Indonesia International Institute for Life Sciences

ENRICHMENT PROGRAM REPORT

The Effect Of Different Oil and Water Ratio To The Physical Properties Of Meltique Meat

STUDY PROGRAM
Food Technology

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Effects of Different Oil to Water Ratio to the Physical Properties of Meltique Meat

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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

Meat marbling is defined as white fleck of fat in meat cuts and usually associated with juiciness, palatability, and quality. Meat marbling is often graded based on the amount of intermuscular fat that creates the marbling effect. In a n attempt to increase the value of meat through marbling, fat or emulsions are often injected into lean meat. This process is called artificial marbling. In this project, emulsions of two different types are injected into lean meat in order to create artificial marbling. Two types of emulsions, water in oil and oil in water emulsions, are going to be injected into meat samples. Quality of the resulting samples are going to be measured by physical properties measurement such as Water holding capacity, Emulsion stability, color, texture, and marbling grade. Out of the results, water in oil emulsion samples shows a more promising quality aspect. However, more studies are still needed in regards to several detailed aspects in this project.

Keyword: Artificial Marbling, Physical Properties, Meat Quality, Emulsion.

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I. INTRODUCTION

1.1 Company History

PT. Garindo Food International is a company that is a part of the meat industry. Established in 2021, it began its operation in making meat products in early 2022. The factory is a part of PT. Suri Nusantara Jaya group and has been producing meat products such as sausage, nuggets, meatballs, and meat cuts products.

1.2 Vision and Mission

Below are the vision and mission of the company itself

Vision:

To become a company that brings prosperity to its workers while also being beneficial to the society

Mission:

- To work sincerely and provide the best service for the customer while maintaining a reasonable price.
- To have professional workers that are honest in their words and actions.
- To ensure the prosperity of their manpower in accordance with their responsibilities and workers attitude.

1.3 Main Activity

The main activity in this factory is producing processed meat products such as sausages, nuggets, and meatballs. It also produces raw meat products such as sliced meat and meat cuts. The factory operates according to customers' demands for each month. Therefore, the activity in each day of the week and each week of the month can be different.

1.4 Organizational Structure

The organizational structure of the company starts with Mr. Boediono E Tandu as the director. Then there are 3 departments which are RnD, Production, and Quality Control. Each department manager is directly under the director’s line of command. Continuing from there is the factory worker which are divided into each role such as packaging, engineering, processed meat line, and raw product line.

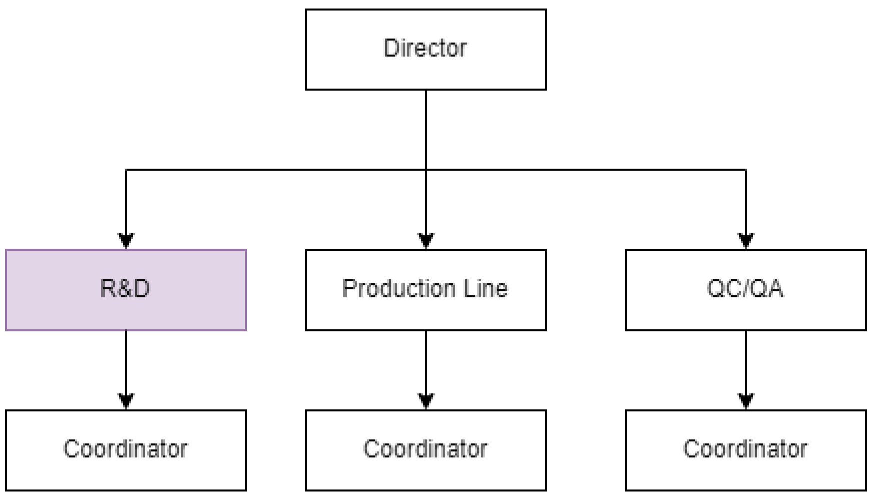


Figure 1. Organizational structure of PT. Garindo Food International

1.5 Internship Unit or Department

The Research and Development department is the unit where new products are being tested and developed. It also includes fixing or further development of existing products to improve product and production quality. The RnD department took care of new product development, existing product development, production scale development, material and resources searching, production cost, and product pricing. Most of the activities done by interns in this department are creating the formulated product for new product development and participating actively in developing new products in form of suggestions or insights.

II. INTERNSHIP ACTIVITIES

2.1 Working Conditions

During the internship, the working hours follow the company's working hour which is 8am to 4pm with occasional overtime if needed. Although there are irregular schedules at times, most of them are regular working schedules.

2.2 Internship Tasks

The tasks given range from testing new products to doing quality control in the field. Several projects to be named are assisting in the development of several new products such as premium sausage, smoked beef, chicken karaage, spice mix substitute, and jumbo meatballs.

2.2.1 Premium Sausage

The trials for premium sausage production are done by hand, including the mixing and stuffing. These activities were being held on several non consecutive days depending on the availability of time and ingredients. The product development process includes testing for different flavors of the product and the suitable ingredients and process used. As the trial results are sometimes not according to expectation, repetition of the trial is often conducted.

2.2.2 Smoked Beef

During the smoked beef trial, the process is similar to the usual sausage production process. However, the casing used is bigger in diameter when compared to regular sausages. The trials were done in 2 non consecutive days depending on the schedule and availability of ingredients. Trial results were used in other product trials as an ingredient.

2.2.3 Chicken Karaage

Trials for chicken karaage lab are done in the RnD lab using two types of premixes from two different companies. The trials were done in 2 to 3 non consecutive days in order to compare which premixes are suitable to be used for the product. Aside from production, the development process also includes deciding the best storage procedure and condition to store the finished product.

2.2.4 Spice Mix Substitute

During the early few weeks of the internship, a trial was conducted to search for a suitable substitute for a spice mix. A mix of several available seasonings are tested to search for the one that was the most similar to the existing seasoning. The trials are done for a few non consecutive days which also includes production scale testing in the production room.

2.2.5 Jumbo Meatballs

In the jumbo meatball trial, the aim is to produce a good texture filled meatball that also has a good appearance. The trial ranges from lab scale to production scale that are done in several non consecutive days. Minced beef was used as the meatball filling and cooking was done under controlled temperature. Several Problems such as bursting or cracking during the cooking process are encountered, therefore more trials are done in order to resolve the problems.

