DEVELOPMENT OF LOW FAT MAYONNAISE WITH LADY FINGER BANANA PURE (Musa acuminate colla sp)

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<table>
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<tr>
<th>NAME</th>
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<tbody>
<tr>
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<td>DEVELOPMENT OF LOW FAT MAYONNAISE WITH LADY FINGER BANANA PUREE (<em>MUSA ACCUMINATA COLLA SP</em>)</td>
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<td>DATE OF VIVA</td>
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</tbody>
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First of all I would like to thank God for giving me the strength for everything I do and more than ever during this part of my life. I would like to express appreciation to my parents, for all their love and financial support throughout my education.

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03rd June 2013
This research was carried out in order to investigate the effect of an addition of Lady Finger banana puree in sensory properties, nutrition contents and change in physicochemical and microbiological on storage study of the low fat mayonnaise, using the full fat formulation as a reference. A total of 5 formulations were produced. The best formulation was chosen by hedonic test based on the sensory evaluation. F2 formulations (44.9% w + 10% Bp + 15% Co + 18% Eg + 2.5% Mp + 2% Cs + 0.3% Xg) are selected as the best formulation. Proximate analysis that was conducted on the best formulation is carbohydrate (13.02 ± 0.67), crude fibre (5.69 ± 0.05), protein (2.82 ± 0.02), fat (20.48 ± 0.49), ash content (2.26 ± 0.02) moisture content (67.29 ± 0.03) and energy content of 259.06 ± 2.18 kcal. Result of physicochemical analysis show that there was increases during storage study of pH value for both low fat and control formulation (pH 4.40 to pH 3.97) and pH 4.31 to pH 3.70) respectively. For the moisture content, the full fat formulation show the low percentage of moisture content (19.17% to 31.83%) compared to the low fat formulation (67.27% to 67.68%) due to the higher water content in the banana puree. Whereby, the result of the FFA show that the full fat formulation was presented on high value of FFA (1.97% to 5.64%) due to the high fat content compared with the low fat formulation (2.40% to 3.36%). While for the color result show that both formulation changes from dark yellowish to light yellowish. Microbiological analysis that conducted show result that both of the control and final product formulation that kept at 4°C cold room for 4 week or 28 day period were still safe for use by the assumption that the total colony growth were less than 30 colony per gram sample.
ABSTRAK

PEMBANGUNAN MAYONIS KURANG LEMAK DENGAN PURI PISANG EMAS (MUSA ACCUMINATA COLLA SP)

Penyelidikan ini dijalankan bertujuan untuk menentukan kesan penambahan puri pisang Lady Finger ke atas ciri-ciri sensori, kandungan nutrisi, perubahan fizikokimia dan mikrobiologi dalam ujian penyimpanan produk mayonis rendah lemak dengan menggunakan formulasi mayonis tinggi lemak sebagai rujukan. Sebanyak 5 formulasi telah dihasilkan. Formulasi terbaik telah dipilih melalui ujian hedonik berdasarkan penilaian sensori. Formulasi F2 (44.9% w + 10% Bp + 15% Co + 18% Eg + 2.5% Mp + 2% Cs + 0.3% Xg) telah dipilih sebagai formulasi terbaik. Analisis proksimat ke atas formulasi terbaik mendapati mengandungi kandungan karbohidrat (13.02 ± 0.67), serabut kasar (5.69 ± 0.05), protein (2.82 ± 0.02), lemak (20.48 ± 0.49), abu (2.26 ± 0.02) lembapan (67.29 ± 0.03) dan tenaga sebanyak 259.06 ± 2.18 kcal. Keputusan analisis fizikokimia sepanjang ujian penyimpanan menunjukkan peningkatan nilai pH bagi kedua-dua formulasi tinggi dan rendah lemak dengan nilai pH masing-masing (pH 4.40 kepada pH 3.97) dan (pH 4.31 kepada pH 3.70). Bagi kandungan lembapan, formulasi tinggi lemak menunjukkan peratusan rendah (19.17% kepada 31.83%) berbanding formulasi rendah lemak (67.27% kepada 67.68%) disebabkan oleh kandungan tinggi air dalam puri pisang. Dalam pada itu, keputusan FFA bagi formulasi tinggi lemak menunjukkan peratusan tinggi (1.97% kepada 5.64%) disebabkan kandungan lemak yang tinggi berbanding formulasi rendah lemak (2.40% kepada 3.36%). Manakala perubahan warna daripada warna kuning gelap kepada kuning terang didapati berlaku ke atas kedua-dua formulasi. Hasil ujian mikrobiologi menunjukkan produk yang disimpan dalam bilik sejuk pada suhu 4°C adalah masih selamat untuk digunakan dengan anggaran koloni kurang daripada 30 per gram sampel.
# TABLE OF CONTENT

