



**UNIVERSITI PUTRA MALAYSIA**

***CONVERTING THE BANANA-BASED TRADITIONAL DESSERT INTO A  
READY-TO-EAT FOOD BY ADOPTING THE SAUSAGE TECHNOLOGY***

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**Ip  
FK 2018 1**

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## ABSTRACT

Banana-based local desserts have potentials to be introduced to the global market by improving their commercial values. One of the ways to achieve this is by transforming the desserts to become a ready-to-eat food for consumers' convenience and preference. Thus, this study focusses on converting the banana-based traditional dessert to become a ready-to-eat food by adopting the sausage technology. The product development involved formulating the dessert based on the bingka pisang recipe using overripe bananas for the suitability of the process. Banana and wheat flour weight were varied in the formulation. Result shows, sample with 80% of banana content had lower value of maximum compressive load, 11.85 N, because of high moisture content in the sample which was 43.75%. It also affected the texture of the sample. Sensory evaluation shows that the sample with 80% of banana content was more acceptable with the 6.8 of score.

In the process design part, the mass balance of each process was determined based on the percentage obtained during the lab-scale production and the costing that involved in this project. The production of RTE banana dessert is 67.53 kg/hr. The capital costing is RM 1,303,470.83 while for total operating cost is RM 2,098,345.15. Pay back time to achieve annual positive profit is 3 years and percentage of return in investment is 33.96%. In According to the findings, the produced product has potential to be commercialized for local market based on the overall acceptability in terms of the texture, appearance and sensory.

## **ABSTRAK**

Pencuci mulut tempatan berasaskan pisang yang mempunyai potensi untuk diperkenalkan ke pasaran global dengan meningkatkan nilai komersial mereka. Salah satu cara untuk mencapai matlamat ini adalah dengan mengubah pencuci mulut menjadi makanan siap sedia untuk kemudahan dan keutamaan pengguna. Oleh itu, tujuan kajian ini adalah untuk mengubah makanan pencuci mulut tradisional berasaskan pisang menjadi makanan siap sedia dengan menggunakan teknologi pemrosesan sosej. Pembangunan produk ini melibatkan penghasilan rumusan pencuci mulut berdasarkan resipi bingka pisang dengan menggunakan pisang yang terlalu masak bersesuaian dengan pemrosesnya. Berat pisang dan gandum divariasikan dalam rumusan ini. Hasil menunjukkan, sampel yang mengandungi 80% kandungan pisang mempunyai nilai daya mampatan maksimum yang rendah, 11.85 N, kerana kadar kelembapan yang tinggi dalam sampel ini iaitu 43.75%. Ia juga menjejaskan tekstur sampel. Penilaian sensori menunjukkan bahawa sampel dengan 80% kandungan pisang adalah lebih diterima dengan skor 6.8.

Dalam bahagian reka bentuk proses, keseimbangan jisim setiap proses ditentukan berdasarkan peratusan yang diperolehi semasa pengeluaran makmal dan kos yang terlibat dalam projek ini. Pengeluaran pencuci mulut pisang RTE adalah 67.53 kg / jam. Pengeluaran modal adalah RM 1,303,470.83 manakala bagi jumlah kos operasi ialah RM 2,098,345.15. Masa yang diperlukan untuk mencapai keuntungan positif tahunan adalah 3 tahun dan peratusan pulangan dalam pelaburan adalah 33.96%. Menurut penemuan, produk yang dihasilkan berpotensi untuk dikomersialkan untuk pasaran global berdasarkan penerimaan keseluruhan dari segi tekstur, penampilan dan rasa.

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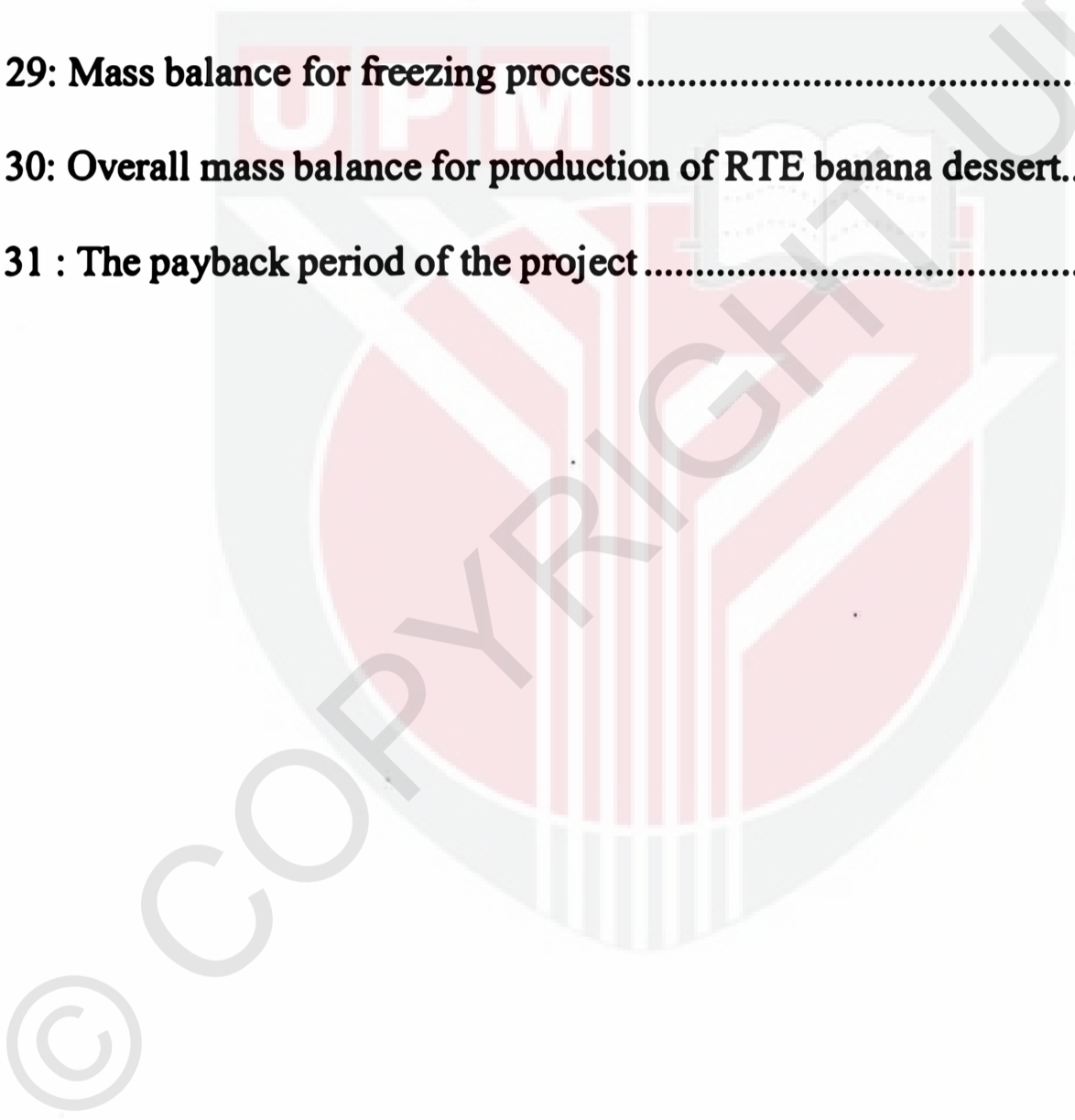
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## LIST OF ABBREVIATIONS

<b>Musa parasdisiac</b>	<b>Banana</b>
<b>RTE</b>	<b>Ready-to-eat</b>
<b>MRM</b>	<b>Mechanically recover meat</b>
<b>FSIS</b>	<b>Food Safety and Inspection</b>
	<b>Service</b>
<b>FAOSTAT</b>	<b>Food and Agriculture</b>
	<b>Organization Corporate</b>
	<b>Statistical Database</b>
<b>L*</b>	<b>Lightness</b>
<b>a*</b>	<b>Redness</b>
<b>b*</b>	<b>Yellowness</b>
<b>ISBL</b>	<b>Inside Battery Limits</b>
<b>OSBL</b>	<b>Outside Battery Limits</b>
<b>fL</b>	<b>Lang factor</b>
<b>CW</b>	<b>Working capital</b>
<b>ROI</b>	<b>Return on investment</b>
<b>°C</b>	<b>Degree Celcius</b>
<b>N</b>	<b>Newton</b>

## CHAPTER 1

### INTRODUCTION

#### 1.1 Background

Bananas (*Musa paradisiac*), from *Musaceae*, *Musa*, are enduring herbs that are broadly dispersed in tropical and subtropical districts (Jose, Pelissari, Mari, & Menegalli, 2012). Bananas are among the main tropical fruit that grows largely in Asia, Latin America and Africa. Based on the volume of production, bananas come fourth after rice, wheat and maize (Idris & Soon, 2016).

Banana is a type of fruit that only bears fruit once in their lifetime. Ten to twelve months is the time needed to make sure the fruit is ready to be harvested. Usually, banana tree is to be cut during the harvesting process. The bottom part of the stem and rhizome will be left because new tree will be developed from them (Abdullah, Sulaiman, Miskam, & Taib, 2014). Past examinations have recorded that developed banana was domesticated from family *Musaceae* through different intra- and between hybridizations. To date, more than 1000 banana cultivars are developed in the tropical and subtropical areas of the world (Li & Ge, 2017). Annually, 100 million tons and above of banana are produced and planted over ten million hectares

of plantation. 87% of global banana production is for the neighborhood utilization while the rest is sent out to another country (Idris & Soon, 2016).