Through the internship, several experiences are gained. These experiences include patience, perseverance, creativity, communication, problem solving, and proper working attitude. These experiences are gained through various trial and error in product development and trying to solve problems that occurred during the quality control in the factory.

2.3 Comparison Between Theory and Practice

Adjustment and flexibility are the key in working in a factory. Not everything will go according to theory due to the lack of controlled environments. Things such as proper meat thawing conditions or proper mixing conditions. The collaboration between theoretical and real-life conditions is needed to produce a safe and marketable product. For example, the batter mixing condition needs to be monitored constantly by personnel to ensure the correct temperature and final batter texture. Due to the lack of equipment and manpower, adjustment is implemented in regards to temperature. Things such as issuing an appropriate temperature range creates more flexibility in the measurements while maintaining the appropriate quality of the product.

2.4 Difficulties

Some of the difficulties encountered are the lack of controlled environment during trials and projects, the lack of manpower to help during factory scale trials, and the difficulty to conduct trials without inhibiting the production process during the day. These difficulties can be overcome with a few scheduling adjustments and trial scale adjustments. Clear work division can also aid in the process of conducting a proper trial. Another issue that appears during the project is the lack of literature that is available to support the findings of the project.

III. PROJECT DESCRIPTION

3.1 Introduction

Meltique or artificially marbled meat is a food product where fat / emulsion is injected into lean meat and creates an artificial marbling effect. This process increases the value, quality, and palatability. To further enhance those aspects, seasonings or flavor enhancers can also be added (*Food Safety Information*, 2019). In this project, lean meat cut taken from the cube roll part will be injected with an emulsion mixture. The emulsion used contains fat (a mix of beef fat and palm oil with 1:1 ratio), water, and soy protein isolate which acts as an emulsifier .

Isolate Soy Protein is the most concentrated form of the commercially available soy proteins in the market. It contains over 90% of protein in a dry condition. ISP is commonly used in the meat industry in its texturized form to act as meat replacements. However, powdered ISP is also used in emulsion making in sausage, or in this project, it is used as an emulsifier in the emulsion to create artificial marbling on meat (FAO, 2022).

In this project, emulsion is used to create the artificial marbling in the meat. Emulsion itself is a stable mix of two immiscible liquids by the help of a small percentage of surfactants that acts as emulsifiers (Ebnesajjad, 2011). In this case, a mix of beef fat, palm oil, and water are mixed together with the help of ISP as the emulsifier to create an injectable emulsion. As a result of that, two different emulsions are used in this project. The first one is an oil in water emulsion. This emulsion is formed with oil as the dispersed phase and water as the continuous phase (Akbari & Nour, 2018)(). In this emulsion, the oil molecules are surrounded by the water molecules in the system.

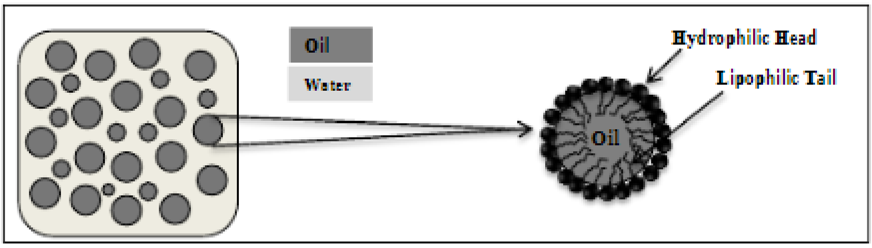


Figure 2. Oil in water emulsion

Another type of the emulsion used in this project is the water in oil emulsion. In which the water acts as the dispersed phase and the oil acts as the continuous phase (Akbari & Nour, 2018)(). In this emulsion, water molecules are surrounded by oil molecules in the system.

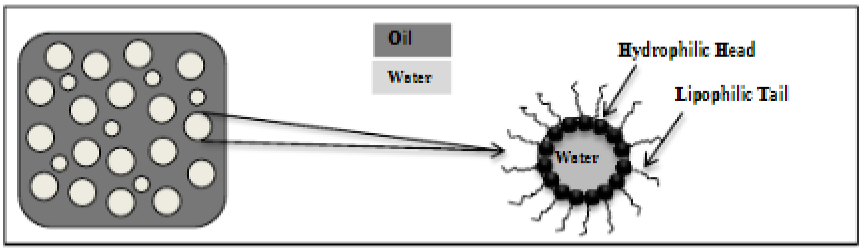


Figure 3. Water in oil emulsion

In emulsion making, the dispersed phase is usually the liquid that has the smaller ratio in the system. For the project, one emulsion sample has a higher oil ratio in the mixture, which makes it a water in oil emulsion. On the other hand, the other emulsion used has a higher water ratio in the mixture. This creates an oil in water emulsion system

Physical properties of the samples are the indicator measured to assess the quality of the product. The assessment of physical properties are already widely used to assess food quality in the food industry. Other than acting as an indicator of the quality of a food product, it can also assist in measuring consumer acceptability of a certain product (Scanlon, 2011). Several physical properties that are analyzed in this project are Water Holding Capacity, Emulsion Stability, Color, Texture, and Marbling.

Water Holding Capacity is defined as the ability of food to keep or retain its own or added water during the application of heating, pressure, force, or centrifugation (Gyawali & Ibrahim, 2016). In this project, water holding capacity is important to measure the decrease in weight as a result of water loss from either thawing or cooking process. The lower the amount of water loss is in a product, indicates a better water holding capacity. Thus, the quality of the product is better when less water loss is observed.

Emulsion stability is defined as its ability to resist changes in physicochemical properties overtime. According to Akbari & Nour (2018), the stability of emulsion is influenced by the amount and type of emulsifier used. Those surfactants work by film formation on the water drops and decreasing the tension between the water and oil interface. A good emulsion is the emulsion that has 100% stability overtime. Thus, a higher emulsion stability indicates a better quality emulsion.

Color is the other parameter measured in this project. It is usually measured as an indicator of freshness, flavor, and quality of the product. Color measurement are usually done using the colorimeter and presented in La*b* values. The L values indicate the lightness of the product. Meanwhile the a* value indicates the redness to greenness and the b* value indicates the blueness to yellowness hue (Ly et al., 2020).