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>i</td>
</tr>
<tr>
<td>VERIFICATION</td>
<td>ii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF CONTENT</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF EQUATION</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF TABLE</td>
<td>xii</td>
</tr>
<tr>
<td>LIST OF FIGURE</td>
<td>xiii</td>
</tr>
<tr>
<td>CHAPTER 1: INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>1.1 Background</td>
<td>1</td>
</tr>
<tr>
<td>1.2 Objectives</td>
<td>3</td>
</tr>
<tr>
<td>CHAPTER 2: LITERATURE REVIEW</td>
<td></td>
</tr>
<tr>
<td>2.1 Mayonnaise</td>
<td>4</td>
</tr>
<tr>
<td>2.1.1 Regulation of Mayonnaise</td>
<td>4</td>
</tr>
<tr>
<td>2.1.2 Mayonnaise Production</td>
<td>5</td>
</tr>
<tr>
<td>2.1.3 Physicochemical properties of Mayonnaise</td>
<td>6</td>
</tr>
<tr>
<td>2.2 Food Emulsifier Properties</td>
<td>7</td>
</tr>
<tr>
<td>2.2.1 The Formation of Food Emulsification</td>
<td>8</td>
</tr>
<tr>
<td>2.3 Main Ingredient of the Low Fat Mayonnaise</td>
<td>8</td>
</tr>
<tr>
<td>2.3.1 Vegetable Oil</td>
<td>9</td>
</tr>
<tr>
<td>2.3.2 Egg</td>
<td>9</td>
</tr>
</tbody>
</table>
2.3.3 Vinegar

2.4 The Factor Influence the Low Fat Mayonnaise Storage
   2.4.1 Oxidation Stabilization
   2.4.2 Emulsification Stabilization

2.5 Botanical of Banana

2.6 Lady Finger Banana (Musa acuminate colla sp)
   2.6.1 Nutrition Composition of Lady Finger banana
   2.6.2 Micro particle Protein of Lady Finger Banana Puree as Fat Substitute for Low Fat Mayonnaise Production
   2.6.3 The Production of Low Fat Mayonnaise

CHAPTER 3: MATERIAL AND METHOD

3.1 Material

3.2 Formulation

3.3 Development of the Low Fat Mayonnaise
   3.3.1 The Preparation of the Lady Finger Banana Puree
   3.3.2 Pasteurization of the Egg yolk
   3.3.3 Development of mayonnaise banana

3.4 Selection of the Best Formulation of the Low Fat Mayonnaise Production
   3.4. 1 Sensory Evaluation – Hedonic Test

3.5 Research on Storage Quality of the Final Product
   3.5.1 Proximate Analysis
   3.5.2 Physicochemical Analysis
   3.5.3 Microbiological Analysis – Total Plate Count (TPC) and Yeast Count

3.6 Statistical Analysis
CHAPTER 4: RESULT AND DISCUSSION

4.1 Selection of the Best Formulation of the Low Fat Mayonnaise Production
   4.1.1 Sensory Evaluation – Hedonic Scale

4.2 Best Formulation for Final Product

4.3 Storage Study of Low Fat Mayonnaise
   4.3.1 Physicochemical analysis
   4.3.2 Microbiological Analysis – Total Plate Count (TPC) and Yeast Count
   4.3.3 Proximate Analysis

4.4 Nutrition information of Low Fat Mayonnaise with Lady Finger Banana Puree

CHAPTER 5: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

5.2 Suggestion for Future Research

REFERENCE

APPENDIX
<table>
<thead>
<tr>
<th>Equation</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Percentage of water content</td>
<td>24</td>
</tr>
<tr>
<td>3.2</td>
<td>Percentage of ash content</td>
<td>24</td>
</tr>
<tr>
<td>3.3</td>
<td>Percentage of Fat content</td>
<td>25</td>
</tr>
<tr>
<td>3.4</td>
<td>Percentage of Crude Fiber</td>
<td>26</td>
</tr>
<tr>
<td>3.5</td>
<td>Percentage of Carbohydrate</td>
<td>26</td>
</tr>
<tr>
<td>3.6</td>
<td>pH Value determination</td>
<td>26</td>
</tr>
<tr>
<td>3.7</td>
<td>Percentage of FFA value</td>
<td>28</td>
</tr>
<tr>
<td>3.8</td>
<td>Colony counting</td>
<td>30</td>
</tr>
</tbody>
</table>
LIST OF TABLE

