Indonesia International Institute for Life Sciences

ENRICHMENT PROGRAM REPORT

Determining Physicochemical Properties of White Cheese Sauce Using Different Types of Hydrocolloids and Starches

STUDY PROGRAM
Food Science & Nutrition

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DETERMINING PHYSICOCHEMICAL PROPERTIES OF WHITE CHEESE SAUCE USING DIFFERENT TYPES OF HYDROCOLLOIDS AND STARCHES

By
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We hereby declare that this final thesis project is from student's own work. The final project/thesis has been read and presented to i3L's Examination Committee. The final project/thesis has been found to be satisfactory and accepted as part of the requirements needed to obtain an i3L bachelor's degree.

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ABSTRACT

Hydrocolloids are widely used in many food formulations to increase shelf life and quality characteristics specifically the viscosity and texture of a product. Furthermore, measuring the physicochemical properties of food is critical for design and quality control during food processing. In this project, the physicochemical test covered pH and viscosity of several hydrocolloids and starch prototypes used in white cheese sauce manufacturing. The scope of the project was to determine the most suitable hydrocolloids and starch substitution based on the nearest value of pH and viscosity of the control variable. As for the pH value, the acceptable range difference was about 0.2, while for the viscosity measurement, the value must be 0. The instrument used for measuring the pH was a pH meter while for the viscosity, it used Bostwick Viscosity Consistometer. This project only used one formulation that was adapted from the company. The result concluded that all types of hydrocolloids proven could substitute the reference product, whereas for the starch the suitable one was starch 2.

***Keywords**: Physicochemical Properties, Hydrocolloids, Starch, Substitute, Gelling Agent, Thickening Agent*

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Through this writing, the author hopes that it will be beneficial to the readers. Any suggestions and/ or comments are highly appreciated.

Jakarta, December 2022

Sarah Seraphine

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LIST OF ABBREVIATIONS

F&F	Flavor & Fragrance
PSD	Powdered Soft Drink
HORECA	Hotel, Restaurant, and Cafe
RTU	Ready to Use
COVID-19	Corona Virus Disease 2019
WFO	Work From Office
FiA 2022	Food Ingredients Asia 2022

CHAPTER 1: INTRODUCTION

1. INTRODUCTION

1.1. Company History

PT XYZ is known as one of the flavor and fragrance (F&F) manufacturers and distributors who care about the long-term viability of natural-based ingredients. This company was established in 1968 in Baturraden, Purwokerto, Central Java, Indonesia with the sole purpose of distilling and exporting Clove Leaf oil. Then, in 1992, they began distilling clove oil derivatives such as Eugenol, Isoeugenol, and Caryophyllene Acetate and distributing flavor and fragrance to the Indonesian market. This company now sells essential oil products such as Patchouli, Nutmeg, and Citronella Oil. Back in 1994, they began producing botanical extracts such as cocoa, coffee, and tea, which have since expanded to include vanilla, ginger, red ginger, turmeric, and other spices.

This company was one of the first companies in Central Java that received ISO 9002:1994 certification in 1996, which was given in the recognition of the Quality Management System and was continuously upgraded to the latest standard. After a while, in 2001, they expanded their operations by establishing a factory in Cileungsi, West Java. Moving forward, this company entered the Seasoning and Savory Ingredients segment in 2008 and expanded into the food service sector by 2020. By 2009, PT XYZ had received Primaniyarta awards as the Best Performing Exporter and in 2021, it received the same awards for the ninth time from the Republic of Indonesia's Ministry of Trade. As for now, PT XYZ has established an Essential Oil Center (EOC) in Baturrraden which is dedicated to the processing and compounding of essential oils.

1.2. Vision and mission

PT XYZ's vision is to be a regional leader in ingredients for food, flavor and fragrance industry through innovation, efficiency, and sustainable business practices. This is also aligned with their mission which to create innovative solutions with sustainable natural-based ingredients for life.

1.3. Company's Activity

Essentially, this company is a research-oriented and innovation-driven organization that believes in sustainable practices. By developing a diverse range of natural ingredients derived from Indonesian botanicals and other naturals to aid in the creation of limitless everyday products and provide solutions to their customers. Aroma Ingredients, Taste and Wellness, Food and Savory Solution, and Specialty Ingredients Distributor are four businesses that offer solutions to customers.

1.3.1. Aroma Ingredients

On the aroma ingredients, this company operates value-added businesses based on natural ingredients. They provide natural and nature-based ingredients to create or amplify specific aromas, enhance taste, and bring function through the world of smell, taste, and well-being.

1.3.2. Taste & Wellness

As for Taste & Wellness, it includes Indonesian botanical extracts and CO_2 extracts that improve food and beverage applications while also providing beneficial and functional properties that can be used in other industries such as cosmetics, nutrition, pharmacy, agriculture, and even animal feed.

1.3.3. Food & Savory Solution

Meanwhile, for Food & Savory Solution, it manufactures customized seasonings and savory ingredients and has recently expanded into providing Food & Beverage Solutions.

1.3.4. Specialty Ingredients Distributor

As a Specialty Ingredients Distributor, they collaborated with several global leaders in specialty ingredient distribution to distribute and market their products in Indonesia. With their strong expertise in innovation and application, they are able to assist their customers in developing a wide range of product applications.

1.4. Description of Student's Department

Under Sales and Marketing Food Ingredients, which is led by the Administrative Assistant, there are six departments, including Sales Food Ingredient, Business Support, Marketing Food Ingredient, Sweet Innovation and Application, Business Analyst, and New Business Development (Figure 1). Furthermore, the author's division, Product Formulation and Application, is located within the Sweet Innovation and Application department. This department is divided into four sections: Product Development - Food Service & Sweetener, Sweet Innovation & Application Technologist, Product Development - Beverage, and Product Development-Sweetener. Except for Product Development - Sweetener, each division has its own product applicator division.