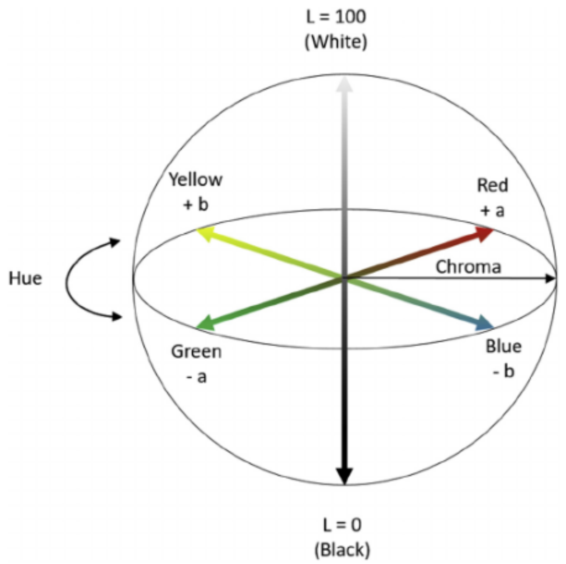


Figure 4. La*b* color diagram

Texture is usually regarded as the mechanical strength of the muscle and connective tissue, often associated with meat products (Ziender, 2000). The texture of meat samples are measured to assess the effect of emulsion injection into lean meat and if there are any effects on the texture/tenderness of the product.

Marbling is often used as a visual indicator of meat quality. It is defined as the white freckles of intramuscular fat within the meat cut and is often linked with flavor and juiciness of the meat cut (Cheng et al., 2015). The injection process in meltique beef is aimed to artificially create the visual aspects of marbled meat and is conducted to enhance the quality of the meat itself. In developed countries, marbling is usually assessed by machine for a more accurate grading. Other than that, marbling grades are also issued by a trained and certified meat marbling grader to provide standardized results.

3.2 Scope of Research

The scope of research will be assessing the effect of different fat to water ratio in the emulsion used through the assessment of physical properties of the meat and the emulsion. The assessed parameters for the meat product are color, texture, marbling, and water holding capacity. Meanwhile, the assessed parameters for the emulsions are color and emulsion stability.

3.3 Objectives and Hypotheses

The objectives of this research are:

- Determine the effect of fat (beef fat and palm oil on 1:1 ratio) to water ratio in the emulsion to the injected final product.
- Assessing the physical properties of the product and emulsion (color, texture, water holding capacity, marbling score, and emulsion stability)
- Decide the best sample according to the obtained results.

In relation to the objectives, the hypothesis of this research is as follows:

H0: the physical properties of the oil based emulsion is not closer to the control (commercial sample)

H1: the physical properties of the oil based emulsion sample is closer to the control (commercial sample).

3.4 Occurring Problems and Solution (meltique production, i3l facilities to conduct analysis)

There are several questions that serve as a base of this project such as the effect of different water to oil ratio in the emulsion used for the meltique product. Specifically, the difference that is going to be looked into is referred to the physical properties of the product itself. In which are done to figure out which product has a better quality.

In response to that, this project is done on the intentions of assessing the difference between the two emulsion formulas by measuring several physical properties of the product and making a comparison of it to the competitor product that is available in the market. The sample preparation starts from trimming the fat and tendons off the lean meat that were going to be injected by the emulsion. These lean meats were cutted into slabs before being injected. Emulsion samples are made and mixed using the feeding tank that is attached to the injection machine.

Figure 5. Feed Tank of the Injection Machine

FIgure 6. Injection Machine Used to Make Meltique Meat.

Meat slabs are then placed inside the machine to get injected, multiple injections may be done to get the desired marbling effect. After the samples are injected, transglutaminase is added in the form of powder onto the surface of the meat. The meat slabs are then combined and the transglutaminase will glue the meat slabs together during the shaping process. As the enzyme requires time to work, the shaped product is frozen overnight before it is cutted into steak cuts. The analysis is done by measuring the decided physical properties of the samples (WHC, Emulsion Stability, Color, Texture, and Marbling) with biological and technical duplicates. All analysis was done using the equipment in the I3L lab facilities. The samples will be subjected to heat (cooking) to measure the WHC and emulsion stability will be done by the centrifuge to separate the stable emulsion from the unstable particles. Color will be tested with colorimeter and presented in La*b* values and texture will be measured with texture analyzer using compression force.

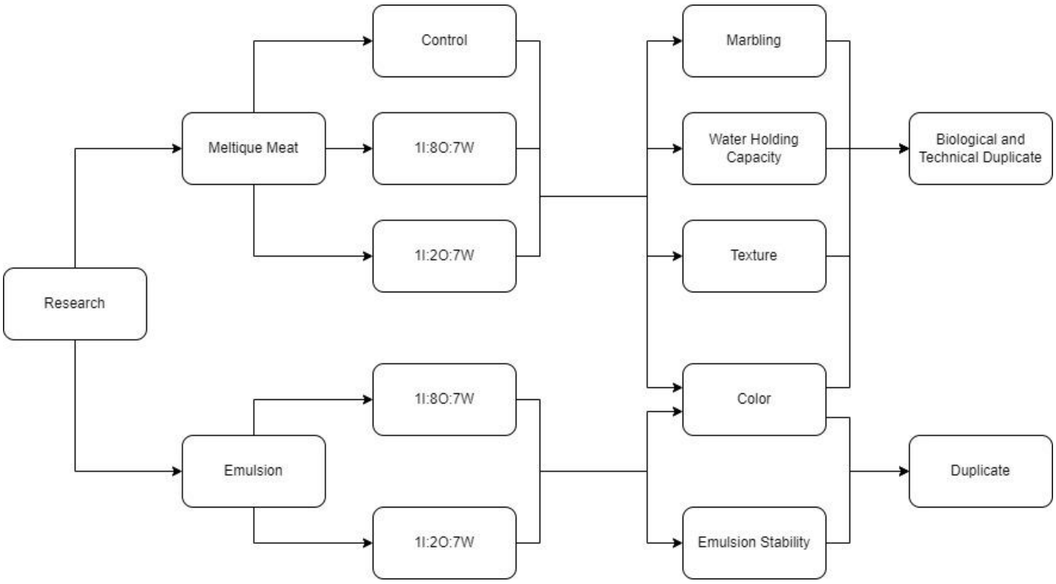


Figure 7. Research design

Figure 5. Shows a simple schematic diagram of the sample analysis process, in which samples are labeled according to their composition.