In Malaysia, bananas positioned second, as far as generation range and fourth in sending out income in view of the adjust of exchange figures. It is the second most generally developed organic products, settled around 29,000 hectares with an aggregate generation of 294,000 metric tons. Around half of the banana developing range is developed with Pisang Berangan and Cavendish sort while the staying prevalent cultivars are Pisang Raja, Pisang Nangka, Pisang Tanduk, Pisang Rastali, Pisang Mas, Pisang Abu and Pisang Awak (Idris & Soon, 2016). Figure 1 shows the common banana trees which are grown in Malaysia

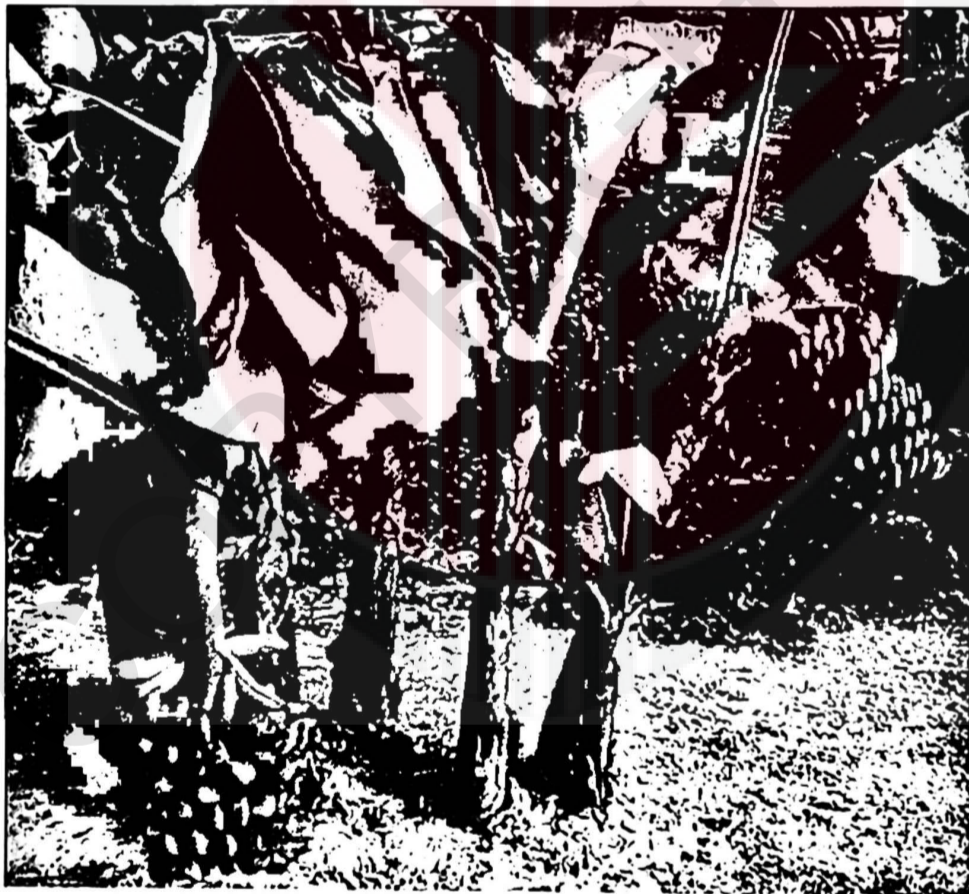


Figure 1: Banana tree

## 1.2 Traditional Dessert

In Derbyshire, as in the vast majority of alternate zones of Britain, they have dependably possessed the capacity to grow an assortment of grains, to keep a wide

range of kinds of creatures, and to develop delicate and stone fruits of numerous sorts. Cooks have possessed the capacity to exploit dried and citrus fruits and many types of spices imported from abroad as the result of development as worldwide exchanging houses such as East India organization (Dunstan, 2008).

After, rum and sugar cane product available when the exchange with British colonies in the Caribbean happen, English cooks were ready to change the old medieval pottages and custards always update them as their new ingredients discovered their way into the nation (Dunstan, 2008).

In the making of the old traditional Malay dessert, the ancients did not have the same recipe as now. They only make the desserts without using a specific measurement in the recipes. This is because the recipes made are suitable for flour, water and so on when kneading process. The Malay cake is easy to make and its ingredients are also readily available such as flour, pandan leaves, banana leaves and others (Puteh, 2012).

### **1.3 Ready-to-eat Food**

Ready-to-eat (RTE) foods are those food products that have gone through some kind of processing and can be consumed without undergoing any further bactericidal treatment such as through heating. These foods do not require further preparation prior to consumption, except washing, thawing, or moderate reheating (Farber & Harwig, 1996). As the name implies, RTE foods can be readily consumed without further preparation or processing and thus extremely convenient for present-day, busy consumers. Surveys of consumer purchase behaviors show an increasing trend in the consumption of RTE food industry. Ready-to-eat sandwiches account for

32% of sales from vending machines and include a large share of a multibillion-dollar annual business in the United States. Supermarket and convenient stores carry a large selection and variety of RTE food products (Hwang & Huang, 2010).

#### **1.4 Sausages Technology**

The oldest form for handling processes meat is in sausage form discovered from historical evidence. One of a kind method is used to make sausage by utilized nutritious and edible trimmings from beef, pork, sheep and also meat from various types of poultry. Besides, the sausage is the most seasoned type of method of prepared meat, it also has been an exceptionally alluring, "fast and simple" food for ages. Sausage can be classified into certain types such as fresh sausage, cooked and smoked sausage, uncooked smoked sausage, fermented sausage, semi-dry sausage, dry or fermented sausage, and mold-ripened sausages (Mohan, n.d.).

In the sausage making process, the most important component is the casings. Usually, after the grind meat was mixed with all of spices or seasonings to produce sausage mixture, it will be stuffed into the casings that usually in cylindrical shape. There are two types of casings, natural and artificial types. For natural type of casings, the casings are derived from animal digestive organ such as pork, beef and lamb intestine. For artificial or fabricated casings, they usually made from cellulose and collagen base. The purpose of casing in sausages technology is to combine and held the sausage mixture in desired shape during additionally handling advances, for example, smoking, bubbling, broiling or simmering.

## 1.5 Problem Statements

Banana is a fruit that is high in rate of ripeness and it can be determined by using the banana ripeness grading pictorial scales with seven stages of banana ripeness (Yap, Fernando, Brennan, Jayasena, & Coorey, 2017). Overripe of banana is considered as waste and increases each year with the increment of world's banana production. High amount of wastage in fresh banana industries due to the concern about the appearance of the fruit as it affects the sales rate of the company. Since this problem happened and involves the overripe banana fruit, this study introduce to used this waste as main ingredient in development of ready-to-eat traditional banana dessert by adopting sausage technology in the process of their production. According to Yap, Fernando, Brennan, Jayasena, & Coorey (2017), banana at last stage of ripeness has the highest content in sugar among the other stages and it is really suitable as the main ingredient in the making of sweet dessert and subsequently it can reduce the use of extra sugar in formulation of the product

In Malaysia, there are various kinds of traditional desserts, especially dessert that involved banana as the main ingredient such as *bingka pisang*, *lepat pisang*, *lempeng pisang* and others. All of this traditional desserts are really popular among the Malaysians especially but it is only has high in demand in rural area compared to urban areas. This problem occurs due to the low in product aesthetic value which can cause a lack of demand from customers. To fix this problem, this research helps to expand the traditional or local dessert market by converting them into ready to eat food for the convenience of the customers. The traditional banana dessert possessed longer shelf life since it is frozen food product. The use of sausage technology

especially in casings application and the fixed of the formulation can contribute in the uniformity of shape and flavor of the ready-to-eat traditional banana dessert.

## **1.6 Objectives**

The objectives of this research are:

1. To convert banana-based traditional dessert to a ready-to-eat food via sausage technology
2. To propose a process design for the production of banana sausage dessert for food industry.

## **1.7 Thesis Outline**

The thesis contains five chapters which are each chapter was focusing on the processing of converting of traditional banana dessert into a ready-to-eat food by adopting sausage technology. Chapter one is an introduction which consists of seven main components, background, traditional dessert, ready-to-eat food, sausage technology, problem statement, objective and thesis outline. The literature review was covered in chapter two which tell about some earlier research and information that related to banana and traditional. This chapter also discusses more explanation about the technology that has been used in the sausage production. Chapter three represents the method that has been applied to obtain the result of this study. Chapter four reports on the result and discussion. Finally, chapter five covers the conclusion and the recommendation.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Banana (*Musa sp.*)

The sweet or dessert banana and the cooking banana are two sub-group which is the banana (*Musa sp.*) can be classified (Pillay et al., 2001). Cooking banana or 'plantain' is general term is applied to a specific subgroup of cooking bananas (Valmayor et al., 2000). The yellow banana or sweet banana commonly can be found in the market. Sweet banana shows enormous diversity in terms of plant stature and fruit size, and fruit color extends from yellow and green to red and orange (Ploetz, Kepler, Daniells, & Nelson, 2007). In the family of *Musaceae*, banana is classified under genus *Musa* which is included at least other genus (*Ensete*) and,, depending upon the affiliations of the taxonomist, may also include the monotypic genus *Musella* (Constantine & Rossel, 1999).

All genera are monocotyledons and, as such are technically defined as 'herbs' even though some species can grow up to 15m tall (Australian Government. Department of Health and ageing., 2008). The modern day edible bananas are a mix

of wild and cultivated, species and hybrids associated with *M. acuminata* and *M. Balbisiana*. *M. acuminata* is the most widespread of the species on section *Musa* (Daniells, Karamura, Jenny, & Tomekpe, 2001) and the centre of diversity is thought to be either Malaysia or Indonesia (Horry et al. 1997).

### **2.1.1 World Production of Banana**

Bananas (*Musa parasdisiac*) are herb association to *Musaceae*, *Musa* that can be found extensively in tropical and sub-tropical countries (Jose et al., 2012). The banana is one of popular and most essential nourishment edits in the world. For sweet banana, it make up almost 43% of global banana production while cooking banana makes up almost 57% (Valmayor et al., 2000). Banana manors is usually has low speculation, high proficiency and quick-pay have been growing quickly and turned into a basic industry in the provincial economy of southern China. Figure 2 shows the world banana production from 2011 until 2016. In 2011, the world production of banana is close 19.91 tons per hectare. This number then increase slightly every year from 2012 until 2015. In 2015, the world production of banana was the highest which is 21.16 ton per hectare before it was drop to 20.62 ton per hectare in 2016 due to a series of tropical storms destroyed the banana crops in some countries (FAO, 2016).