During the author's early internship period, the author had the opportunity to work in the Food Service & Sweetener division's product development and application. This division was created specifically for HORECA, and the final product is frequently packaged as premixes. However, the product's development may vary from PSD to jam, syrup, and ice cream. Meanwhile, during the third month of the internship, the author had the opportunity to shift the division into the Cheese Powder application. The product applications in this division are completely different from those in the Food Service & Sweetener division, and the applications are much more varied. RTU sauce, cream filling, dipping cream, whipping cream, processed cheese, cookies, and seasonings are among the items available.

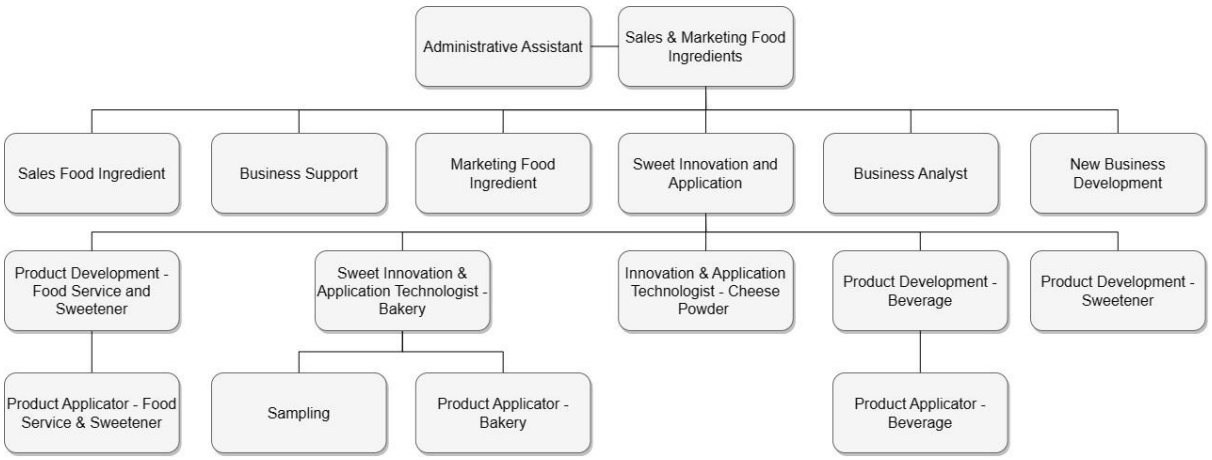

Figure 1. The Structure Organizational of PT XYZ

CHAPTER 2: INTERNSHIP ACTIVITIES

2. INTERNSHIP ACTIVITIES

2.1. Working Conditions

After the COVID-19 pandemic cases decreased significantly and the governmental regulation confirmed that WFO could be implemented, all activities within this company, including all internship activities, were carried out on-site gradually, followed by periodic checking of rapid antigen swab tests to expedite handling and reduce spreading if someone had been infected. The Internship program was carried out starting from July 4th until December 30th, 2022. On the other hand, the regular working schedule of this company is Monday to Friday, 8 a.m. to 5 p.m., with a lunch break from 12 p.m. to 13 p.m. During this internship program, the author was assigned to the Product Innovation and Application Department in both Sweet and Savory Departments. The Product Innovation and Application department will typically work on product development in the laboratory, and each division can complete three to four or even more projects per day. Thus, based on the work pace, this company can be classified as fast-paced.

2.2. Daily Tasks and Experience Gained

The author was assigned to a project task and day-to-day activities during the internship program. The typical daily activities can be classified as follows.

2.2.1. Samples Preparation

The main activity as a Product Innovation and Application was to create a product application according to the client's request. In the Food Service division, the products include PSD, jam, syrup, and ice cream. Despite the variety of applications, the samples delivered to the client were in the form of premixes. However, throughout the trials in developing the product and making the premixes, the author assisted in starting from preparing, weighing, and packing the samples. Plating was sometimes required for liquid flavoring or coloring samples so that they could be mixed and turned into powder form. When preparing for the jam and syrup application, cooking with a hot plate and magnetic stirrer was required. The temperature is usually set to 90^{o}C, and the speed of the stirrer can be adjusted depending on the sample quantity and form (e.g., more liquid, more viscous, etc.). Whereas, for ice cream application, usually the powder ingredients were weighed and mixed first, followed by dissolving in hot water. Thereafter, it would be run in the ice cream machine.

Meanwhile, in the Cheese Powder Application, the products include RTU sauce, cream filling, dipping cream, whipping cream, processed cheese, cookies, and seasonings. The samples were delivered and prepared in the form of an application requested by the client. It can be in the form of cookies, sauce, seasoning powder or paste, processed cheese, cream filling that is frequently applied to wafers, and so on. Generally, the author would be asked to create a base that includes all of the basic ingredients that do

not need to be adjusted and/or reduced. In this part, the plating of liquid or paste flavoring and coloring were required to ease the mixing process. On the other hand, to avoid unpleasant texture in the cream filling, it must be run through the refiner six to eight times. Furthermore, during the author's internship period in this division, the host company provided the author with the opportunity to contribute to the FiA 2022 by assisting in the preparation and production of the samples, as well as packing the samples, and assisting on the d day.

2.2.2. Assisted in Product Application Development

The author was taught the fundamentals of product development in the first week of the internship period, which included things that need to be noticed when developing a product, as well as given immediate practice to match several target products such as flavored milk and flavored tea. Starting from observing all the composition and nutrition facts of the product until running several tests such as pH test, and measuring Brix of the product. During this time, the author had the chance to develop several products based on the author's analysis along with the supervisor's guidance. The author was honored to develop several applications including jam, ice cream, syrup, seasoning powder, and sauce, which not only cover the taste but can also be the color.