Table 1. Sample Code and Description

Sample Name	Description
1I : 8O : 7W	The emulsion sample that has more oil and fat content in the emulsion; water in oil emulsion. Meat samples injected with the same emulsion will also be labeled this way.
1I : 2O : 7W	The emulsion sample that has more water in the emulsion; oil in water emulsion. Meat samples injected with the same emulsion will also be labeled this way.

Sample coding that is going to be used in this experiment are listed above in the table.

The marbling parameter will be measured with picture to picture comparison using the universal standard of meat marbling. The marbling grade ranges from 0 to 12 with 0 -1 being little to no marbling and 12 being very abundant marbling (Gotoh et al., 2018).

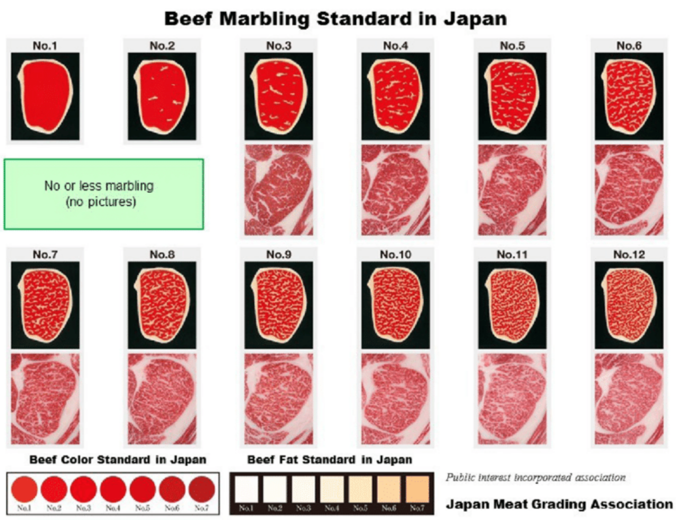


Figure 8. Meat marbling grade

3.5 Result and discussion

3.5.1 Emulsion stability

The emulsion stability is measured using a centrifuge at 40000 rpm at 25C for 15 minutes. The initial weight of the emulsions are measured before being centrifuged. Afterwards, the emulsions that are still stable are weigh In a small beaker glass.

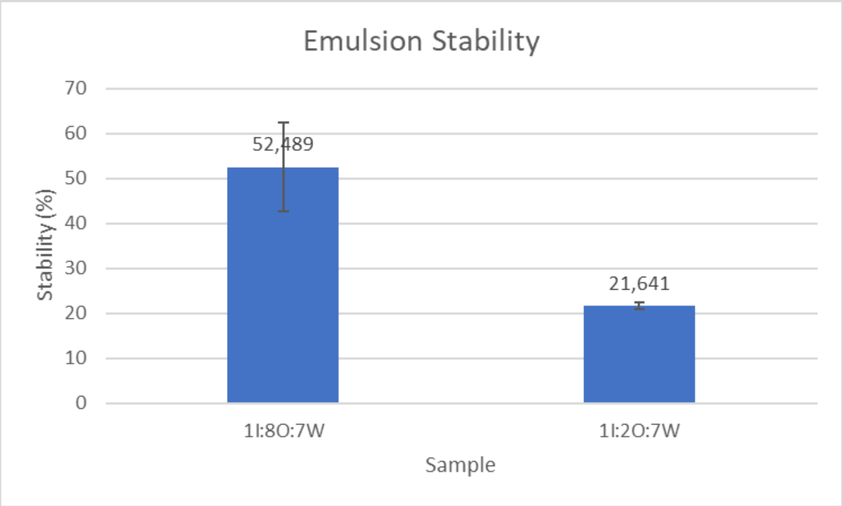


Figure 9. Graph of Emulsion Stability

From the table and graph, it can be seen that the emulsion sample that contains more oil is more stable when compared to the sample that contains more water. More than 50% of the 1I:8O:7W emulsion sample is stable after the centrifuge process. Only 20% of the 1I:2O:7W sample is stable after the centrifugation. This is potentially caused by the less amount of water in the 1I:8O:7W sample emulsion when compared to the amount of oil in the emulsion.

Table 2. Statistical Analysis Result of Emulsion Stability

Sample	1I:8O:7W	1I:2O:7W
Stability (gr)	23,763	8,432
	18,228	8,881
R	41,991	17,313
n	2	2
R2/n	881,622	149,87
n	4	
k	2	
H	603,895215	
p-value	3,841	

Statistical analysis is done using the non-parametric Kruskal Wallis test on Excel. The null hypothesis of this analysis is that the median of the samples has equal values, while that alternative hypothesis is that the median of the samples did not have equal values. Based on the results, the H value is higher than the p-value which indicates that the null hypothesis is rejected. This results indicates that the two samples emulsion stability results have a significant difference.

Two major components of ISP, which are glycinin and beta conglycinin, have different molecular weight. In which beta conglycinin has a lighter molecular weight which makes it easier for the molecule to move to the oil/water interface and create a more stable emulsion (Chen et.al., 2014). Based on the results obtained, there is a possibility that the beta conglycinin protein molecules have an affinity to oil when compared to water. This may cause the 1I:8O:7W sample emulsion to have a more stable mixture after centrifugation. There are no sufficient references to support this claim as of now, therefore further study can be conducted regarding this issue.

3.5.2 Color

The color of both meat and emulsion samples are measured with a colorimeter. The results are presented in La*b* value.

Table 3. Statistical Analysis Results of Emulsion Color

	L		a		b	
	1I:8O:7W	1I:2O:7W	1I:8O:7W	1I:2O:7W	1I:8O:7W	1I:2O:7W
	26,86	31,34	-0,08	2,09	15,89	14,52
	22,62	25,94	-0,3	0,07	10,63	12,08
R	**49,48**	**57,28**	**-0,38**	**2,16**	**26,52**	**26,6**
n	**2**	**2**	**2**	**2**	**2**	**2**
R2/n	**1224,135**	**1640,499**	**0,0722**	**2,3328**	**351,6552**	**353,78**
n	**4**		**4**		**4**	
k	**2**		**2**		**2**	
H	**49,056**		**-13,932**		**16,872**	
p-value	**3,841**		**3,841**		**3,841**	

Similar to the emulsion stability statistical analysis, Kruskal Wallis non parametric test is used on the emulsion color sample analysis. Therefore, the results shown that the L and b* H value is higher than the p-value and thus the null hypothesis is rejected. This indicates that the L and b* H values of both samples are significantly different. However, the opposite conclusion is shown on the a* value. As the H value is lower than the p-value. This indicates that the a* values of both samples are not significantly different.