| Table 2.1 | Production and export of the banana in 2006 | 12 |
| Table 2.2 | Production and import of the banana in 2006 | 12 |
| Table 2.3 | Nutrition composition of Lady Finger banana | 15 |
| Table 3.1 | The Formulation of the Low Fat Mayonnaise from Golden Banana | 21 |
| Table 4.1 | Mean Acceptability Scores for Color, Aroma, Sweet and Sour Attributes | 38 |
| Table 4.2 | Mean Acceptability Scores for Banana Taste, Texture of Spreadibility, Mouthfeel and Overall Acceptance Attributes | 41 |
| Table 4.3 | Storage analysis of pH, FFA and Moisture of final product | 45 |
| Table 4.4 | Storage analysis of color of final product | 48 |
| Table 4.5 | Storage analysis of microbiological analysis | 49 |
| Table 4.6 | Mean score of nutrition content of the final products | 51 |
| Table 4.7 | Mean score of nutrition content of the final products | 54 |
| Table 4.8 | Nutrition information of low fat mayonnaise | 56 |
# LIST OF FIGURE

<table>
<thead>
<tr>
<th>Figure 2.1</th>
<th>Pathways leading to the development of edible bananas</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 3.1</td>
<td>2-Dimension of color spectrum</td>
<td>28</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Background

Consumers demand for more natural, more nutritional and healthier food products presenting both nutritional and health benefits has increased over the years. In view of the general consensus that the amount and type of fat consumed is of importance to the etiology of several chronic diseases (e.g. obesity, cardiovascular diseases, cancer), it is not surprisingly that consumer readily adhere to nutritional guideline concerning fat consumption. As a consequence, there has been pressure on the food industry to reduce the amount of fat, sugar, cholesterol, salt and certain additives in the diet (Hanan et al., 2012).

One of the major trends is to reduce the fat content of salad dressings, which has led to popular “reduced fat”, “light”, “low fat” or “free fat” versions of these traditional products. However, as a food component, fat contribute to the flavor, appearance, texture and shelf life of the food products. McClements and Demetriades (1998) reported on their previous study that it is difficult to produce reduced fat products which have the same appearance, texture, stability and flavor as their full-fat counterparts. Thus, to establish the formulation of reduced fat products, it is necessary to use a combination of non fat ingredients with different functional roles to replace the quality attributes lost when fat is removed. In order to develop low fat formulation, food technologists have focused their efforts on fat replacers. Fat replacer is an ingredient that can be used to provide some or all of the functions of fat yielding fewer calories than fat such as gum, starches and proteins based (Liu et al., 2007).
Mayonnaise is an important ingredient for the manufacturing of various kinds of mayonnaise-based products. It can be used as a decorative element or raw material in production of salads, sauces and other delicacies. Despite the high oil content relative to water, mayonnaise is an oil in-water emulsion. This emulsion is formed by first mixing the eggs, vinegar, mustard and then slowly blending in the oil. Mayonnaise is made by emulsification of vegetable oil and water phase of egg yolk. In general, water phase is composed of water, salt, sugar, vinegar, polysaccharides, additives and condiments, especially mustard. Traditional mayonnaise is a mixture of egg, vinegar, oil and spices, which typically contain 70-80% fat (Depree and Savage, 2001). Whereas, the "light" mayonnaise products, marketed only in recent years, contain about 36% fat (McClements, 2005). There is currently interest in producing reduced-fat mayonnaise and substituting fat without altering the consistency of the products.

Therefore, to produce a dietetic mayonnaise, it is necessary to decrease the dispersed phase and to increase the water content (Hanan et al., 2012). Some fat replacer such as modified starch, and thickeners (e.g. xanthan gum) were generally used to stabilize the emulsion and to increase the viscosity of light mayonnaise. Based on the current economic changes, mayonnaise has a very high potential in market include in the global markets. The international product has been widely distributes throughout the world. In a Malaysian market, as we can see the mayonnaise market is still high as the high demand of people in their daily use.