When the author first entered the Cheese Powder Application division, the author was given a basic understanding of the flavor pyramid, which consists of basic notes, middle notes, and top notes. Following that, the author was given a quick review of several ingredients that will be frequently used in the product application, followed by a sensory of various cheese powders and an attempt to analyze their flavor properties. During that time, the author also attempted to become acquainted with all of the ingredients used and their roles in the food product. This experience broadened the author's knowledge about sensory properties, flavor profile, aroma, and texture characteristics, particularly from the expert point of view, and trained the sensory sensitivity of the author.

2.2.3. Conducted Sensory Analysis Test

In most cases, the client will need a sensory analysis test to determine whether or not people's perceptions of the product imitating the target product are already similar. The method usually used in testing the food product application is the Triangle test in which all respondents are given three samples with details 2:1 meaning two of the same sample and one different sample. Following that, respondents must determine which sample is the outlier and explain their reasoning on the answer sheet. The determination of the statistical significance was according to the p values which were used to test the hypothesis. The cut-off that is usually used is 0.05. If the $P \leq 0.05$ it indicates a significant difference, while if the p-value is above 0.05 resulting in no significant difference. The determination of the

significant difference was done by calculating its Z-value using Z-Test and the calculation used as seen below (Greenland, …, & Altman, 2016).

$$Z = \frac{(P_{obs} - P_{chance}) - (1/2n)}{\sqrt{\frac{pq}{n}}}$$

2.2.4. Applied 5R

5R is an abbreviation for *Ringkas, Rapi, Resik, Rawat, dan Rajin.* In this subdivision, the author was assigned to create a raw materials stock list and a naming blueprint for the storage of the ingredients. Moreover, the author was also expected to always maintain the cleanliness of the laboratory and positioned all the raw materials and instruments back to their initial placement.

2.3. Project Tasks

Along with the daily internship tasks, the project was completed in the middle of the internship program. The project involved determining the physicochemical properties of White Cheese Sauce using various types of hydrocolloids and starches. The goal was to identify the suitable hydrocolloids and starch substitute in White Cheese Sauce that had similar physicochemical properties to the control. In this project, all prototypes were tested for pH and viscosity and the results were compared to the control.

2.4. Theory and Practice Comparison

During the internship program, the author discovered that all of the laboratory courses and study plans obtained from i3L are incredibly helpful, particularly in supporting the daily tasks assigned by the host institution. The author was provided with knowledge as well as hands-on experience in the laboratory, which prepared the author to enter the actual workplace. Courses such as Food Additive, which assisted the author in recognizing the ingredients used when developing a product, for example, various types of sweeteners and their flavor properties, Flavor Chemistry and Technology, which is one of the fundamental learning in knowing the fundamentals of flavor and aroma, particularly in this field as a Product Innovation and Application in the food industry, and Sensory Analysis which is also one of the important things to understand because it is frequently applied to assess the food product applications.

2.5. Difficulties Encountered

In doing the internship, the author encountered many challenges which taught and challenged the author to do better. It includes adapting to the work pace of the company, familiarizing with all the ingredients and instruments used, adjusting to the tasks given which frequently required multitasking, etc. As for the author, firstly, it was challenging to do the tasks given because it was new to the author, especially in doing a lot of processing food while the authors had not gotten a lot of

exposure to it. However, as time goes by, the author managed to adapt to all the tasks given.

CHAPTER 3: PROJECT DESCRIPTION

3. Introduction

3.1. Project Background

The physicochemical properties of food are primarily responsible for the final product's quality. Furthermore, measuring these properties is critical for design and quality control during food processing. There are several physicochemical properties of food, in this project, the experiment would cover pH and viscosity of several White Cheese Sauce prototypes with different hydrocolloids and starches (Igual, & Martínez-Monzó, 2022). According to the literature, pH would most likely affect the stability of a food product, especially a viscous one. In order to produce a high-quality end-product, the selection of hydrocolloids that act as a gelling agents and starch that act as thickeners must be followed (Andrés-Bello, …, & Martínez-Monzó, 2013).

Hydrocolloids are a heterogenous group of long-chain polymers that form viscous dispersion and/ or gels while scattered in water. It stands for hydrophilic colloids that are referring to the dispersion produced by the increase of affinity in binding water molecules (hydrophilic) which also denotes the characteristic of colloids (Saha, 2010). Particularly, hydrocolloids have the ability to modify the rheology of food systems including their flow behavior (viscosity) and mechanical solid property (texture) which indirectly affect the sensory properties of a food product. It is widely used in many food formulations to increase shelf life and quality characteristics. In addition, hydrocolloids are frequently used specifically for several applications such as soups, sauces, gravies, jams, jellies, and so on, to attain the desired viscosity, mouth feel, and texture (Saha, 2010).

Generally, hydrocolloids have a wide range of functional properties including emulsifying, stabilization, controlling the crystal growth of ice and sugar, and the most common ones are thickening and gelling (Saha, 2010). According to the literature, thickening agents are likely to increase the viscosity of a food product while having no effect on other properties such as taste. As for gelling agents, they function similarly to thickeners, but the gelling process is influenced by the concentration used, pH, and temperature of the food product (Qin, 2018).

On the other hand, starch has been used as a thickener in manufacturing various food product applications including pudding, sauces, candy, sweet gums, etc. The physical and chemical properties of granule starches influence their properties and functionality. Furthermore, hydration influences the gelatinization of starch, whereas temperature influences the swelling process. In terms of viscosity, it can change in accordance with the hydration and heating time (Cornejo-Ramírez, …, & Cornejo-Ramírez, 2018).