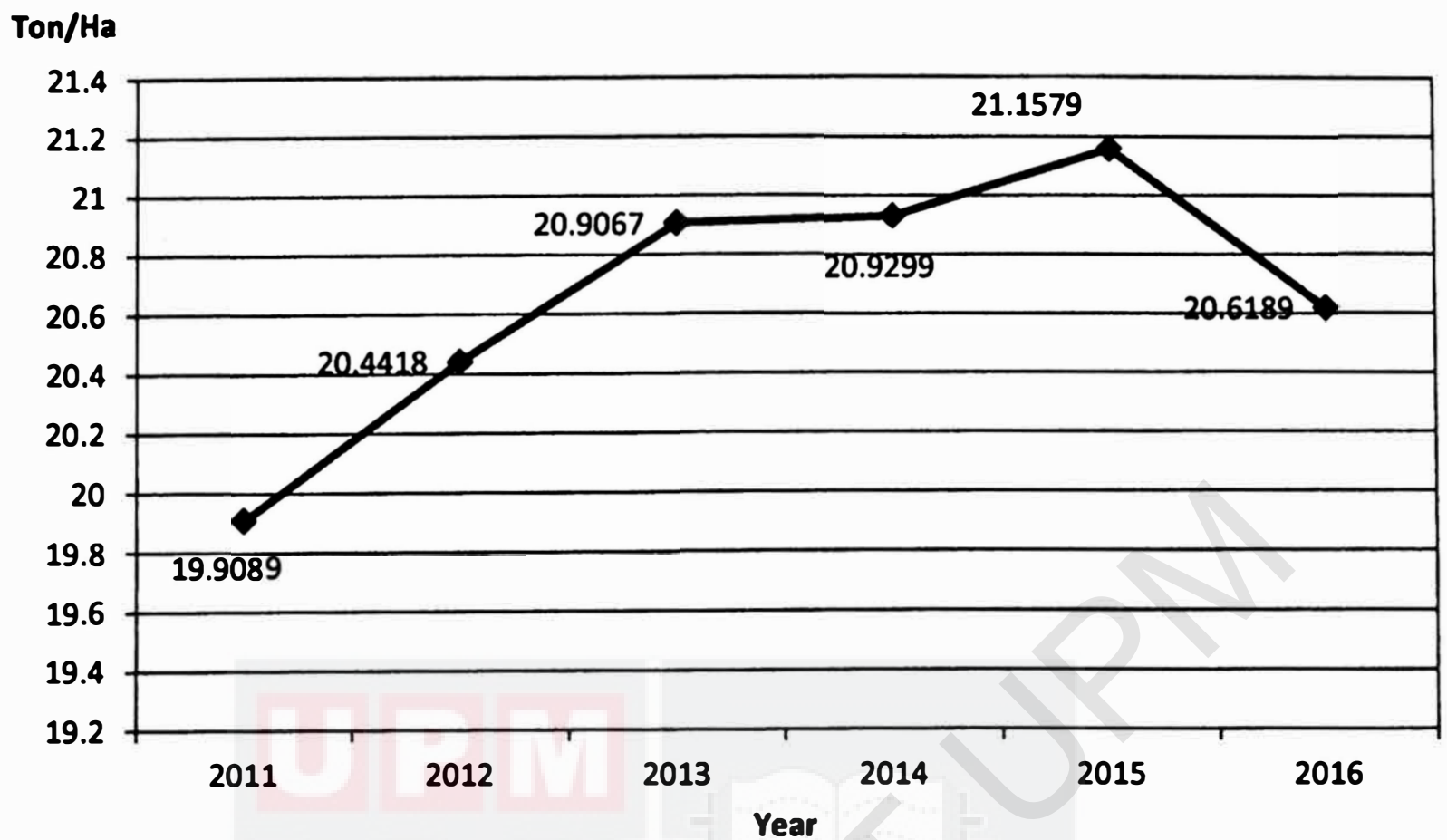


Figure 2: World banana production

Figure 3 shows the world banana export from 2013 until 2017. Following two consecutive years of sustained growth, global exports of banana, excluding plantain, are expected to reach 18.1 million tonnes in 2017. This would mark a healthy recovery from the weatherinduced drop in exports experienced in 2015, when volumes fell to 16.7 million tonnes. Exports from Latin America and the Caribbean are expected to increase by 4 percent in 2017, on the back of an estimated 10 percent growth in Ecuador and Colombia. Exports from the Caribbean are estimated to drop to 177.000 tonnes in 2017 (54 percent decline compared to 2016) following severe weather-related disruptions to production in the Dominican Republic, which accounts for approximately 98 percent of exports from the region. Asian exports remained subdued by slow production growth in the Philippines, the largest exporter in the region. The Philippines account for approximately 87 percent of total export volumes from Asia. Exports from the Philippines are accordingly predicted to drop to 1.67 million tonnes in 2017, an estimated decline of 3.8 percent compared to the

previous year. Africa's exports are predicted to close at an estimated 8 percent above the level of 2016. Côte d'Ivoire and Cameroon, the two leading exporters in the region which is export 53 percent of total export volume from Africa (FAO, 2017).

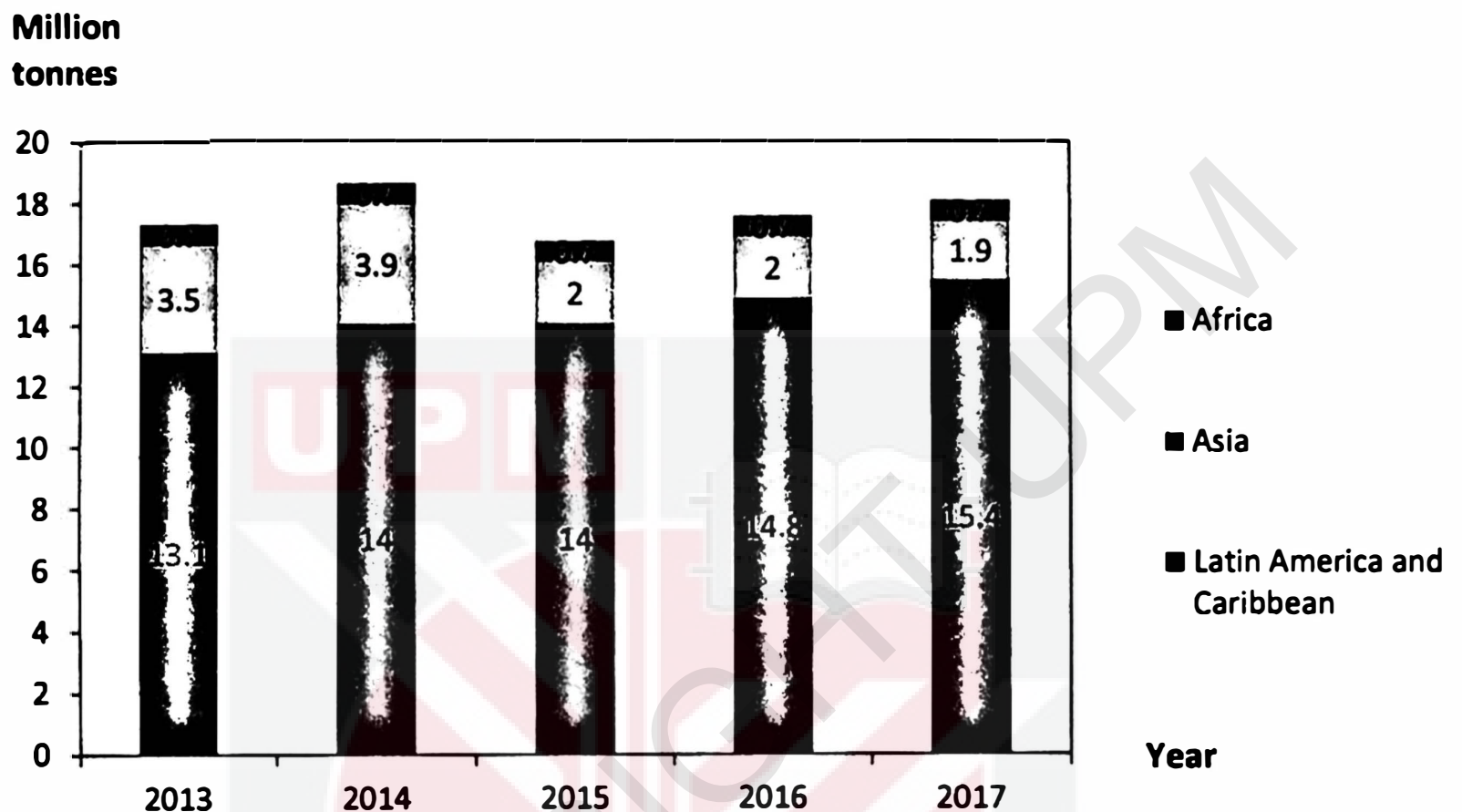


Figure 3: World banana export

### 2.1.2 Banana Production in Malaysia

Malaysia is a small producer of banana when compared with other larger countries such as Philippines and Indonesia. In 2016, banana production in Malaysia was 0.11 million Hg/Ha, the highest we have achieved since 2011 (shown in Figure 4). More than 10 percent of aggregate natural product hectare is used for banana plantations. A common type of banana is grown in Malaysia for export to the other countries is Cavendish type: Pisang Berangan and Pisang Mas. The countries that involved in banana export from Malaysia are Singapore, Brunei, Middle East, Hong Kong and Japan. For local utilization, the common types of banana used include Pisang Rastali, Pisang Lemak Manis and Pisang Embun especially for common

dessert or traditional dessert (Jamaluddin, n.d.). Figure 4 shows the fluctuation in Malaysia banana production. In 2011, the production of banana in Malaysia shows 10.5136 ton per hectare before the value drop to 9.9008 ton per hectare in 2012. The value then increasing drastically in 2013 and continuously fall in the next two years. The highest banana production was recorded in 2017 which is 11.0397 ton per hectare (FAO, 2016).