Banana serves as an ideal and low cost food source for developing countries where most of the populations rely mostly on bananas for food (Mohapatra et al., 2010). Banana is one of the most important energy sources for people living in many countries, including Brazil. From scientific research, banana has been prove that banana contain a very good nutrition (Emaga, 2007). Banana is a fruit which is contain carbohydrate, protein, and fat, high in fiber, pectin and phenol compounds. All of this
nutrition is can be use as the substitute ingredients in mayonnaise production. In fact is banana fruit is the fruit which is do not cause allergic among the children. On the other hand, banana also contains low fat and occupies the requirements for the low fat mayonnaise.

In contrast, Malaysian is known as one of the country which produces high in banana fruit. However, the high production and misconduct of the banana harvest sometime can contribute in waste of fruit as it cannot be use for many others product production (Abbas, 2009). However, it can be preserved their quality by develop it into new form of products such as a new product of mayonnaise. In this study, a new low fat formulation was carried to investigate the effect of an addition of Lady Finger banana puree on their substitution on sensory properties, nutrition contents and change in physicochemical and microbiological on storage study of the low fat mayonnaise, using the full fat formulation as a reference.

1.2 Objectives

i. To develop a best formulation for a low fat mayonnaise with addition of Lady Finger banana puree.

ii. To determine the proximate composition of low fat mayonnaise with addition of Lady Finger banana puree.

iii. To determine the physicochemical and microbiology quality of low fat mayonnaise with addition of Lady Finger banana puree during storage period.
CHAPTER 2

LITERATURE REVIEW

2.1 Mayonnaise

Mayonnaise is probably one of the most widely used sauces worldwide and commonly used as a sandwich spread in North America. It was first produced commercially in eastern United States in the early 1900’s where it was introduced as Hellman’s Mayonnaise. The market for this product is mounting as different and interesting flavors and ingredients are launched and healthy versions are developed (McClements, 2005).

Mayonnaise is an oil-in-water emulsion despite containing between 70-80% fat. Oil in water emulsions consist of finely dispersed droplets of oil in a continuous phase of water or a dilute aqueous solution. Droplet size range is from less than 1μm to 20μm or more (Snyder and Kwon 1987). This emulsion is formed by mixing the eggs, vinegar and spices, and then slowly feeding the oil, resulting in a closed-packed foam of oil droplets or coarse emulsion. Dissimilarly, if the aqueous and oil phases are mixed at once the result is a water-in-oil emulsion, whose viscosity is similar to the oil from which it was made (Depree and Savage, 2001).

2.1.1 Regulation of Mayonnaise

Mayonnaise is as an emulsified semisolid food prepared from edible vegetable oil(s) (not less than 65% by weight), acidifying ingredient(s) including vinegar and/or
lemon/lime juice (not less than 2.5%), and egg yolk-containing ingredients. Optional ingredients include salt, nutritive carbohydrate sweeteners, spices, monosodium glutamate, sequestrates, and crystallization inhibitors (USDA National Nutrient Database for Standard Reference, 2013). These ingredients have limitations imposed on them. For example, 16 added seasonings cannot simulate the color of added egg yolk and salts are permitted as metal chelators at levels up to 75ppm to protect the oil form oxidizing or reverting in flavor and to protect the mayonnaise from color loss. Mayonnaise may be blended and packed in an atmosphere in which air is replaced in whole or in part by carbon dioxide or nitrogen.

2.1.2 Mayonnaise production

Generally, mayonnaise produce with a combination of a high speed blender and a homogenizer is usually used (Hui, 1992). A wide variety of edible oils has been used for mayonnaise preparation. Recent trends show the demand of reduced fat, low fat, or fat free versions of traditional food products. Ford et al., (2004) reported that the total fat content of emulsified products can be reduced by replacing the fat droplets with nonfat ingredients. These oils include soybean, cottonseed, corn, canola, olive, sesame, safflower and sunflower.

When the fat content is reduced the flavor profile of the product is affected, which is one of the toughest qualities attributes to mimic. For that reason, the supplementation of the biopolymer fat replacers with surfactants or flavorings is necessary. According to Frank (2000) when trying to achieve a highly viscous product, such as mayonnaise, the lower the fat content the larger the quantities of thickening agent required to produce the same texture. The desired taste and aroma of the final product is achieved by the contribution of sugars, salts, acids, and flavorings.
Different emulsifiers or thickening agents can act at the droplet interface, where the main function is to prevent droplet coalescence. Stability of emulsions that practically use for the food industry requires the incorporation of substances such as emulsifiers or thickening agents (McClements and Demetriades, 1998). Emulsifiers that are commonly used to stabilize mayonnaise include phospholipids, proteins, and particulate matter, all of which are surface-active components found in eggs.