Generally, starch is one of the hydrocolloids types, however, in this project, starch was separated from the hydrocolloids due to its differentiation in the function used for this product. Hydrocolloids in this product worked as the gelling agent of the product. Meanwhile, starch is used as a thickening agent in this product.

3.2. Scope of The Project

One of a company's responsibilities to its customers is to ensure the availability of ingredients or raw materials for the continuation of mass production. In fact, as production continued, the availability of those ingredients could not be predicted. As a result, some alternatives or substitute ingredients are required to continue production, and several tests must be performed to ensure that the quality of the product remains consistent with the original. In this project, the author created several prototypes of white cheese sauce using various types of hydrocolloids and starches, and then subjected them to physicochemical tests, specifically pH measurement and viscosity measurement, to determine the most suitable hydrocolloids and starch substitution based on the nearest and/ or similar value of pH and viscosity to the control. The project was carried out at PT XYZ from September 22nd to November 4th, 2022, and it included formulation, determination of both hydrocolloids and starch substitute, base mixture preparation, the manufacturing process, and the physicochemical test which include pH and viscosity measurement. The measurement of the physiochemical properties was done in one replication due to the limitation of ingredients availability and the instrument used which in this case the viscosity measurement which has to be done in the company's factory in Cileungsi.

3.3. Objectives

The objectives of conducting this project were:

1. To determine the best substitute of hydrocolloids based on the pH and viscosity according to the reference product.
2. To determine the best substitute of starch based on the pH and viscosity according to the reference product.

3.4. Problem Formulation

1. How to determine the best hydrocolloid substitute for making white cheese sauce?
2. How to determine the best starch substitute for making white cheese sauce?

3.5. Proposed Solution

1. Making White Cheese Sauce with various types of hydrocolloids, putting them through a physicochemical test, and comparing the results to the control.
2. Making White Cheese Sauce with various types of starch, putting them through a physicochemical test, and comparing the results to the control.

3.6. Materials and Methods

3.6.1. Materials

The ingredients needed were, water, oil, maltodextrin, starch, cheese powder, sugar, non-dairy creamer, salt, acidulants, hydrocolloids, and flavoring. While, for the equipments needed were beaker glasses,

thermomixer, pH meter, Bostwick Viscosity Consistometer, spatula, bowl, and plastic pouch.

3.6.2. Methods

In order to find the best substitute for hydrocolloids and starch in White Cheese Sauce, six steps are taken (Figure 2). After completing all of the steps, the sample and formulation were ready to be delivered to the client and subjected to mass production if necessary.

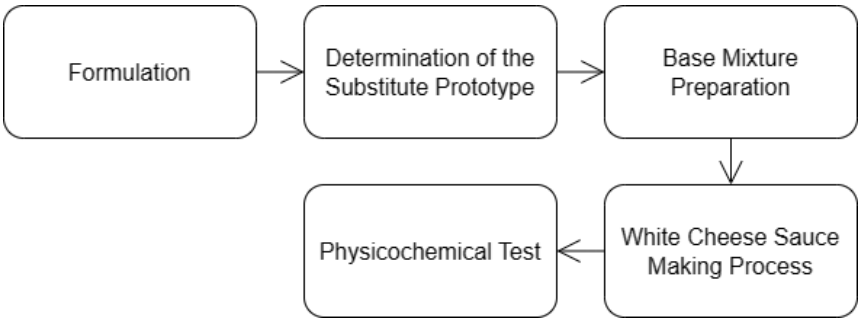

Figure 2. The Flow of Substitute Hydrocolloids and Starch Determination on White Cheese Sauce

3.6.2.1. Formulation Development

Initially, the formula was made according to the company's reference and it had been through several trials to become a final formulation. The final formulation were attached below (Table 1).

Table 1. The Final Formulation of White Cheese Sauce

Materials	Formula
Water	63 %
Oil	23 %
Starch	3.6 %
Cheese Powder	3.1 %
Non-Dairy Creamer	2.94 %
Sugar	1.7 %
Maltodextrin	1.18 %
Salt	0.9 %
Acidulants	0.34 %
Flavorings	0.14 %

Materials	Formula
Hydrocolloids	0.1 %

3.6.2.2. Determination of the Substitute Ingredients Prototypes

In terms of hydrocolloids, the control was the mixing of hydrocolloids A+B, and for the substitution, eight prototypes were determined, including hydrocolloids A, hydrocolloids B, hydrocolloids C, hydrocolloids D, hydrocolloids E, hydrocolloids B+C, hydrocolloids B+D, and hydrocolloids B+E (Table 2). As for the control product, the hydrocolloids used were hydrocolloids A+B with a ratio of 1:1 and the starch used was starch 1.

According to Saha and Battacharya (2010), hydrocolloids that are classified as thickeners include hydrocolloids B, and hydrocolloids C. Whereas, hydrocolloids D and hydrocolloids E, on the other hand, are primarily used as a gelling agent.

Table 2. The Hydrocolloids Prototypes

Number	Prototypes
1.	Hydrocolloids A+B (Control)
2.	Hydrocolloids A
3.	Hydrocolloids B
4.	Hydrocolloids C
5.	Hydrocolloids D
6.	Hydrocolloids E
7.	Hydrocolloids B+C
8.	Hydrocolloids B+D
9.	Hydrocolloids B+E

Meanwhile, for the starch, the control used starch 1, and for the substitution, there were two prototypes: starch 2 and starch 3 (Table 3).

Table 3. The Starch Prototypes

Number	Prototypes
1.	Starch 1 (Control)
2.	Starch 2
3.	Starch 3

3.6.2.3. Base Mixture Preparation

The base mixture consisted of maltodextrin, cheese powder, non-dairy creamer, salt, and flavoring. All of the ingredients for the base mixture were weighed, sieved, and mixed in a plastic bag.

