
L	0	.341	180	.000	.707	180	.000
	1	.303	180	.000	.739	180	.000
	2	.302	180	.000	.735	180	.000
a	0	.205	180	.000	.931	180	.000
	1	.147	180	.000	.972	180	.001
	2	.132	180	.000	.946	180	.000
b	0	.159	180	.000	.932	180	.000
	1	.123	180	.000	.901	180	.000
	2	.090	180	.001	.964	180	.000

a. Lilliefors Significance Correction

Appendix 3. Homogeneity Test for Each Flavor Analysis

Test of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Syneresis	Based on Mean	129.133	2	537	.000
	Based on Median	125.492	2	537	.000
	Based on Median and with adjusted df	125.492	2	325.298	.000
	Based on trimmed mean	127.884	2	537	.000
pH	Based on Mean	2.885	2	537	.057
	Based on Median	.982	2	537	.375
	Based on Median and with adjusted df	.982	2	179.388	.377
	Based on trimmed mean	.978	2	537	.377
L	Based on Mean	.324	2	537	.723
	Based on Median	.057	2	537	.945
	Based on Median and with adjusted df	.057	2	533.367	.945
	Based on trimmed mean	.281	2	537	.755
a	Based on Mean	19.642	2	537	.000
	Based on Median	12.638	2	537	.000
	Based on Median and with adjusted df	12.638	2	468.570	.000
	Based on trimmed mean	19.585	2	537	.000
b	Based on Mean	5.309	2	537	.005
	Based on Median	4.550	2	537	.011
	Based on Median and with adjusted df	4.550	2	468.985	.011
	Based on trimmed mean	5.105	2	537	.006

Appendix 4. Normality Test for Each Flavor Analysis

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Sample	Statistic	df	Sig.	Statistic	df	Sig.
Syneresis	Plain	.159	180	.000	.935	180	.000
	Coconut	.114	180	.000	.914	180	.000
	Black Grass Jelly	.103	180	.000	.950	180	.000
pH	Plain	.106	180	.000	.975	180	.002
	Coconut	.523	180	.000	.048	180	.000
	Black Grass Jelly	.099	180	.000	.958	180	.000
L	Plain	.067	180	.048	.985	180	.049
	Coconut	.080	180	.007	.990	180	.266
	Black Grass Jelly	.178	180	.000	.863	180	.000
a	Plain	.134	180	.000	.972	180	.001
	Coconut	.268	180	.000	.861	180	.000
	Black Grass Jelly	.193	180	.000	.902	180	.000
b	Plain	.113	180	.000	.965	180	.000
	Coconut	.160	180	.000	.940	180	.000
	Black Grass Jelly	.162	180	.000	.916	180	.000

a. Lilliefors Significance Correction

Appendix 5. Non-Parametric Test Summary of Three Flavors on Day 0

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Syneresis is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of pH is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of L is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of a is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of b is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Appendix 6. Non-Parametric Test Summary of Three Flavors on Day 1

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Syneresis is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of pH is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of L is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of a is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of b is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Appendix 7. Non-Parametric Test Summary of Three Flavors on Day 2

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Syneresis is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
2	The distribution of pH is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
3	The distribution of L is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
4	The distribution of a is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.
5	The distribution of b is the same across categories of Flavor.	Independent-Samples Kruskal-Wallis Test	.000	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .050.

Appendix 8. Friedman Test Statistic of Syneresis Plain Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-6.737[b]	-6.736[b]	-6.736[b]
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix 9. Friedman Test Statistic of pH Plain Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-3.989[b]	-5.236[b]	-2.722[b]
Asymp. Sig. (2-tailed)	.000	.000	.006

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 10. Friedman Test Statistic of L* value of Plain Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-6.360[b]	-6.699[b]	-3.453[b]
Asymp. Sig. (2-tailed)	.000	.000	.001

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 11. Friedman Test Statistic of a* value of Plain Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-3.034[b]	-4.380[b]	-.801[b]
Asymp. Sig. (2-tailed)	.002	.000	.423

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 12. Friedman Test Statistic of b* value of Plain Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-2.610[b]	-2.268[c]	-3.446[c]
Asymp. Sig. (2-tailed)	.009	.023	.001

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

Appendix 13. Friedman Test Statistic of Syneresis Coconut Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-6.665[b]	-6.736[b]	-4.966[b]
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix 14. Friedman Test Statistic of pH Coconut Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-4.213[b]	-4.212[b]	-1.301[c]
Asymp. Sig. (2-tailed)	.000	.000	.193

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

c. Based on negative ranks.

Appendix 15. Friedman Test Statistic of L* value of Coconut Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-.375[b]	-2.982[b]	-2.495[b]
Asymp. Sig. (2-tailed)	.707	.003	.013

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix 16. Friedman Test Statistic of a* value of Coconut Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-.167[b]	-4.776[b]	-2.922[b]
Asymp. Sig. (2-tailed)	.867	.000	.003

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 17. Friedman Test Statistic of b* value of Coconut Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-.861[b]	-1.522[b]	-.885[b]
Asymp. Sig. (2-tailed)	.389	.128	.376

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix 18. Friedman Test Statistic of Syneresis Black Grass Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-6.630[b]	-6.736[b]	-5.657[b]
Asymp. Sig. (2-tailed)	.000	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

Appendix 19. Friedman Test Statistic of pH Black Grass Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-1.625[b]	-6.519[b]	-5.541[b]
Asymp. Sig. (2-tailed)	.104	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 20. Friedman Test Statistic of L* value of Black Grass Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-3.472[b]	-3.857[c]	-4.623[c]
Asymp. Sig. (2-tailed)	.001	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

Appendix 21. Friedman Test Statistic of a* value of Black Grass Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-3.527[b]	-2.412[b]	-1.584[c]
Asymp. Sig. (2-tailed)	.000	.016	.113

a. Wilcoxon Signed Ranks Test

b. Based on negative ranks.

c. Based on positive ranks.

Appendix 22. Friedman Test Statistic of b* value of Black Grass Jelly on All Day

Test Statistics[a]

	Day1 - Day0	Day2 - Day0	Day2 - Day1
Z	-1.872[b]	-4.588[b]	-4.134[b]
Asymp. Sig. (2-tailed)	.061	.000	.000

a. Wilcoxon Signed Ranks Test

b. Based on positive ranks.

Appendix 23. Statistical Analysis for Water Activity

Test Statistics[a,b]

	aW
Kruskal-Wallis H	3.429
df	2
Asymp. Sig.	.180

a. Kruskal Wallis Test

b. Grouping Variable: Sample

Descriptives

aW

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Plain	2	.4732	.00318	.00225	.4447	.5018	.47	.48
Coconut	2	.4051	.01506	.01065	.2697	.5404	.39	.42
Black Grass Jelly	2	.3998	.02291	.01620	.1940	.6056	.38	.42
Total	6	.4260	.03867	.01579	.3854	.4666	.38	.48

Ranks

	Sample	N	Mean Rank
aW	Plain	2	5.50
	Coconut	2	2.50
	Black Grass Jelly	2	2.50
	Total	6	

Appendix 24. Turnitin plagiarism score