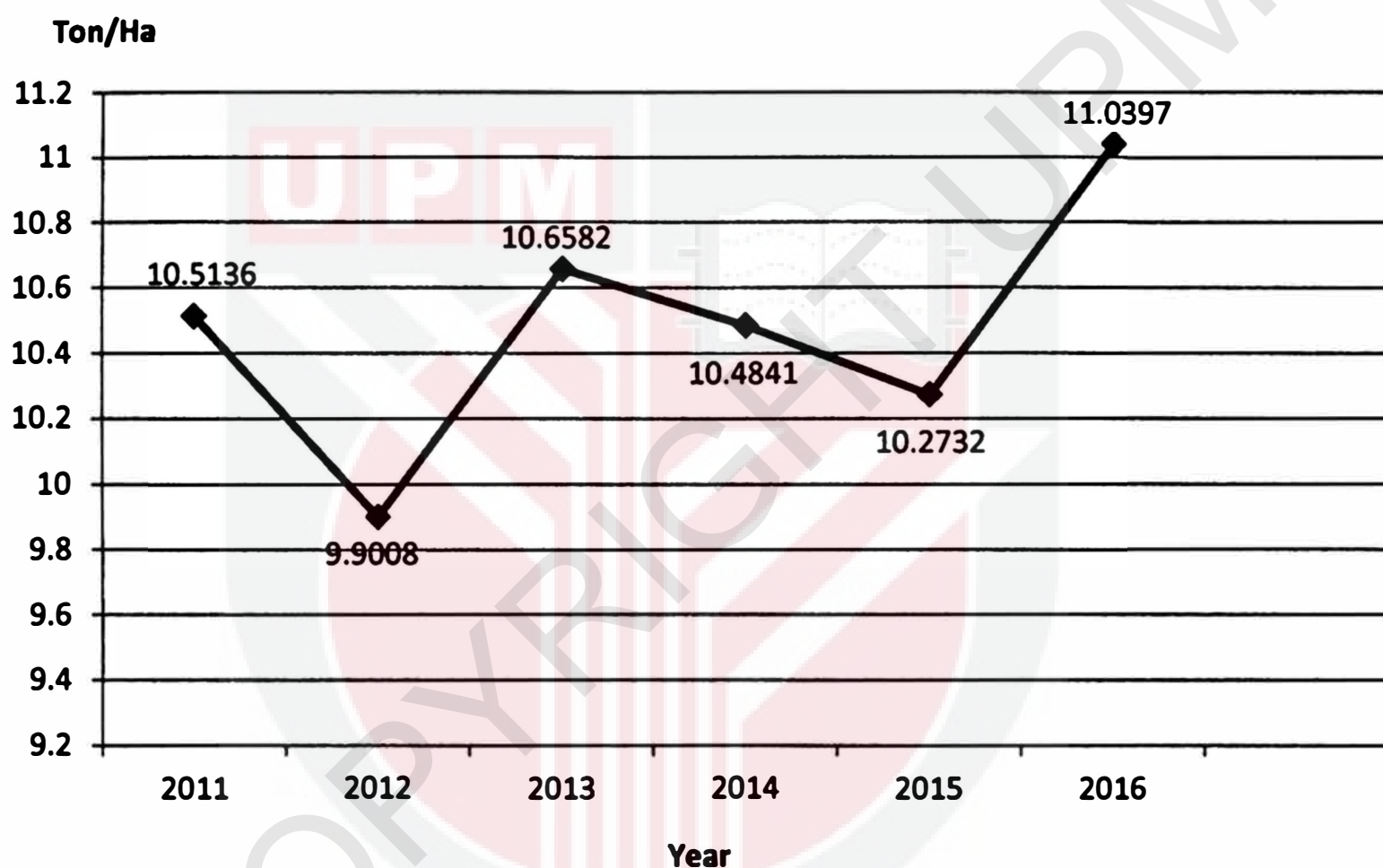


Figure 4: Banana production in Malaysia

### 2.1.3 Potential of New Types of Banana Products

Banana (*Musa paradisiaca*) is one of the plants that contains a high content in starch, thus it has industrial value and really suitable for starch isolation especially from the unripe banana fruit (Jose et al., 2012). Besides, banana peel can be used to produce edible film from for food packaging applications. Previous study has shown that the edible film can be produced by the mixing of banana peel, glycerol and clove

oil (Astuti & Erprihana, 2014). Glycerol acts as a plasticizer and clove oil as the antimicrobial substance.

In addition, the trunk of the banana plant can be used as the main material for producing wrapping paper. Some researchers found that the material in the banana trunk is suitable for paper making ingredient by combining with two other main materials, sugar cane bagasse and wastepaper (Ramdhonee & Jeetah, 2017). Other studies in Uganda, have done some effort to increase the shelf-life and increase the value of the banana (Van Asten, Florent, & Apio, 2010). The method they used is by process the banana into dries slices.

In Malaysia, there are varieties of traditional desserts and snacks produced from banana because of its sweet taste and unique flavor that are really suitable with the taste pallet of Malaysians. *Pengat pisang, lempeng pisang, cekodok pisang and bingka pisang* are the most common traditional desserts and snacks which is really popular and favorable among Malaysians especially Malays (Puteh, 2012). However, all of these desserts and snacks have a really small market niche and aren less popular among youngster especially those living in the urban area. Besides, the shelf life of these traditional desserts and snacks is short which is mainly due to the formulations, especially coconut milk, that cause the food to be easily spoiled. Food produced from coconut milk may undergone lipid oxidation and lipolysis causing chemical deterioration which results in off odors and flavors (Waisundara, Perera, & Barlow, 2007). So, they need to be served and eat immediately right after being cooked. Hence innovation is needed to tackle the mentioned issues of our traditional desserts and snacks in order to increase their market values. One possible way is by converting them into a ready-to-eat food by adopting the sausage technology.

### 2.1.3 Banana in Traditional Dessert

According to Yap et al (2017), the sugar content of overripe banana (stage 7) is the highest among the other stages. The fructose content increases from stage 1 to stage 7. The changes of the sugar content along the stages affect the flavor and taste of the fruit. In contrast, the same research group also reported a decrement of the starch content in the banana from stage 1 to stage 7 (Yap et al., 2017). In traded cultivars of bananas, starch content in the fresh pulp of the unripe (green fruit) is around 20%. During ripening process, the starch was almost completely hydrolyzed to form sucrose, glucose, and fructose. Some of the recent studies reported that the transformation of carbohydrate in bananas to become trisaccharide (Marriott, Robinson, & Karikari, 1981). Since the overripe banana is high in sugar, it is suitable to be used as the main ingredient in the making of various Malaysian traditional desserts (Puteh, 2012). Some examples of the banana-based Malaysian traditional dessert are shown in Figure 5.

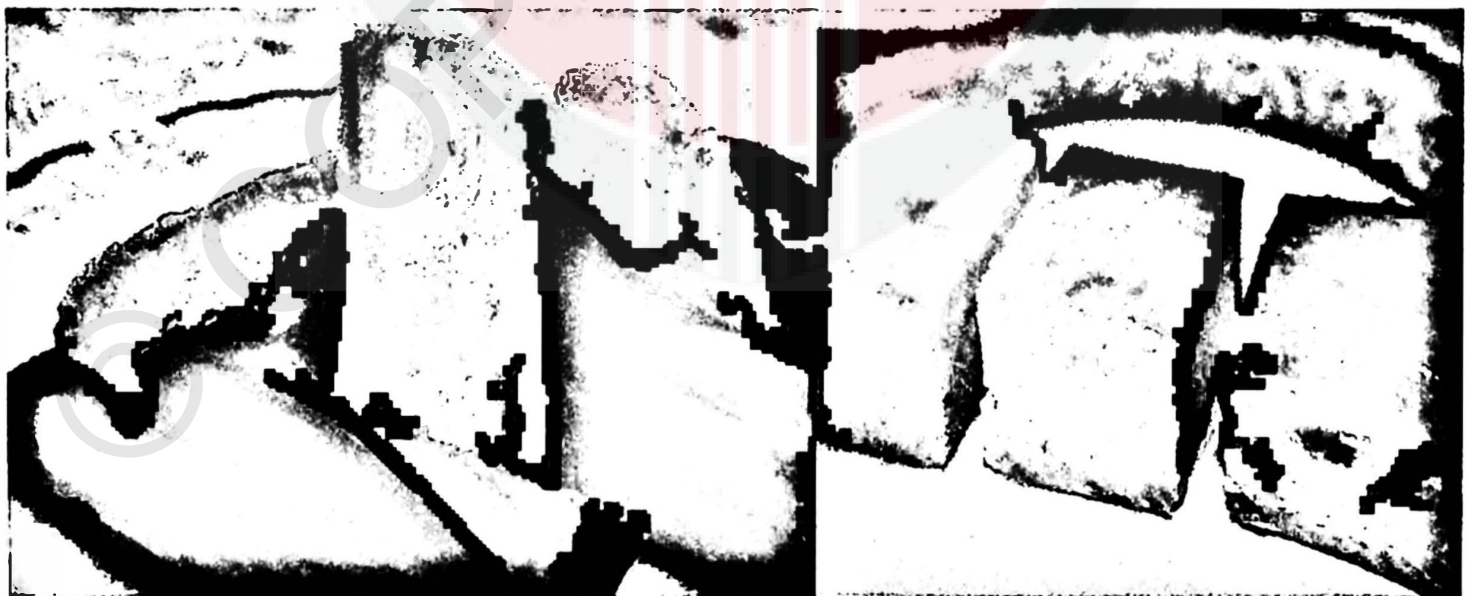


Figure 5: Banana-based Malaysian traditional desserts

## **2.2 Ready-to-eat Food Via Sausage Technology**

Ready-to-eat food (RTE) foods are very attractive to consumers looking for convenient meals as they provide a source of readily available and nutritious meals. Thus, the production of RTE foods is growing as a result of lifestyle changes and consumers' increased demand for convenient foods. According to the Codex Alimentarius Commission, RTE foods include any food (including beverages) consumed in its raw state or any food handled, processed, mixed, cooked or otherwise prepared into a form in which it is normally consumed without further processing. RTE food is food that can be directly consumed without the need for cooking or other processing effective to eliminate or reduce the micro-organism in the food to an acceptable level (Kotzekidou, 2016). Some examples of RTE foods include the following: dairy products (cheeses, yogurt, sourcream, pasteurized milk), fruit and vegetable (salads and leafy greens, salsa, and juice), poultry (buffalo chicken, chicken wraps, deli cuts, chicken salad), meats (deli meat, sausages, hot dogs, corned beef) and other products (Hwang & Huang, 2010).