3.6.2.4. White Cheese Sauce Making Process

The processing flow was divided into four steps, as shown in Figure 3. To begin, thoroughly combine the water, sugar, and hydrocolloids in a thermomixer for 3 minutes on speed 3 until the powder dissolves. After that, scrape the entire edge of the thermomixer with a spatula before adding the base mixture, then run for another 3 minutes at speed 3.5. The third step involved scraping the entire edge of the thermomixer, then adding starch and oil and mixing them for 5 minutes at speed 5 at 60°C. Finally, the entire edge of the thermomixer was scraped and acidulant was added before running them for 30 minutes on speed 5 at 90°C.

Since the objective of this project was to determine the best substitute of hydrocolloids and starch inside the reference product of White Cheese Sauce, therefore, the application of heating treatment of all prototypes was synchronized as the treatment for the reference product. Thereafter, the result would be compared and determined which one performs better compared to the reference product.

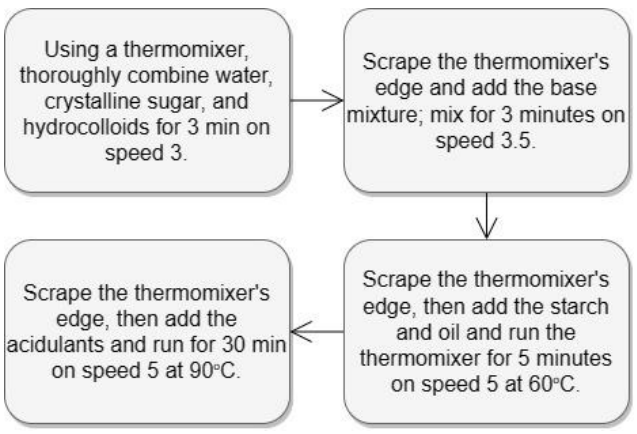

Figure 3. The Process of Making White Cheese Sauce

3.6.2.5. Physicochemical Test

In this project, the analysis covered pH measurement and viscosity measurement. As for pH, it was measured using a pH meter. Furthermore, to keep the accuracy in measuring the pH, it needs to be calibrated with two-point calibration. The commonly used points value of buffers are pH 4.01 and 7.01 or pH 7.01 and 10.01 (Kulasekaran, Gopal, Lakshimipathy, & Alexander, 2015). The measurement was done right after the sample was set to room temperature.

Meanwhile, for the viscosity measurement of White Cheese Sauce, it was using Bostwick Viscosity Consistometer at the company's factory in Cileungsi. Therefore, after the sauce was finished and chilled for several hours at room temperature, it was packed in a plastic pouch and delivered to the company's factory the next morning. The Bostwick Viscosity Consistometer is intended to be positioned at a specific small angle. Adjusting a series of screws until the leveling bubble on the front of the instrument is centered ensures that the sloped flowing lane is in the proper position. The narrow instrument's sample reservoir has a capacity of approximately 100 ml and is connected to the flow lane via a sluice gate. The flow lane is essentially a rectangular aisle with very small surface roughness. The idea is that once the sluice gate is opened, the material filling the reservoir begins to flow down the aisle. The distance covered after 30 seconds and was measured in centimeters (Perona, 2005).

3.7. Result and Discussion

3.7.1. White Cheese Sauce with Several Hydrocolloids Prototypes

3.7.1.1. pH

In general, pH is an indicator of hydrogen ion concentration [H^+] in a water solution. The scale that is commonly used ranges from 0-14 with 7 as the midpoint. pH values less than 7 sequentially indicate more acidic reactions, while pH values greater than 7 sequentially indicate more basic or alkaline reactions (Boyd, Tucker, & Viriyatum, 2011). In measuring pH value, there are two common methods: the colorimetric method which is applied using indicator solution or papers, and the electrochemical method which is using electrodes and a millivoltmeter (pH meter) as the instrument (Webster, 2003).

As previously stated, nine prototypes were created, including the control, which was a mixture of hydrocolloids A+B, and the substitute prototypes including hydrocolloids A, hydrocolloids B, hydrocolloids C, hydrocolloids D, hydrocolloids E, the mixture of hydrocolloids B+C, the mixture of hydrocolloids B+D, and the mixture

of hydrocolloids B+E. Figure 4 depicts the pH measurement results for these prototypes. Based on the graph, the pH of the control was 4.67. Following that, according to the host institution regulation, a difference of pH less than 0.2 was still acceptable and considered as human error or technical error, implying that none of the prototypes differed significantly from the control. On the other hand, the greatest difference in the pH was located on hydrocolloids A and the second one was hydrocolloids E with the gap number of 0.12 and 0.05 respectively.