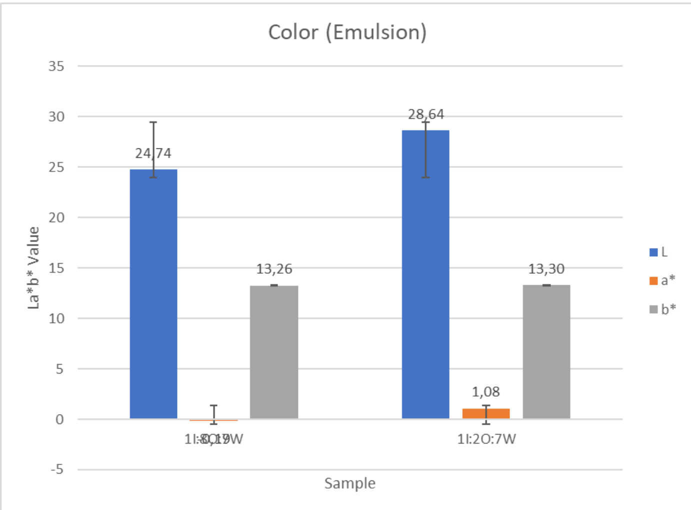


Figure 10. Graph for Emulsion Color Measurement

Based on the data above, both emulsion is seen to have similar La*b* values with 1I:2O:7W samples appearing to be lighter in comparison. This may be due to the amount of water that is in the emulsion which is bigger in ratio when compared to the amount of oil in the mixture. This may create a lighter hue in the end mixture. This results in accordance with a paper by Harrison & Cunningham (1985) in which it is stated the color of an emulsion usually depends on the color of its continuous phase. In this case, the continuous phase of the 1I:8O:7W emulsion sample is the fat and palm oil. Whereas the continuous phase of the 1I:2O:7W emulsion sample is the water itself.

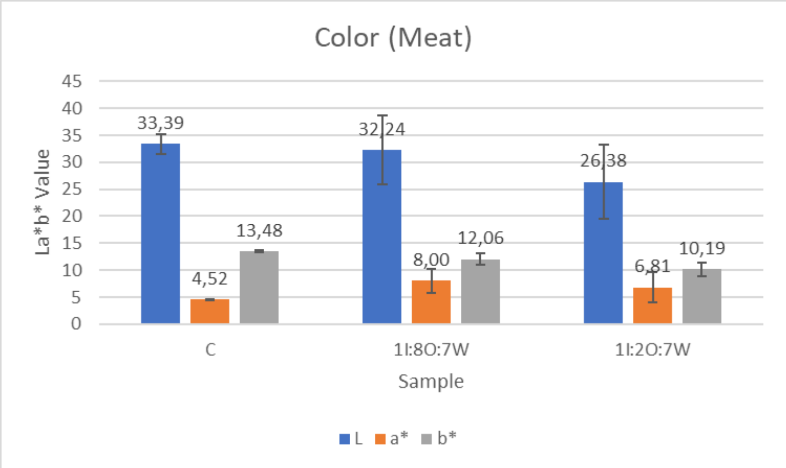


Figure 11. Graph for Meat Color Measurement

Based on the data above, commercial samples are the lightest in color when compared to the other two samples. Meanwhile redness hue is more prominent in 1I:8O:7W sample and less prominent in the commercial sample. Yellow hue is seen to be more visible in the commercial samples when compared to the other two as well. This may be due to the emulsion color of the meat itself. As the commercial samples are taken from the general store, changes may occur in the color of the meat during storage before It was used for testing.

Table 4. Statistical Analysis Results of Meat Color L value

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	95,45371	2	47,72686	1,234143	0,347451	4,737414
Within Groups	270,7044	7	38,67205			
Total	366,1581	9				

A different approach on statistical analysis was performed on the meat color samples. Due to the difference in sample size, one-way ANOVA are done to analyze the significance of the color analysis values. The null hypothesis used in one-way ANOVA is that the values of the samples are not significantly different whereas the alternate hypothesis is that the samples values are significantly different. Based on the analysis results, p value are bigger than the α of 0.05. Therefore the null hypothesis is accepted which indicates that there are no significant difference between the samples

Table 5. Statistical Analysis Results of Meat Color a* value

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	18,28269	2	9,141345	1,643232	0,259963	4,737414
Within Groups	38,9412	7	5,563029			
Total	57,22389	9				

Table 6. Statistical Analysis Results of Meat Color b* value

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10,33221	2	5,166105	4,301605	0,060478	4,737414
Within Groups	8,4068	7	1,200971			
Total	18,73901	9				

Similar results were observed on the a* and b* value of the meat color analysis. In which the p-value is higher than the α of 0.05. This indicates that the null hypothesis is rejected and the values are not significantly different between the samples.

A paper by Pflanzier & de Felicio (2011) indicates that intermuscular fat in meat has a correlation to the L value of meat product. The paper suggests that an increase in L value during colorimetric measurement is due to the amount of the visible intermuscular fat in the meat. The more intermuscular fat present, a higher L value will be displayed. This correlates with the finding in this project in which the sample that has a more intermuscular fat webbing after the injection has a lighter L value when compared to the sample that has a slightly uneven injection result. This indicates that the evenness of emulsion injection influences the color of the product.

However, as seen from the data above, it is possible that emulsion color has little to no influence in the meat color of the end product. This can be seen from the result in which the sample injected with the lighter coloured emulsion did not necessarily present the lighter color in the colorimetry results.

3.5.3 Water Holding Capacity (WHC)

Water holding capacity of the product is measured by calculating the water loss of the product during the process. This process includes thawing and cooking.