2.1.3 Physicochemical properties of Mayonnaise

Physicochemical properties of mayonnaise include stability, rheology, appearance and flavor. The perceived quality of mayonnaise is greatly determined by product rheology. According to Harrison and Cunningham (1985), the factors that affect the oil-in-water emulsion stability of mayonnaise include the amount and stability of the oil, amount of egg yolk used, relative volume of the oil phase to the aqueous phase, types and amounts of emulsifiers, methods of mixing, water quality, temperature, and viscosity. Commonly, the term emulsion stability refers to the capacity of an emulsion to resist changes in its physicochemical properties with time.

Mayonnaise is a thermodynamically unstable system due to the energetically unstable contact between oil and water molecules, and due to the difference in densities of oil and water. In order to preserve the stability (appearance, texture, taste) of the emulsion, the prevention of droplet coalescence, flocculation, and/or creaming is necessary (Rao, 1999). Coalescence is the process by which two or more droplets merge together to form a single larger droplet. Flocculation is the process by which two or more droplets stick together to form an aggregate in which the droplets retain their individual integrity. In mayonnaise, the driving force for droplet flocculation is attributed to the screening of electrostatic repulsion between droplets.
Creaming becomes a problem in low fat products, i.e., those containing less than 50-60% fat. Creaming is defined as the process by which droplets move upward due to gravity because they have a lower density compared to the surrounding liquid (McClements and Demetriades, 1998). This phenomenon can be prevented through the addition of thickening or gelling agents, such as gums or starches, to the aqueous phase of the emulsion.

2.2 Food Emulsifier Properties

Polar lipids such as glycerophospholipids, cholesterol and lipoproteins are important in food systems because of their ability to stabilize emulsions. Emulsions are colloidal systems of two immiscible liquids, one dispersed in the other continuous phase. In mayonnaise production, the “oil-in-water” emulsions is implies (Sivasankar, 2008). Emulsion is prepared by vigorous mixing of the two immiscible liquids so that small droplets of the dispersed phase are formed.

A simple emulsion breaks down rapidly as the dispersed phase droplets coalesce to form a layer which either float to the surface or settle down to the bottom of the vessel. Emulsion stability is enhanced by the presence of substance called emulsifiers or emulsifying agents, whose molecules have both polar and non-polar regions such as phospholipids (Karas et al., 2002).

The traditional source of food emulsifying agents is the egg yolk. Approximately 33% of egg yolk is lipid and the protein content is about 16%. Almost two-third of lipid is triglyceride and about 28% is phospholipids and the rest 5% is cholesterol. Yolk actually content of a suspension of lipids/proteins particles in a protein/water matrix. Egg yolk acts as an emulsifier in the preparation of mayonnaise (Kato et al., 1985).
2.2.1 The Formation of Food Emulsification

At its most basic, an emulsion is a suspension two liquids within each other that would not naturally mix (McClements, 2005). For example, a cup of vinegar, for instance as made up of millions of tiny droplets. If we pour oil into the vinegar, at first the oil will float on the top of the vinegar because it's less dense. However, if we whisk them together, the tiny droplets forming each liquid start to mix together and become suspended within each other. This is an emulsion.

However, this simple vinaigrette will eventually separate back into vinegar and oil because, at a chemical level, there is nothing holding the drops of each liquid together except for the temporary confusion of having been whisked together. To get a stable, permanent emulsion, we need to use something to hold the drops of opposing liquid together and prevent them from separating. This "something" is called an emulsifying agent (Garti, 1997). And this agent is like a mutual friend who holds the oil-based liquid in one hand and the water-based liquid in the other. It creates a chemical bond with each liquid and becomes a bridge between them. The most common emulsifying agent is an egg yolk, as in mayonnaise (Sivasankar, 2008).

2.3 Main Ingredient of the Low Fat Mayonnaise

The main ingredient in low fat mayonnaise preparation is the vegetable oil, egg yolk as and vinegar. The vegetable oil that available for mayonnaise preparation is soya bean oil, sunflower oil and corn oil. The next important component of low fat mayonnaise is the egg yolk which contributes on emulsification of the oil in water. The vinegar act as preservative and to break the bond of oil so that it can be emulsify homogenously.
2.3.1 Vegetable Oil

Vegetable oils are oils derived from vegetable (plant) sources, e.g. sunflower oil, safflower oil, soya bean oil, avocado oil, canola oil, olive oil, peanut oil, blended vegetable oils and flavored oils. Vegetable oils, as defined by the Australian Guide to Healthy Eating, are a component of the “fats and oils” food group, and fall within the “Extra Foods” category which are recommended to be eaten sometimes or in small amounts (Wendin et al., 1999).