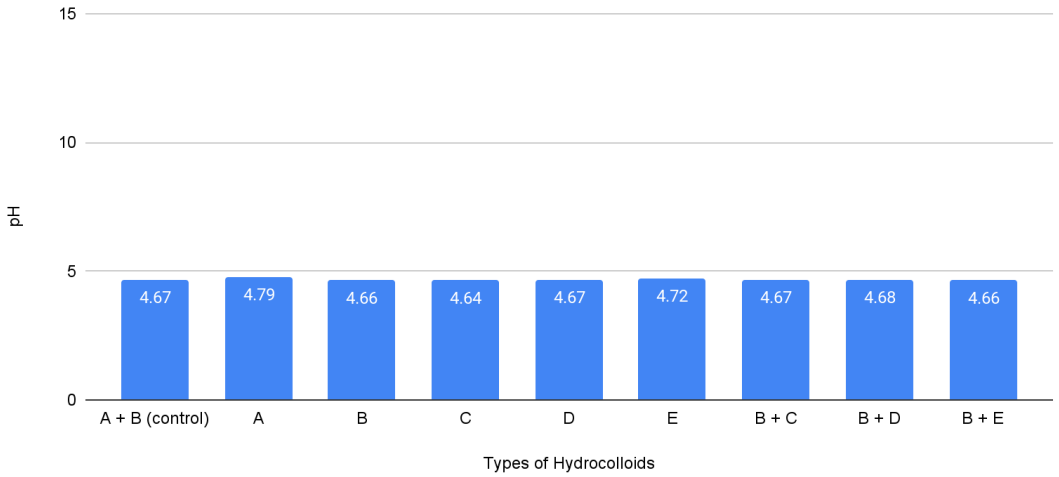

Figure 4. The pH of White Cheese Sauce with Several Hydrocolloids Prototypes

According to the literature review, hydrocolloids A refers to stabilizers that enhance the texture, appearance, and shelf life of a food product (Gafour, & Aly, 2020). As for hydrocolloids E is derived from various species of red seaweed. It has no nutritional value and effect on the pH of the food product. However, the application is predominantly on sauces as a gelling, thickening, and stabilizer (Necas, & Bartosikova, 2013). Based on the journal both hydrocolloids A and E did not gave any influence into the pH of the final product. Thus, a big difference in the pH value may be occurred because of an error in the manufacturing process such as weighing the raw ingredients.

3.7.1.2. Viscosity

According to the host institution, the viscosity standard for sauce production is 0. In terms of this regulation, all of the hydrocolloid prototypes meet the requirements (Figure 5). As a result, all of the hydrocolloid prototypes can be used in place of the hydrocolloids used in the control.

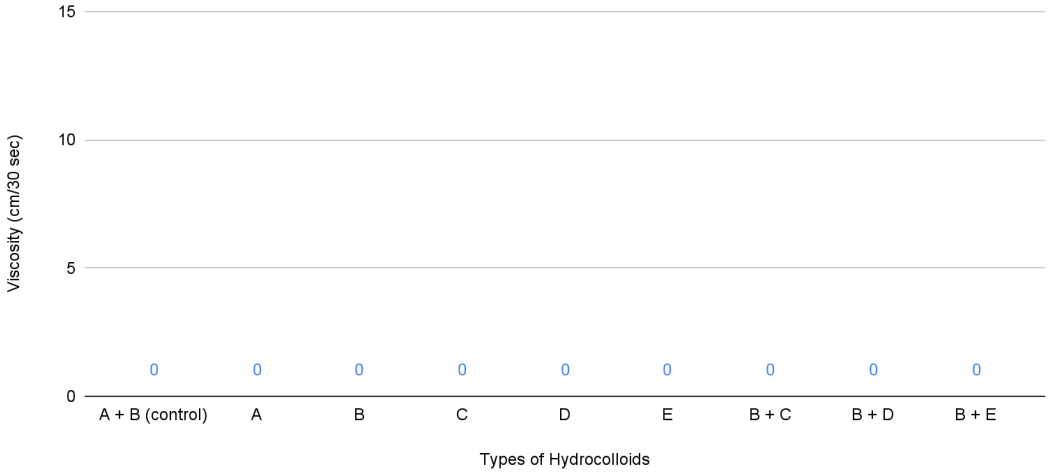

Figure 5. The Viscosity of White Cheese Sauce with Several Hydrocolloids Prototypes

However, the result of the hydrocolloid prototypes might be the same because ot its viscosity properties which was depending on the substance. In this case, the sauce can be categorized as non-Newtonian fluid specifically Pseudoplastic fluid whose viscosity decreases in response to force. These products appear to be Bingham fluids at first glance due to their high viscosity prior to applying force, but they do not have yield value (Berk, 2009).

Despite, each hydrocolloid prototype has a distinct texture. The texture differs significantly depending on whether it is classified as a gelling agent or a thickening agent. Gellification refers to a process in which polymer chains are linked together or crosslinked to create a three-dimensional network that traps or immobilizes water to create a rigid structure (Banerjee, & Bhattacharya, 2012). Whereas, thickener is typically a surfactant-based aqueous solution system where the surfactant forms micelles. The presence of an electrolyte raises the number of micelles that can form associations, which changes spherical micelles into rod micelles and raises the system's viscosity and resistance to motion (Vu, …, & Kasting, 2020). However, according to the journal, non-gelling agents (such as hydrocolloids B and hydrocolloids C) and gelling agents (such as hydrocolloids E) are frequently combined to increase viscosity and/ or improve the properties of food gels, such as elasticity. Blending different polysaccharides is an alternative method for creating new textures (Saha, 2010).

According to its characteristic, hydrocolloids B, has a high shear thinning characteristic and maintains viscosity in the presence of electrolytes, high temperatures, and a wide pH range. Meanwhile, for hydrocolloids C, it has a very high low-shear viscosity, is highly shear thinning, and is electrolyte independent. As for, hydrocolloids C, it performs high viscosity at a very low concentration (Mudgil,

Barak, & Khatkar, 2014). In the meantime, it was discovered that using less hydrocolloids D results in more noticeable shear-thinning. As a result, hydrocolloids D will be a better thickening agent (Belalia, & Djelali, 2014). Lastly, for hydrocolloids E, it performs a highly viscous aqueous solution, but the viscosity varies depending on concentration and temperature. High temperatures and low pH cause complete functional loss. That can be said that, even though the viscosity value was shown in the same manner (the value was 0) however, judging by its characteristics, the final product's texture may differ based on its characteristics.