In the sausage making industry, the existing sausage nowadays can be in the form of uncooked or ready to eat sausage. The sausage is usually made from red meat such as pork, beef, lamb or veal. Sausage also can be made from poultry such as turkey or chicken. For uncooked sausage, it can include the fresh sausages (for example, bologna and frankfurters) while for ready to eat or cooked sausage (for example, the sausages that have been through smoking process). Most of the sausage products in the market have been cooked to avoid the foodborne illness. Different main materials that are used in the sausage result in different temperatures used in their cooking process. For red meat sausage (pork, beef, lamb and veal) the cooking

process is operating at 71°F while for white meat sausage (poultry) the temperature must exceed 74°F during cooking process (United States Department of Agriculture, 2013).

Food sausage that has been dry, they usually smoked, unsmoked or cooked while semi-dry sausage may be heated in the smokehouse in order to fully cook the sausage and partially dry it. The cooked sausages such as bologna and frankfurters, the sausages are cooked and may also be smoked (United States Department of Agriculture, 2013).

### **2.2.1 Sausage Technology**

The creation of the method to preserve food, especially meat by using sausage method in ancient time is actually caused by three considerations. First consideration is the size of the animal they have obtained from hunting activities. Usually the animal is in a larger size and need to cut into more convenient size to be eaten. This also led to the creation of various tools for cutting the meat during ancient times. The second consideration is the shelf-life of the meat. They already know smoking and drying can increase the shelf-life of the meat. Early human also knows that salt also can increase the quality and also can improve the shelf-life of food. Last consideration is about packaging and about avoiding wastage from the hunting animal. They aware that some organ of the animal such as intestines, stomachs and skin can be used as packaging material for the food. So, all these three considerations are led to the formation of what we know as sausage nowadays (Allen, 2015).

Over hundreds of years, sausage has been adjusted to suit both civilization and atmosphere. So, many ideas from the past about what kind of food should be

filled in the sausage casing. A few nations, they produce delicious, but cheap food that is in sausage form by using cheap meat part such as skin, ears and mechanically recover meat (MRM). There is also some culture that has rigid management during sausage forming process because they use meat that has more quality and not mixing them with anything other than pure meat. Besides, some of occasional vegetables also has been developed into special sausages (Fletcher, 2012).

Sausages processing usually used red meat or poultry that is mixed well with other ingredient such as water, binders and seasoning for produce desirable texture and flavor. The mixture will stuffed in to the casings and will be cured, smoked or cooked before they are ready to be served (Essien, 2003). There are few consideration in making sausage as discussed in the sub-sections below.

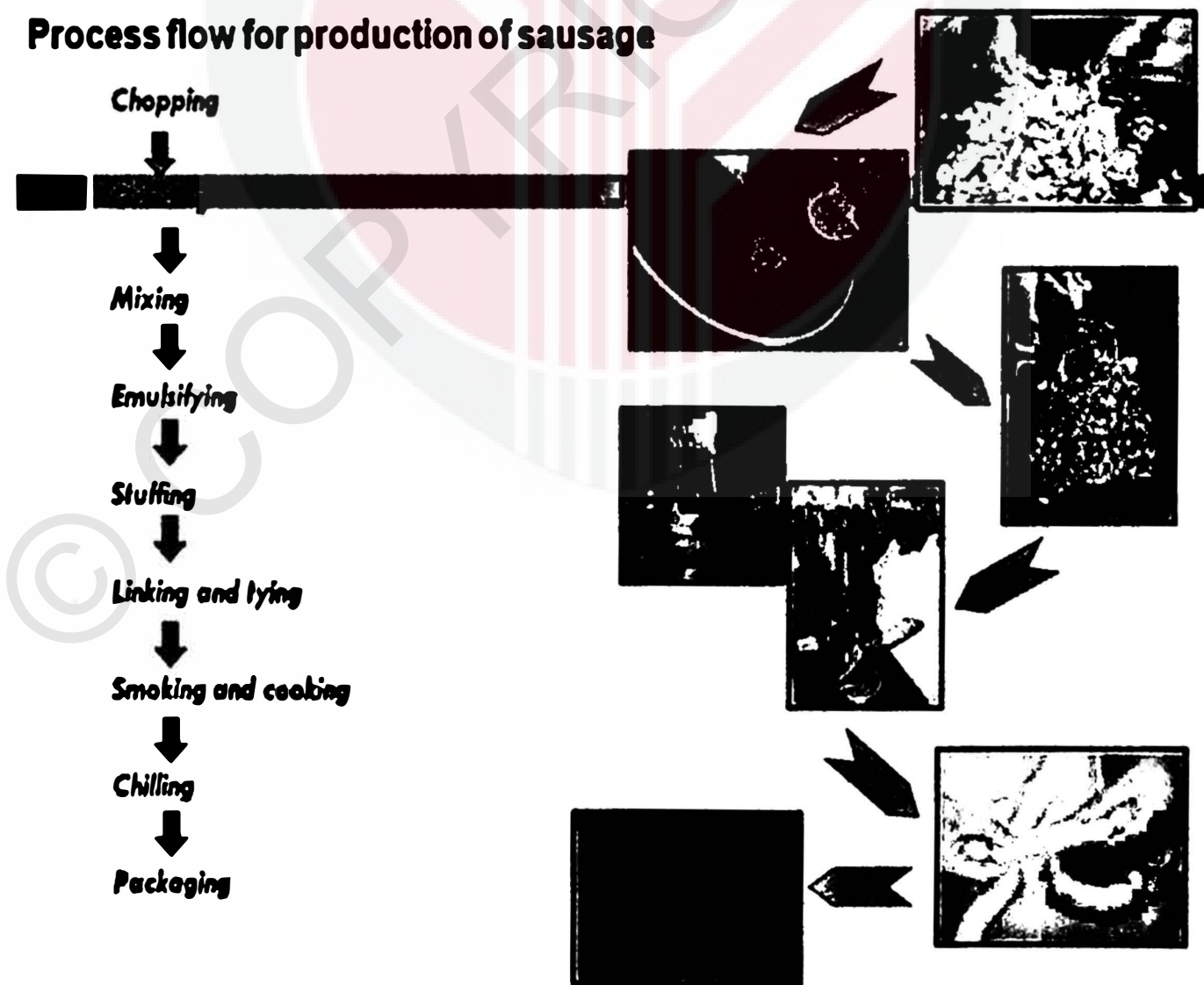


Figure 6: Process flow for production of sausage

### **2.2.1.1 Shape**

Cylindrical with hemispherical ends is common and popular shape for sausages. However, time by time, the demand for this shape become less popular and consequently lead to the development of other shapes and sizes of sausages. For example, sandwich sausages that served in slice and dice shape, skin-on or skinless, for fast food outlets and others. The shape of the sausage needed is depend on the presentation of the food and fit with the packaging (Essien, 2003). The figure below shows sandwich type shape of sausage that has high demand from the consumers due to its convenient.



Figure 7: Slices of sandwich sausage

### **2.2.1.2 Casing**

Casing is an important part of the sausage that act as barrier to separate the sausage from the external environment and produce the desired shape. Beside providing shape, size and integrity of the sausage, the casing is an important element during the stuffing process until it is serve to the consumer except for skinless sausage. There is no universal casing that suitable for production of all kind of sausage because casings act in both direct and indirect roles in the sausage

production. To select the type of casing, one must be dependent on the basic characteristics of the casing such as their mechanical strength, adhesion and elasticity, permeability to water and gases, as well as chemical inertness, impermeability to fat, uniform diameter, resistance to temperature variations, etc. Mechanical properties of casing (strength and flexibility) are important parameters in sausage production since they influenced the way filling process should be executed (Djordjevic et al., 2015).

There are two types of sausage casing, natural and synthetic, in which each of them has different properties and affect the final product properties. Both of them are different in terms of cost, smoking and cooking ability, and the final product or cooked sausage appearance.



Figure 8: Natural Sausage Casing from cow intestine organ

Natural casings (example shown in Figure 8) has been used in ancient time as a packaging for sausage product (Joseph, Ph, & The, 2010). They basically consist of collagen from the gastrointestinal tract of animal. Then, the taken and cleaned intestine typically salted for conservation to anticipate the development of microscopic organisms. The collagen content will affect the last product tenderness

and permeability of the casing. Hog and sheep casings have small diameter and thinner wall. It cause the final sausage product has the most tender texture compared when used others animal casings. Beef casings has larger in diameter. As the size increase, the casings will be become thicker but it has restriction in mechanical strength and is unable to hold the full weight of a stuffed of product especially in smokehouse for cooking and smoking process. However, larger diameter provides additional durability in the form of stockinettes (Joseph et al., 2010).