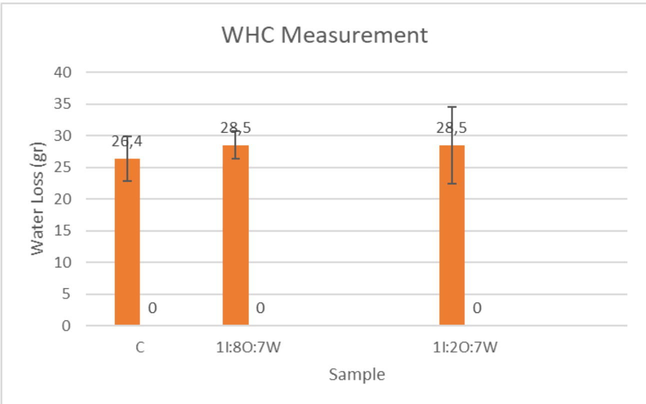


Figure 12. Graph of Water Holding Capacity

From the table and graph above it can be observed that sample 1I:8O:7W has the most water loss during thawing when compared to the 1I:2O:7W sample and commercial sample. However, during cooking, 1I:2O:7W samples and commercial samples have similar water loss. Despite that, the 1I:8O:7W and 1I:2O:7W sample has similar water loss in total, which is slightly higher than the commercial sample.

Table 7. Statistical Analysis Results of Meat Water Holding Capacity

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	6,990893	2	3,495447	0,17723	0,841231	4,737414
Within Groups	138,0587	7	19,72267			
Total	145,0496	9				

The statistical analysis for WHC samples are done similarly to the meat color samples in which one-way ANOVA are used. Therefore, the null and alternative hypothesis used is also the same. Based on the results, the p-value is shown to be higher than the α of 0.05 which indicates that the null hypothesis is accepted and that there are no significant differences between the value of the samples.

These results may be due to the binding preference of ISP. ISP is a soy-based protein which acts as an emulsifier in emulsion mixture. It has amphiphilic protein which binds to both oil and water, mixing the two immiscible liquids into a homogenous liquid (Chen et.al., 2014). Main protein components of ISP are glycinin and beta conglycinin in which both are able to act as emulsifiers (Chen et.al., 2014).

Glycinin is a part of 11S protein which has a molecular weight of 300-380 KDa (Hammond, Murphy, & Johnson., 2003). Meanwhile, beta Conglycinin isa a 7S protein that has a molecular weight of 150-250 KDa (Hammond, Murphy, & Johnson., 2003). Both proteins are able to bind with oil and water. However the difference in molecular weight may cause a difference of stability in the emulsion created. Depending on the type of ISP used and its composition, the water holding capacity may also be affected.

The water holding capacity of the 1I:8O:7W sample is shown to be lower in value during the thawing process shown by more water loss measured by weight. This may be an effect of emulsion instability which causes more water to be released from the emulsion. However, other possibilities that may induce this water loss is the process in which the product is prepared.

In the processing of artificially marbled meat, injection and cutting processes are done to prepare the final product. During shaping, the injected meat parts are glued together using transglutaminase which denatures the meat proteins and thus infuses the muscles together to make one whole piece of meat (Kaić et al., 2021). The lack of control during the addition of transglutaminase may cause excessive meat protein denaturation which leads to more water to be released from the product.

3.5.4 Texture

The texture of the product was tested using a texture analyser using the compression mode at room temperature.

Table 8. Statistical Analysis Results of Meat Texture

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	118346,1	2	59173,05	6,728415	0,023437	4,737414
Within Groups	61561,5	7	8794,5			
Total	179907,6	9				

In the meat texture analysis, one-way ANOVA is also used to determine any significant difference in the samples. According to the results, the p-value is lower than the α of 0.05 which indicates that the null hypothesis is rejected and the alternative hypothesis is accepted. Therefore, there is a significant difference between the samples.

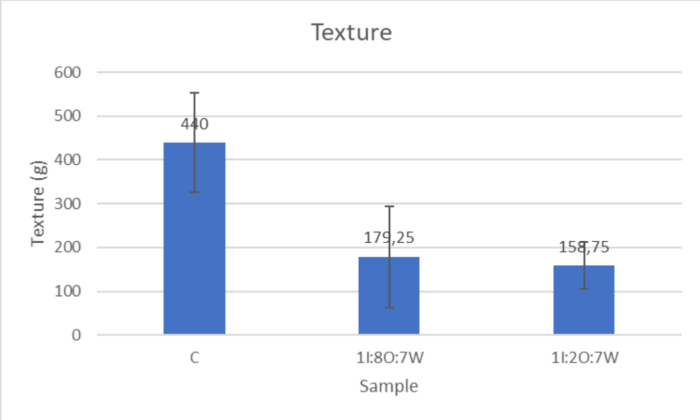


Figure 13. Graph for Texture Measurement

The results for texture show that the commercial samples require more force to press down when compared to the experimental samples. This may be due to various reasons such as part of meat used, thickness of the cut, and other undisclosed information. It is also seen that the 1I:8O:7W samples require slightly more force to press down when compared to the 1I:2O:7W sample. This may be a result of transglutaminase use in order to glue the injected meat pieces together during shaping. As emulsions only have an effect on visual marbling, palatability, and quality, it can be suggested that emulsion has no effect on the texture. However, transglutaminase may have an effect, considering that it is an enzyme used to denature the protein in the meat muscle and “glue” them together. A paper by Kaic et.al., (2021) suggested that addition of transglutaminase denature the proteins in meat which results in improved tenderness. Therefore, it is possible that the 1I:8O:7W and 1I:2O:7W samples have enhanced tenderness as a result of TG addition when compared to the control which possibly has no addition of TG. This finding, however, needs further study due to the lack of information on the detailed process of the commercial sample.

3.5.5 Marbling

The marbling of the meat samples is assessed using a visual grading method, pictures of the samples are taken with a black background and then compared visually with the standard reference picture of universal meat marbling.

sample	photo	marbling
Commercial 1		8
Commercial 2		9

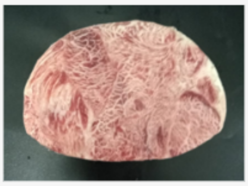
W1.1		10
W1.2		9
W2.1		9
W2.2		9
F1.1		8
F1.2		8
F2.1		5
F2.2		5

Figure 14. Marbling results

The grading of the samples is using the universal marbling grade for beef in Japan, taken from a paper by Gotoh et.al.,(2018). In this paper, beef marbling grades have a score range from 0 to 12 in which 0 - 1 are none or less marbling and 12 are very abundant marbling.