Furthermore, according to Figure 4 and Figure 5 which showed the result of pH and viscosity of White Cheese Sauce with several hydrocolloids prototypes, it can be concluded that all types of hydrocolloids met the requirement of the host institution which is to have less than 0.2 difference in terms of pH measurement with the control/ reference product and have a number of 0 value for the viscosity measurement. Therefore, all types of hydrocolloids could substitute the hydrocolloids used in the control/ reference product.

3.7.2. White Cheese Sauce with Several Starch Prototypes

3.7.2.1. pH

The pH measurement result showed no significant differences between the control and the other two prototypes because the difference was less than 0.2. (Figure 6).

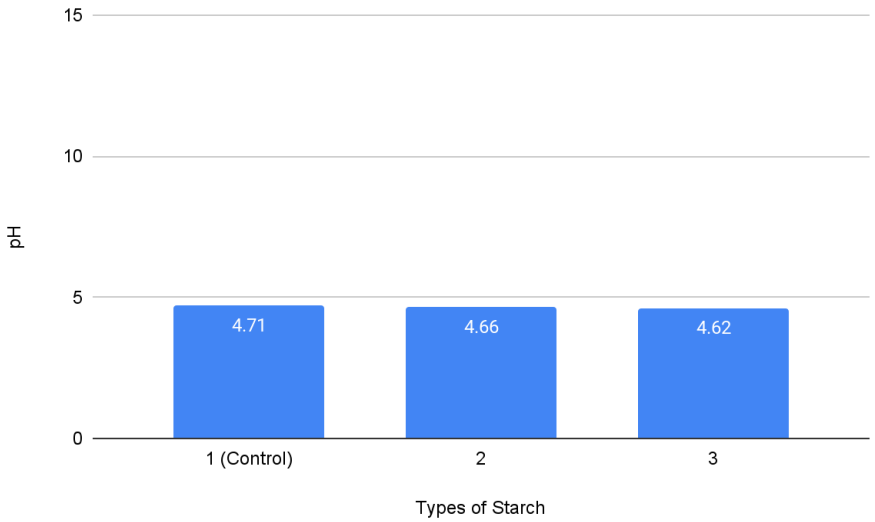

Figure 6. The pH of White Cheese Sauce with Several Starch Prototypes

What differentiates the starch is the type of the starch. Starch 1 is a modified starch derived from maize colored white to off-white. This product is commonly used in fillings and glazes, pudding, sauces, custard, and gravies. While starch 2 and 3, they also a modified starch but it has been through pregelatinization. In general, pregelatinized modified starch was treated with sufficient

heat then underwent drying and grinding. The aim is to develop starch that is able to disperse instantly in cold water and has a thickening/ gelling capabilities (Hong, & Liu, 2018).

Moreover, there is no correlation between the utilization of different types of starch and the pH value. This is due to the acidity level of starch that is considered as neutral meaning will not affect the final pH of the food product. On the other hand, the difference in the pH value may be due to human error in weighing all of the raw materials or to a technical error in the instrument used.

3.7.2.2. Viscosity

Based on the result in Figure 7, it can be clearly seen that Starch 3 prototype has exceeded the viscosity standard of the host institution. Based on the literature, Bostwick measurement would decrease as the viscosity of the product increased (McCarthy, & McCarthy, 2009). Thus, a number greater than 0 indicates that the fluid is less viscous.

According to Figure 7, the result of starch 3 showed in 12.6 value, which was too far from the reference value of the company. Meaning the product is also too aqueous and not suitable for substituting the control.

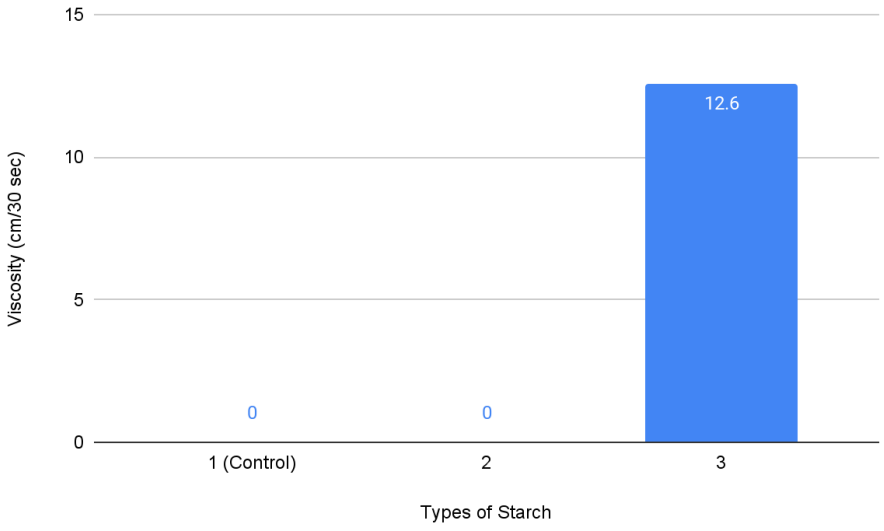

Figure 7. The Viscosity of White Cheese Sauce with Several Starch Prototypes

Based on Figure 6 and Figure 7 which showed the result of pH measurement and viscosity measurement of White Cheese Sauce using several types of starch, it can be concluded that the suitable substitute for starch used in the control/ reference product was starch 2. Proven by its pH value which has a difference of less than 0 when compared to the reference product and the viscosity

measurement value which met the host institution's requirement. As for starch 3, it has exceeded the standard of the host institution's regulation of the viscosity measurement value which has to be 0 rather than 12.6.