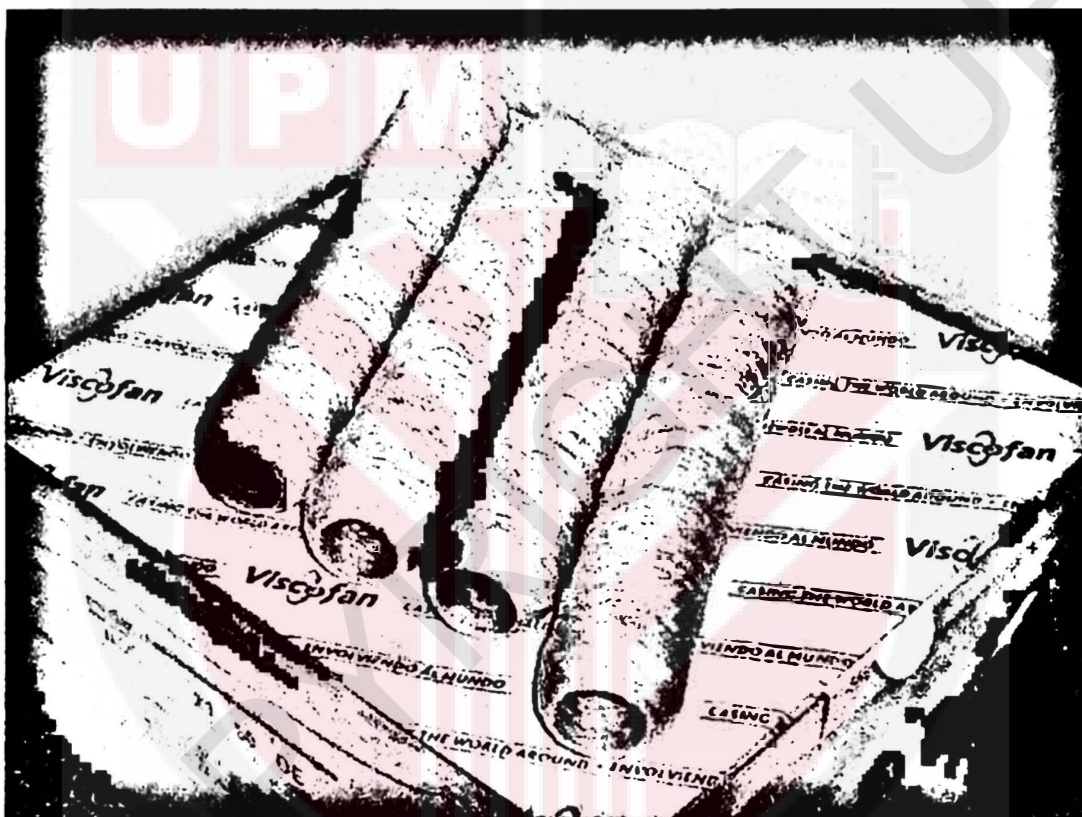


Figure 9: Cellulose Artificial Sausage Casing

Previously decade, the artificial casings (example shown in Figure 9) has been going through a lot of stages of development and currently many selection of shape, sizes and appearance. They nearly duplicated all the characteristic of the natural casings. The additional characteristics to the artificial one are addition of colouring agent, spices, smoke flavoring, and an assortment of different materials as a component of the packaging to be stored on the item surface after stuffing and handling process (Joseph et al., 2010).

### **2.2.2 Product Through Sausage Technology**

Sausage is one of the popular forms of food that is easily accepted by all societies. A lot of products has been created to improve and replaced the existing sausage. Meat-free sausage is one of popular healthy product among the vegens and customers with healthy-conscious. This product provide low fat content compared to the existing meat varieties. It also provide a healthy food that imitate the true meat sausage texture and flavor. Secret Sausage is one of brand that produce vegetarian product in United Kingdom is the example of free-meat sausage that is made of vegetable and rice with no meat substitute. Water, Vitamin C and some spices are including in the ingredient of Secret Sausage. In addition, rice and seaweed with no animal products are include are the main ingredient of their casing (Sharma, 2014).

Pumpkin sausages (Figure 10) is a vegan product that is used pumpkin or squash as a filler material that have poor binding properties. 100% pumpkin puree will result very viscous form because the water content is really high, 91%. To maintain and hold the shape, flours, starches or gums are used in purposed to immobilize the water. Even though, gums has properties to absorb high volume of water, the pumpkin puree is still need to be thickened until it can hold thei form when the sausage is thinly sliced (Meats and Sausages, 2004).



**Figure 10: Sausage for vegetarian with pumpkin as a filler.**

Another product that adopting sausage technology is fish sausage which is popular in some Asian country such as Philippines, Thailand, Malaysia, Japan, and China. This product is made of fermented fish paste and fish sauce. Source of carbohydrate for fermentation and filler in this product is rice . The example of known product is Balao Balao (fermented rice and shrimp) and Burong Isda (fermented rice and fish). This product has some advantages which is to improve the texture, the fish need to be mixed with pork fat, vegetable oil and other meat filler (Meats and Sausages, 2004).

Blood sausages (Figure 11) is old traditional food and every country has their own personal recipes. This product recipes generally same even though they all have different name such as, Black Pudding (UK, Ireland), Boudin noir (France), Blutwurst (Germany), Morcilla (Spain), Jelito (Czech), Kaszanka (Poland), or Mustamakkara (Finland). The main ingredients are blood (from pig,sheep,lamb,cow or goose), filler (oatmeal, buckwheat, breadcrumbs, barley, or other grains) onions and spices.



**Figure 11: Traditional blood sausage**

By considering the flexibility of sausage ingredients, there is potential of combining the banana-based traditional dessert recipe with the production of sausage. In most of the local banana-based desserts recipe, it contains mainly banana puree and starch. These two components are suitable to be integrated for the production of a sausage-shape dessert. However, a few processing considerations are needed in order to produce this new type of ready-to-eat food.

### **2.3 Processing Consideration**

Typical sausage production involves several processing steps namely blanching, grinding, mixing, stuffing, steaming, chilling, freezing which were discussed the next sub-section.

#### **2.3.1 Blanching**

Blanching is a unit operation prior to freezing, canning, or drying in which fruits or vegetables are heated for the purpose of inactivating enzymes; modifying texture; preserving color, flavor, and nutritional value; and removing trapped air. Hot water and steam are the most commonly used heating media for blanching in

industry, but microwave and hot gas blanching have also been studied. Water blanching is performed in hot water at temperatures ranging typically from 70 °C to 100 °C. Water blanching usually results in a more uniform treatment, allowing processing at lower temperatures. Different hot water and steam blanchers have been designed to improve product quality, increase yield, and facilitate processing of products with different thermal properties and geometries. Although blanching seems a simple operation, heat transfer to a conveyed bed of product and its effects on product properties are very difficult to accurately model with predictive mathematics. Processing conditions are usually set up to inactivate enzymes, but other quality parameters, such as color and texture, are commonly monitored (Powers, Joseph R, Jose´I.ReyesDeCorcuera, 2004).

### **2.3.2 Grinding**

Grinding is the most widely recognized type of grating machining. It is a process of cutting materials which connects with a grit which is a instrument whose cutting components are grains of rough material. Grit are described as sharp cutting point, high hot hardness, chemical stability and wear protection (Kharagpur, n.d.). In this research, grinding is the step to decrease the size of meat and changed them into more consistently particles. Mostly crushing and grinding equipment that are used in the food commerce has been taken from the chemical industry. This industry usually uses the crushing and grinding process to reduce very hard materials such as large pieces of minerals (Y.H.Hui, 2012).

### **2.3.3 Mixing**

Mixing is an important process and widely use in many type of industries because this process is involving in chemical and physical change of the last product.

As we know, mixing process is a process has developed or established from chemical industry but many type of industries also use mixing operation as their main process in large scale of production including food, pharmaceutical, paper, plastics, ceramics and rubber industry (Harnby, Edwards, & Nienow, 1997).

For mixing process in this research, the type of mixing involve is solid-liquid mixing. Solid-liquid mixing is the operation the involve crystallization or solid-catalysed liquid reactions. Solid particle tend to suspend in a approximately low viscosity fluid. By using mechanically agitated vessels, it can prevented the formation sediment of the solid and contribute perfect environment for excellent liquid-solid chemical reaction and solid mass transfer (Harnby, Edwards, & Nienow, 1997).

#### **2.3.4 Stuffing**

Stuffing is the process to allow the sausage mixture getting into the casings. After the previous process that is mixing process is complete, the ingradient or the mixture stuffed into a packaged or extruded into a casing. For fresh meat, usually the casing used for stuffing process is natural type animal casings. Stuffer is the important equipment to ensure this process runs smoothly without any problem. For larger production, the equipments used are more sophisticated and complex machines like twin-piston vacuum stuffers or automatic twin-piston stuffer to get constant and uniform product by controlling some parameters such as pressure, time and temperature. While for the small production, the process and equipments are simpler, from the output of the grinder directly stuffed into the casing (FSIS, 1999). The horn is the simplest equipment that has been used where it needs to be installed on the

grinder. The size of the tubes depends on the size of casings used. In this process, minimum air pocket is desired to reduce risk of pathogenic organisms (Mohan, n.d.).

### **2.3.5 Steaming**

Steaming process is one of the most healthiest ways to prepared food. The steam conceals the food materials under varying degree of pressure. There are two common methods used for cooking by using steam, atmospheric or low pressure steaming and high pressure steaming. Atmospheric or low pressure steaming is the method to cook the food by direct or indirect touch with the steam. Direct contact uses a steamer or pan where there is boiling water inside of them and indirect contact is the method that the food cooked between two plates over a pan of boiling water. High pressure steaming is the process that use a special equipment that prevent steam to escape to build up the steam pressure and temperature and thus reduce the cooking time (BSH, 2013).

The benefits by using steaming process as the method of cooking food are the lesser nutrients loss in the food compared to the boiling technique. This process do not immersed the food materials into the water, so it do not cause the vitamins and minerals leach out into the water. The food also can be cooked with little quantity of fat or with no fat at all. When meat are cooked by using steaming process, it will caused the fat from the meat separates by itself and drop as liquid form into the baking pan (BSH, 2013).

### **2.3.6 Chilling**

Chilling is a process that the sausage product will go through cold water shower. This process ensures the product humidity is preserved and ends the previous cooking process by lowering the temperature of the sausage product as far as possible. Chilling process also avoids the shrinkage of the product casing that can lead to the next process which is peeling process can be done easily. Within a desired time, the temperature of the product must be reduced to a specific temperature (FSIS, 1999). According to FDA Food Code, the temperature of the product should be reduced from 60°C to 21.11°C for 2 hours, then from 21.11°C to 5°C or less within an additional 4 hours.

### **2.3.7 Freezing**

Freezing can be categorized under refrigerated preservation of food. Refrigerated preservation is the method of preservation that maintains and decreases the temperature of the food materials and thus reduces the food change rate that causes damage to them. Among the main causes of damage to food are microbiological (i.e. growth of microorganisms), physiological (e.g. ripening, senescence, and respiration), biochemical (e.g. browning reactions, lipid oxidation, and pigment degradation), and physical (such as moisture loss) (Jessen, Nielsen, & Larsen, 2014). Freezing is the process where the formation of ice occurs with the occurrence of temperature reduction process.