The advice includes information on unsaturated and saturated fats. A serve of oil, according to the Guide, is defined as 20g (1 tablespoon). The mean daily intake of vegetable oil for persons aged 19 years and older according to the National Nutrition Survey (1995), was 0.5g per person per day with no difference between males and females. Total fats and oils intake was reported as 12.2g per person per day; hence vegetable oils comprised 4% of the fats and oils consumed. In this development of mayonnaise, the vegetable oil use is the corn oil as it is cheaper and abundant products compare to others vegetable oil.

2.3.2 Egg

Egg component include carotenes and riboflavin and 0.02% based on the dry weight. The carotenes are responsible for the color of the yolk, cannot be synthesized by the hen. The hen feed is responsible for carotene content and the color of the egg yolk. Egg yolk carotenes are classified as xanthophylls and carotenes. While the lutein, zeaxanthin and cryptoxanthin belong to the xanthopil group. Egg is known for as emulsifiying agent in emulsion process. In this development of mayonnaise, the egg yolk is use to emulsify the oil in water (Wendin and Hall, 2001).
2.3.3 Vinegar

Vinegars are the acetic acid that comes from the fermentation. In this research, the vinegar is added to the mixing ingredient in order to inhibit spoilage microbial. Here, the vinegar acts as the preservatives agents (Garti, 1997). However, the amount of vinegar added is in small amount as it will affect the mayonnaise product is a large amount of vinegar is added.

2.4 The Factor Influence the Low Fat Mayonnaise Storage

The factor that influences the low fat mayonnaise storage is the oxidation stabilization and emulsification stabilization. Oxidation is mainly occurring during storage where the chemical reaction occurs in the mixture of ingredients while the emulsification is due to the capability of the emulsifier to completely emulsify the incorporation of oil in water. Generally, mayonnaise stability is dependent on amount of oil, amount of egg yolk, viscosity, and relative volume of oil phase to aqueous phase, mixing method, water quality and temperature (Liu et al., 2007).

2.4.1 Oxidation Stabilization

The oxidation is stabilizes by the addition of the vinegar and the egg yolk (Sivasankar, 2008). The temperature for these mayonnaise products should be keep at 4 - 27°C. Mayonnaise stability usually involves preventing droplets coalescence, flocculation and creaming. Creaming is not usually problem in mayonnaise that have high fat content because the droplets are so closely packed together so that they cannot move. However, in product which has low fat content, creaming is usually prevented by adding thickening agent such as gum or starch to the aqueous phase to slow down the droplet movement. This is because of the increased viscosity of the aqueous phase from addition of thickening which control the oil droplet movement.
2.4.2 Emulsification Stabilization

The factor that influence the formation of the emulsion, include the appropriate condition of emulsifying agents, the phase volume ratio and the temperature of the emulsification (Karas et al., 2002). The temperature of emulsification must be controlled because interfacial tension and viscosity decrease with increases in temperature and the upper limit of temperature depends on the heat sensitiveness of the ingredients. As these researches consist of egg as emulsifier, the temperature use for emulsification is much lower as it more heat sensitive.

2.5 Botanical of Banana

Banana is believed that originated from Indo-Malay tropical areas. From this area, the banana are being migrated to others place by the nomad people, who migrated from place to place a very long time ago (Mohapatra et al., 2010). Based on history, the banana are start to being crops in Asian a few years B.C (before century) and known as *Musa paradisiaca*. The name of Musa is originated from the name of Dr. Antonius Musa, the private doctor of King Octavius Agustus. He advice the king to consume banana in order to maintain his good health (Mohapatra et al., 2010).

Most of the edible bananas are either derived solely from *Musa Accuminata* or are hybrid between two wild diploid species, *M. accuminata colla* and *M. balbisiana colla*, which contributed to A and B genomes, respectively (Mohapatra et al., 2010). Polyploidy and hybridization of A and B genomes has given rise to diploid (AA, AB, BB), triploid (AAA, AAB, ABB, BBB) and tetraploid (AAAA, AAAB, ABBB, AABB) bananas. The three common species of Musa (*M. cavendishii*, *M. paradisiaca* and *M. sapientum*) are widely grown in the world. From this three species, *M. cavendishii* is known as cooking banana, consume after cooked, while the *M. paradisiaca* and *M. sapientum* known as true banana as it usually eaten raw when fully mature (Mohapatra et al., 2010).