3.8. Conclusion and Recommendation

Based on the experiment, it can be concluded that all types of hydrocolloids could replace the control variable. It was proven by the pH value that predominantly approached the control variable. Furthermore, the viscosity measurement resulted in alignment with the pH measurement, indicating that all hydrocolloids could substitute the control variable because the viscosity showed a 0 value, which is the same as the control. Although, there might be a difference in the texture because of the difference in the physical properties. Meanwhile, starch 2 and 3 did not differ significantly from the control in terms of pH. However, judging by the viscosity, starch 3 appears to have a high number value, indicating that it has a liquidy form compared to the control and to starch 2. As a result, starch 2 is a suitable starch substitute for the control.

Furthermore, for future research, it is recommended to do a triplicate on every test in order to obtain a more accurate result that can be analyzed statistically. In addition, another experiment involving sensory properties is suggested for future research in order to make the analysis more credible to maintain the quality of the white cheese sauce.

CHAPTER 4: SELF REFLECTION

4. Self Reflection

Over the past six months of the internship program, the author was provided with immense knowledge, experiences, and lessons. Started with adapting to a work environment, having good communication skills with both colleagues and supervisor, adapting to the company's work pace, managing the daily tasks and the project assigned, and gaining abundant of knowledge that cannot be mentioned one by one. At first, the author faced difficulties in doing all the soft skills aforementioned, but along the way, the author successfully overcame it. In addition, the author believes that joining the BRIGHT sessions is one of the reasoning, remembering that many of the session was purposing for the future career of the students. On the other hand, the i3L's values such as grit, role model, and integrity have guided the author through the internship program. Aside from that, the author also received various trainings and was mentored by experts from the host institution, who assisted, supported, and prepared the author for entering the real-life working situation, especially in the food industry.

In regard to academics, as a Food Science and Nutrition student, the author discovered that all the courses that the author received from i3L were supporting the author during the author's internship. Notably, when it talked about laboratory experiments that the author gained from the laboratory practices in i3L such as Sensory Analysis Laboratory and Food Analysis Laboratory, and topics around flavor and food additives which came from the courses named Flavor Chemistry and Technology, and Food Additives.

In terms of the host institution, the author has fulfilled the responsibilities specified in the Product Innovation and Application field. All in all, the author was extremely grateful to PT XYZ and i3L for giving the author this opportunity and for supporting the author this far.

CHAPTER 5: CONCLUSION & RECOMMENDATION

During the internship program, the author had numerous learning opportunities. Starting with fulfilling the day-to-day activities to completing the project task assigned to the author. In this internship, the author was assigned to the Food Service division and Cheese Powder Application division which is located under Sweet Innovation and Application department, and Savory Innovation and Application department respectively. The author was able to learn from two distinct divisions, which broadened the author's knowledge, skills, and real-life working experience in the food industry. Besides, the author also had an opportunity to put knowledge into practice. Specifically, in applying what the author has learned as a Food Science and Nutrition student in college. Apart from hard skills, this internship experience assisted the author in honing her soft skills.

It is recommended that future interns be enthusiastic about learning new things and be proactive in seeking additional experience and knowledge. Lastly, try to perform as well as the intern can and be willing to accept challenges in order to expand the intern's capacity.

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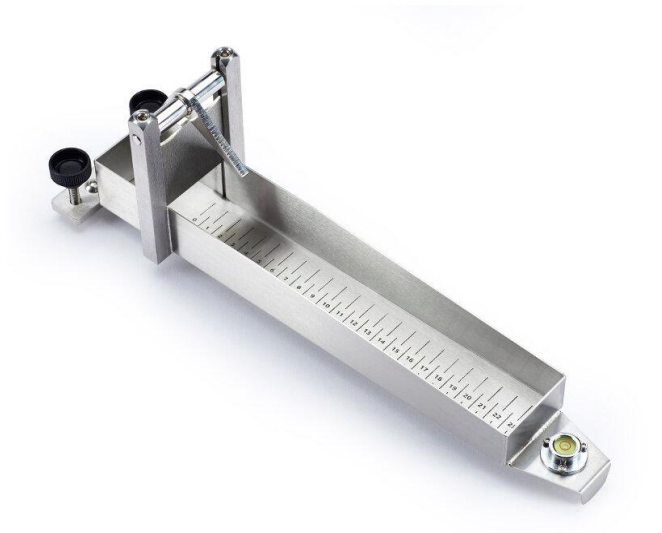
APPENDICES

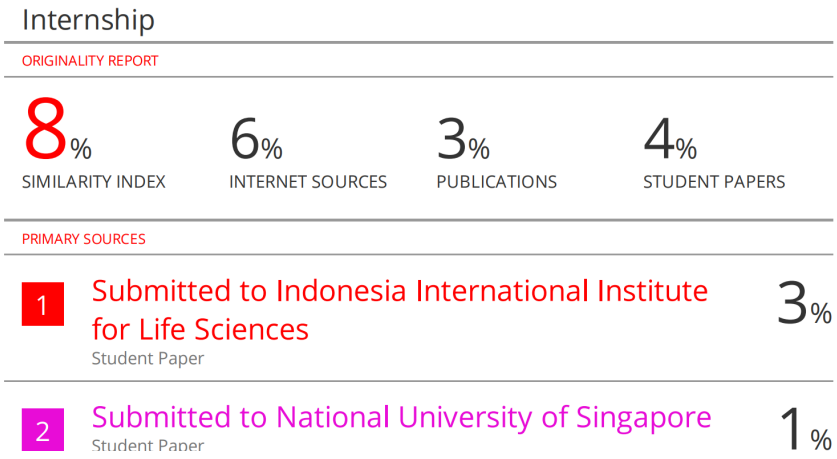
Appendix 1. FiA 2022

Appendix 3. pH Meter

Appendix 2. Thermomixer



Appendix 4. Bostwick Viscosity Consistometer



Appendix 5. Turn It In Result