## **CHAPTER 3**

### **METHODOLOGY**

The study to produce a ready-to-eat banana dessert by adopting sausage technology was divide into two phases below;

1. Development of Ready-to-eat banana dessert; and
2. Process design for the production of Ready-to-eat banana dessert for a small scale industry

In the first phase the study was divided into four sub elements including the raw material preparation, formulation development, processing of RTE banana dessert and analyses of the produce product properties.

In the second phase, the study proposed several aspects to provide some guidelines for any food entrepreneurs (particularly the small and medium enterprise) wish to setup their bussiness for the production of RTE banana dessert. The aspects discussed including process design and cost estimation of the proposed project.

## **Phase 1: Converting Traditional Banana Dessert Into Ready-to-eat Traditional Banana Dessert Via Sausage Technology**

In this phase, this research was focusing to purpose the most appropriate and suitable method to maximize and optimize the rate of the production of ready-to-eat traditional banana dessert. This method was generated from supervisor's suggestion based on original sausage production method. In the information analysis, five sample final product with different formulations were tasted to study the physical and chemical properties of RTE banana dessert in order to choose the better formulation for this new product.

### **3.1 Raw material preparation**

The banana (*Musa acuminata* (AA Group)) was obtained from local convenience stores at Sri Serdang, Malaysia. For this project, overripe banana (stage 7) was used due to the high sugar. Usually in the market, commercial banana is sold at stage 5 and 6. Thus, the purchased bananas in this study were left at room temperature for 3 days to let them to ripe to stage 7. Many dark spots were formed because of browning process. The peel was separated and only the flesh was used as the main ingredient. Other ingredients involved in the formulation of banana sausage mix were flour, coconut milk, salt and sugar which were also obtained from the local convenience store.

### **3.2 Formulation Development**

The purpose is to find the most suitable flour type for banana sausage mixture for the next formulation step. The ratio of banana to flour is 7:3 for 1kg basis of them. For salt, sugar and coconut milk, the values are constant 0.2%, 10% and 30%

respectively from the 1kg basis weigh of banana plus flour. The samples will be going through all the preparation of sample process and will be tested.

The formulations are presented in Table 1. The sausages were continued by replacing banana flesh at a level of 50%, 60%, 70%, 80% and 90% and flour at a level of 10%, 20%, 30%, 40% and 50% of the weight of banana flesh plus flour.

**Table 1: Sample formulation of Ready-to-eat Traditional Banana Dessert**

Ingredient	Amount (%)				
Banana	50	60	70	80	90
Flour	50	40	30	20	10
Salt	0.2	0.2	0.2	0.2	0.2
Sugar	10	10	10	10	10
Coconut milk	15	15	15	15	15

### **3.3 Sample Preparation**

In this study, five samples with different percentage of banana content to banana-flour mixture were prepared in order to determine their physical and chemical properties. To prepare this sample, almost same process to produce sausage were used in order to convert the traditional banana dessert into a ready-to-eat traditional banana dessert via sausage technology. The figure below shows the process flow which was used in this study to produce the RTE banana desserts via the sausage technology.

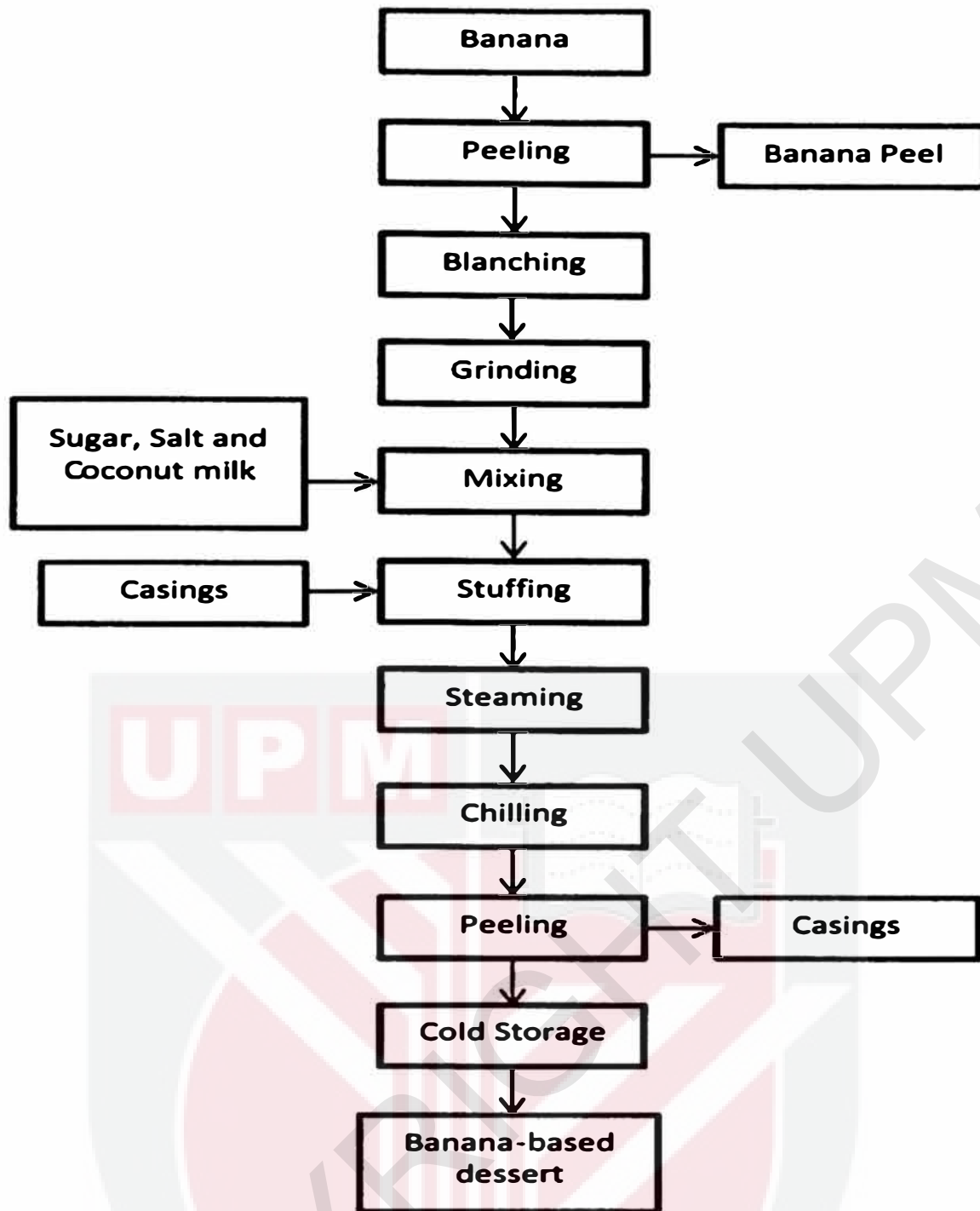


Figure 12 : Process flow production of RTE Banana Dessert

### 3.3.1 Blanching

The bananas were cut into more small shape. The seeds were removed if there are seeds. The process was done by using a plastic cutting board and knife while wearing plastic glove. Then, the water was heated until it reached 60 °C and poured them into the metal container for blanching process. The bananas were soaked into the hot water for 10 min to maintain the freshness of banana and slowing down the browning process to increase the shelf life of the final product. (Jeet, Immanuel, &

Prakash, 2015). After 10 minutes, by using a sieve, the banana and the hot water were separated to prevent more water will be absorbed into the banana.

### **3.3.2 Grinding**

The banana were filled into an electric meat grinder (MK-MG 1500, Panasonic, Japan) and ground to produce more firm in texture. The finer grind setting is used to make sure the banana flesh become into slurry condition, banana puree. It is easy to mix with other ingredient such as sugar, flour, salt and water when the texture is more firm and the mixture will be become more homogenize (Mohan, 2014). The analysis of any physical or chemical characteristic of the product becomes more precisely if all the ingredients in homogenous condition.

### **3.3.3 Mixing**

Mixing is the most important process because all the texture and flavor are depending on this process. At first, salt was added into the banana and mixed well by using a mixer (KENWOOD, Britain). A scoop of flour was added with a few amount of coconut milk, then the mixture was mixed until all the ingredient well mixed and repeat the process until all the flour and coconut milk were added. All banana sausage ingredients were mixed together to alter from heterogeneous physical into more homogeneous mixture. The temperature was maintained at room temperature during the mixing process, 27 °C to 29 °C for 30 minutes.

### **3.3.4 Stuffing**

The casing used is an artificial and inedible that made from cellulose base. The diameter of the casing is 2.5 cm. The length used is 18 cm per sausage where 2

cm from both ends of the tube were used as the area to bind both ends of the casings by using string. Casings that was prepared was slipped onto the stuffing horn that attached to a sausage stuffer (IYouNice, China) . Stuffing horn is an equipment the can hold the sausage casing and channeling the banana sausage mixture into the casing. The casings were inserted carefully to avoid the casing from tears. Next, some banana sausage mixture was filled into the sausage stuffer and the sausage mixture starts to fill the sausages casing. The stuffing process was stopped about 2 cm from the end of the casing. These 2 cm from the casing is used to tie both ends of the sausage casing with cotton strings. The sausage casing was tied as closely to the stuffing horn to avoid developing of air pockets in the sausages.

### **3.3.5 Steaming**

The method to cook the sausages for this product is by using steaming process. Steaming is a way to cook by using steam at high temperature. The water was boiled constantly to change the water into hot vapor. The sausages were steamed an electric steamer (Panasonic, Japan) at 100°C for 30 minutes to preserve the product by eliminating remaining microorganism and to change from the slurry sausage mixture into solid texture to maintain the sausage shape.

### **3.3.6 Chilling**

The cooked products were immersed and left to rest in the cooling water bath at below 4°C for 5 minutes before the artificial casings were removed from the sausages. The purpose water to prevent shrinkage, to facilitate separation from the casings and to ensure the shape of the sausage can be maintain even the casings has been removed.