According to the universal beef marbling score, the commercial sample has a core of 8-9. Meanwhile, the 1I:8O:7W sample has a marbling score range from 10-9 and the 1I:2O:7W sample has the marbling score range from 5-8. The commercial and the 1I:8O:7W sample have quite similar marbling results after injection with minimal blocking observed in the product. However, the 1I:2O:7W samples have several parts of the product that appear to be minimally injected, which causes it to appear to have little to no marbling.

Marbling scores are often associated with the amount of intermuscular fat webbing in the meat muscle, the higher the amount, the higher the marbling score is. It also often serves as an indicator of meat quality. In which, most developed countries are associating a high marbling degree with high price (Cheng et al., 2015). The commercial samples have a grading result of 8-9 which means it has abundant marbling. While the 1I:8O:7W sample has a similar grade range of 8-10 which also considered it to have abundant marbling. The 1I:2O:7W sample has a 5-8 grading score in which 8 is abundant and close to the other sample, while 5 means that the marbling is not very abundant. Or in this case, the marbling is uneven as there are some parts of the meat that have little visible marbling. This may affect the marketability of the product, since higher marbling rate can be assessed by the amount of visible red meat in the cut. Overall,the 1I:8O:7W samples have more similar results to the commercial samples.

3.6 Conclusion and recommendation

According to the results, several parameters measured have shown that the 1I:8O:7W sample has a closer similarity to the commercial or competitor sample. The results of the WHC analysis shows that both samples are similar in their water retaining ability. However it is still a little higher when compared to the commercial/ competitor sample. Emulsion stability analysis shows that the 1I:8O:7W is more stable after centrifugation when compared to the other sample which may indicate that there's a better chance of this emulsion being stable when injected into the product. From the color analysis, there are slight differences in the emulsion color, however the meat sample results do not reflect the result difference in emulsion. This may indicate that the emulsion color has little effect on the product color. During the texture analysis, the commercial samples are shown to be tougher when compared to the experimental sample. However, both the experimental samples did not differ in terms of force required to press down. This may be due to transglutaminase addition in the experimental samples and possibly not due to the emulsion injected into the samples. In terms of marbling analysis, both the experimental and commercial samples have shown similar results, with the 1I:2O:7W samples having a lower grade in some of the samples. This analysis results may indicate that the oil samples have a better opportunity to compete with the commercial/ competitor sample in the market.

Alas, several further research are needed in order to validate the founding and possible claims that are in this paper. Several claims that need further research are the possibility of beta conglycinin having more affinity to oil and the possibility of water in oil emulsion having a better chance at mimicking intermuscular fat in artificially marbled beef. It is possible to utilize other analysis to confirm the findings in this paper. Such as the turbidity check for fat in the emulsion stability testing using the spectrophotometer. This analysis will present a more accurate and exact value in the emulsion stability testing and may be able to provide a more reliable analysis. Another possible analysis to check the marbling capacity of water in oil emulsion is to run an experiment where the meat samples are injected with emulsion with an increasing oil ratio. This experiment may be able to provide insight regarding the insufficient marbling in the 1I:2O:7W sample.

IV. SELF REFLECTION.

During the internship, a couple of hard and soft skills are gained from participating in work activities of the company. Some of the hard skills gained are product preparation skills, sample preparation skill, product defect identification skill, and thorough problem identification on the field. Along with that, several soft skills gained to be noted are organizational skill, diligence, thorough observation, communication skill, problem solving, patience, and list out daily tasks based on priorities. These skills might be beneficial in increasing employment interest due to the experience of working on the field itself. Not only limited in the meat industry, those set of skills may be needed in various food industries as those are the general basic skills in a food factory.

This also leads to several identification of strong and weak points. Those things include the ability to stay calm during most inconveniences that occur during the process and the lack of skills to be able to make immediate decisions during a problem.

I3l and its values have contributed greatly in the process of internship. The values of grit and integrity, as well as being a role model really helped in navigating and learning in the whole internship process. Those values also help in the process of gaining trust and dependability which makes the whole learning and training process go successfully.

The classes at i3l helped a lot during the internship, especially as I am interning in the r&d department that relates with product development and improvement. Several lessons in i3l have been used in the field to further understand the product characteristics and thus be able to create the product with the desired properties.

The BRIGHT sessions that are provided by the campus have helped a lot in training the soft skills needed during the internship. The soft skills gained from those sessions serves as a foundation and continues to be developed during the internship process itself.

The impact of the internship that has been commenced to the workplace are quite notable. Such as the improvement of work principles and order. It is also apparent with the increase of daily production results as a result of troubleshooting the equipment used and observing the flow process of the production. The impact is also visible in the quality maintenance of the product in which more defects are detectable before being sent out to the consumers.

V. CONCLUSION & RECOMMENDATION

The original goals of the internship are to gain hands-on experience on the matter of real-life application of scientific knowledge in the food industry. Other than that, the goal of the internship is to gain working experience in the food industry that may be beneficial for future employment purposes. During the internship, both goals have been successfully achieved during the internship period.

Although the internship has been successfully conducted, there are several things that can be improved during the process. For instance, some students are recommended to start the internship earlier than the start of the semester, however the internship socialization is done around a month or more after several students have started their internship. It may be better to do the socialization of the internship before any students are starting their internship. So there are no students that get the information late and complicate things in their internship with limited time left.

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APPENDICES

Sample	Thawing water loss (%)	Cooking water loss (%)	Overall water loss (%)
Commercial	3.6	23.7	26.4
1I:8O:7W	8.4	21.95	28.5
1I:2O:7W	6.15	23.85	28.5

Appendix 1. WHC data

emulsion stability	before centrifuge (gr)	after centrifuge (gr)	instability (%)	avg
1I:8O:7W	40,000	23,763	40,593	47,51125
	40,000	18,228	54,430	
1I:2O:7W	40,000	8,432	78,920	78,35875
	40,000	8,881	77,798	

Appendix 2. Emulsion data

Sample	Color
Commercial	L: 33.39, a*:4.52, b*:13.48

1I:8O:7W	L: 32.24, a*:8.00, b*:12.06
1I:2O:7W	L: 26.38, a*: 6.81, b*:10.19

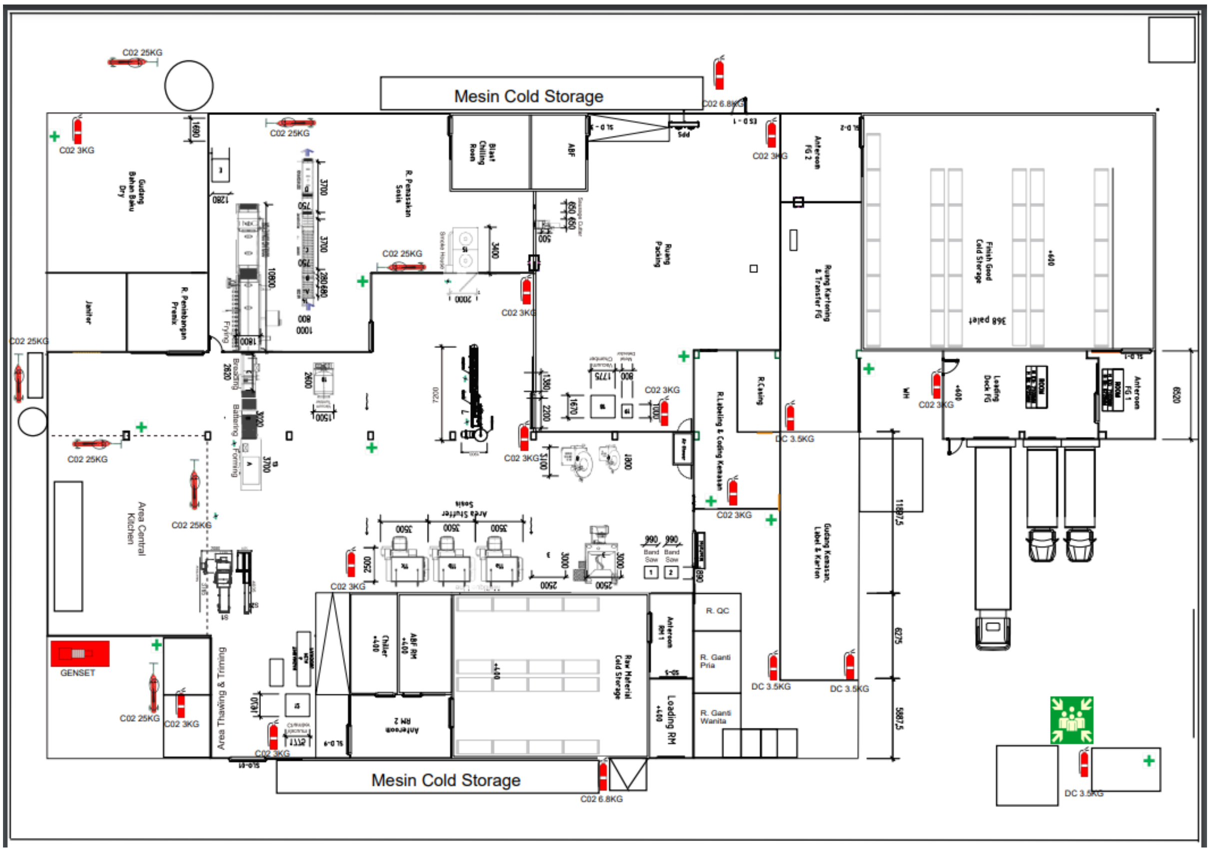
Appendix 3. Color data of the meat

Sample	Color
1I:8O:7W	L: 24.74, a*: -0.19, b*:13,26
1I:2O:7W	L: 28.64, a*:1.08, b*:13.30

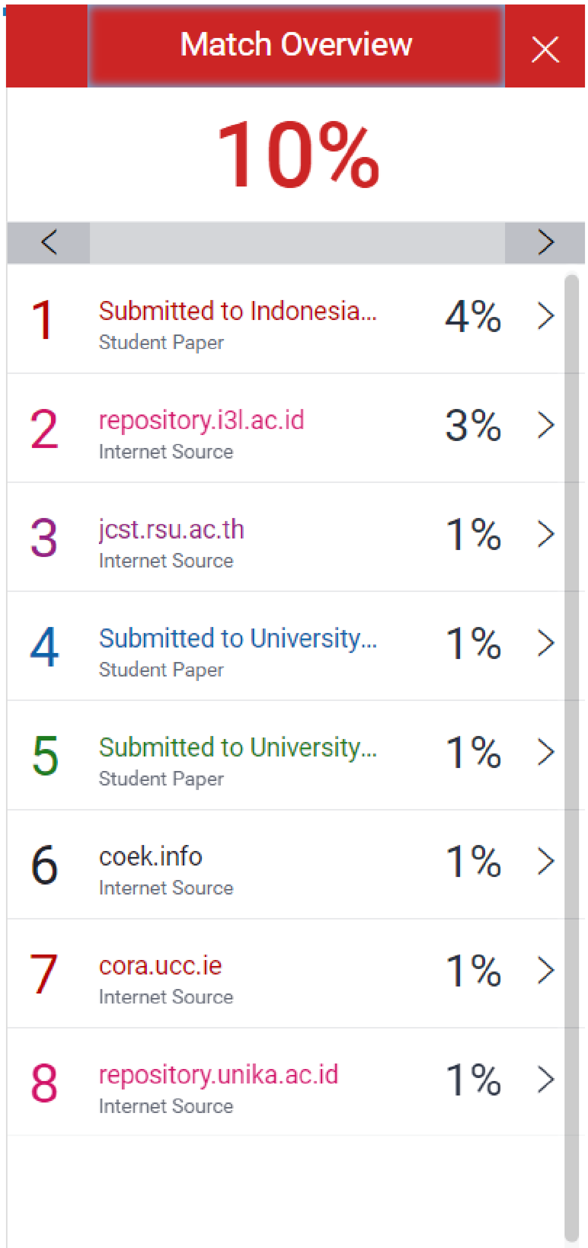
Appendix 4. Color data of the emulsion

Sample	Force (g)
Commercial	440
1I:8O:7W	179.25
1I:2O:7W	158.25

Appendix 5. Texture data



Appendix 6. Factory Layout



Appendix 7. Plagiarism Check