### **3.3.7 Freezing**

The finish products were packed into the food zipper bag and seal to prevent food contamination. The pack products were placed in the freezer at below 0°C to preserve them and make the shelf life more longer by decreasing the water activity in the product.

### **3.4 Analyses of the Produce RTE Banana Dessert**

In this research, a few method were used to determine the physical and chemical properties of ready-to-eat traditional banana dessert. The analyses that prepared in this study are compression analysis, colour analysis, cooking added, sensory evaluation and proximate analysis.

#### **3.4.1 Compression Analysis**

The chilled gels were maintained at room temperature for 2 hours prior to analysis and cut into cylinders (25 mm diameter and 20 mm length). The compression test was performed using Instron Universal Testing Machine (Instron, USA). Samples were placed on a heavy-duty platform, and force was applied onto the sample using a compression probe to determine the maximum load (N) that the samples can bare until breakpoint.

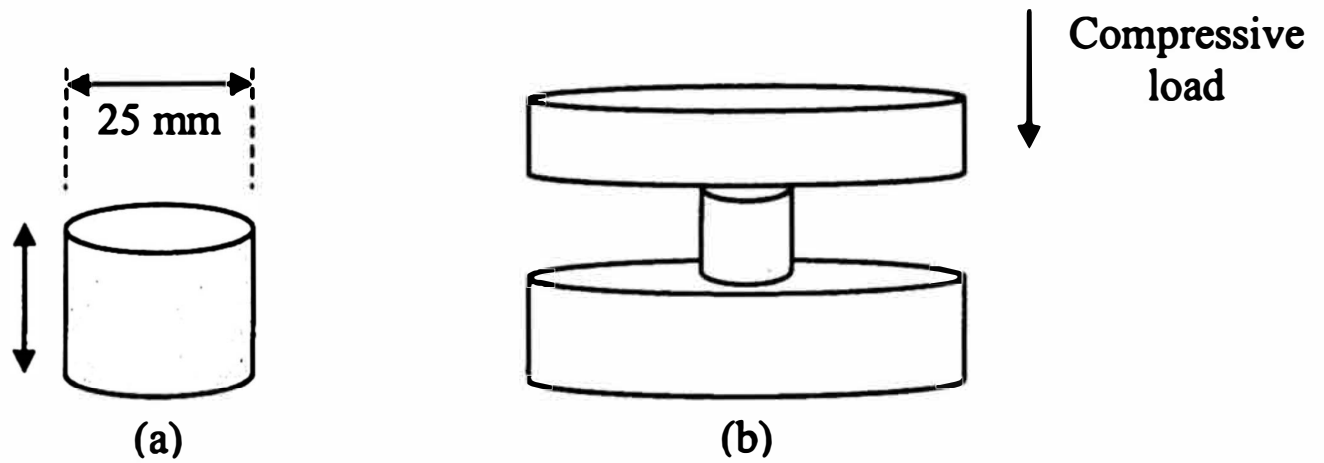


Figure 13: (a) Cylindrical shape gel for maximum load measurement (b) Load direction during compression test by using Instron Universal Testing Machine (Instron, USA).

### 3.4.2 Colour

This analysis was obtained by using a spectrophotometer (Miniscan TZ, Hunterlab, USA). CIE  $L^*a^*b$  method was used to measure the lightness ( $L^*$ ), redness ( $a^*$ ) and yellowness ( $b^*$ ). The spectrophotometer was calibrated by scanning white and black color surfaces. The average result was obtained by scanning three slices of each sausage in the different parts.

### 3.4.3 Moisture Content

Moisture of the samples were measured by using moisture analyzer (MX-50, Japan).. The moisture content of the sample can be calculated by measuring the initial weight of sample and substrate with the final weight of the sample after being heated at  $105^\circ\text{C}$  until the weight becomes constant. Sample weight used for this analysis was in the range 2.0 g to 2.5g.

#### **3.4.4 Re-steaming Added**

The weight of frozen sample is measured first by using electronic digital weight scale and the weight was recorded. Then, the sample was re-steamed in an electric steamer (Panasonic, Japan) about 30 minutes at 100°C. The re-steamed sample was again weight using the digital weighing scale. Comparison was between re-steamed and frozen samples to find the weight difference.

#### **3.4.5 Sensory Evaluation**

The choice of the testers was performed by applying questionnaires to analyze 20 untrained testers that fit the accompanying criteria: (1) Individuals more than 18 years old; (2) Like banana; (3) Have no sustenance limitations or nourishment sensitivities; and (4) Non-smoking. The frozen banana sausage samples of different banana-starch ratios were re-steamed for 30 minutes until cooked. The re-steamed samples were cut into 2.0 cm thick and 2.5 cm diameter dimensions. Five samples of different banana-strach ratios were labelled randomly to 5 numbers and displayed to every tester on a plastic styrofoam plate.. The sensory assessment was performed in a clear room with perfect lighting. The testers were told to purify their palates with mineral water gave in a provided cup before the tests begin. They were additionally taught to observe carefully to the characters of the samples. Sensory attributes to be assesed were visual appearance, color, surface texture and flavor. The testers scored each attributes by a 9-point hedonic scale (1 = disliked extremely and 9 = liked extremely). Asessment sheet provided to them.

### **3.4.6 Proximate Analysis**

The proximate analysis involved for the selected sample were proteins, crude fats, carbohydrates and ash. The elaboration of each analyses was discussed in the next sub-sections

#### **3.4.6.1 Ash**

Ash is an inorganic residue from burning process of organic material at 400-600°C in muffle furnace for 8 hours. 5g of sample was measured and placed into a pre-heated crucible. Then, the crucible was placed in the drying oven for 24 hours at 100°C. After that, the heated crucible was relocated to muffle furnace for 8 hours at 550°C. This process was continued until whitish-grey was acquired. If the whitish-grey was not acquired, poured some distilled water in order to moisten the ash and then dried them on the hot plate. After that process, the crucible was put again into the furnace at 550°C to obtain constant in weight. After finished, the crucible was placed in to a dessicator before the weight was measured after it cooled.

#### **3.4.6.2 Protein**

Protein content in this RTE Traditional Banana Dessert was determined by using Kjeldahl method (AOAC, 1995). 2.0g of sample was measured before it was mixed with 15g of Sodium Sulfate ( $\text{Na}_2\text{SO}_4$ ), 1.0g of Copper (II) Sulfate ( $\text{CuSO}_4$ ), and two salinizes boiling granules, in the Kjeldahl flask. Then, 25 mL of concentrated Sulfuric Acid was mixed by slowly swirl them. By using a heating coil under fume hood, the solution was heated and boiled until it become nearly colourless or light green in colour. Continuously, boiled the solution for another ten minutes. The, the solution should be cooled to 40°C before 200mL of distilled water was added. Additional of boiling granule should be added to avoid any bumping to occur. 0.1 N

Hydrochloric acid (HCl) was measured for 100 mL and was pipette into 500mL of Erlemenyer flask. The 1mL of Conway's indicator was added into the sampe flask. The flask was placed in the condenser to ensure the tip of the condenser was submerged into the acid solution.

100 mL of 50% Sodium Hydroxide (NaOH) was tilted with the digestion sample in the previous Kjeldahl flask. It was added gently down at the side of the flask, so that it was build a layer below the digestion mixture. Next, the flask was linked with the distillation appratus distilling bulb at once. The flask was left to be heated in order to let the ammonia passed over the standard acid. After 150 mL of acid was collected, the flask was disconnected carefully. When distillation was carried out , prolonged boiling and rapid distillation was cleaned. Then, excess HCL was titrated in the distillate with a standard NaOH solution. For blank, same method was applied. 6.25 is the factor used to convert thenitrogen into crude protein. Nitrogen% was calculated base on this formula below:

$$\% \text{ Nitrogen} = \frac{Vs - Vb * Macid * 1.4}{W} \dots\dots\dots(1)$$

Where,

Vs = volume of acid requird to titrate sample (mL);

Vb = Volume of acid required to titrate the blank (mL);

Macid = Molarity of acid;

W = Weight of sample (g).

The crude protein in the sample can be estimated by using %Nitrogen:

%crude protein = % N \* F, where F(conversion factor is 6.25).

### 3.4.6.3 Fat

According to AOAC (1995), fat and oils were determined by using the Soxhlet TM 2050 extractor machine. By using an oven, the clean boiling thimbles were dried at 105°C for about an hour and let them cooled in the desiccator. The weight after the drying process was measured before 2.0g of sample was placed into them. The thimbles then placed to the thimble stand holder. Then, weight the dried boiling flask before 90mL of petroleum ether at 40-60°C was added into them. Next procedure were connect the extraction thimbles tightly with cotton wool. Before the system can be started, make sure the extraction thimbles were inserted correctly.

The system has been set to be work automatically. First is boiled the sample for 15 minutes, then extracted at 155°C for 45 minutes, 10 minutes recovered and finally, cooled down at 30°C for 1 minute. Next step were to remove the extraction thimbles and then the petroleum ether was collected from the top of container and transfer them into another container for re-use. After all the petroleum ether was removed, the flask will go through the drying process in an oven at 105°C for 1 hour. Finally, the flask was cooled in the desiccator before it weighed again. Fat percentage of RTE Traditional Banana Dessert was calculated by using the equation below:

$$\text{Fat content (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} * 100\% \dots\dots\dots(2)$$

#### 3.4.6.4 Carbohydrate

According to AOAC (1995), the percentage of RTE Traditional Banana Dessert can be estimated by subtracting 100% (total percentage of weight from the sample) and total percentage of weight (moisture content, ash, protein and fat)

*Carbohydrate (%) =*

*100% – total percentage of weight(moisture content,protein,ash and fat)*

*.....(3)*



## **Phase 2: Process Design For The Production Of Ready-to-eat Traditional Banana Sausage Dessert For A Small Scale Industry**

### **3.5 Proposing Project Design**

Based on the findings in Phase 1, a project design was proposed by including its scale, stages and development of the product. The project to develop a processing plant to producing a new product by converting of traditional banana dessert, “*bingka pisang*” into a ready-to-eat food via sausage technology. For this study, a production for 62.5 kg of banana dessert per hour was proposed particularly aiming for the small and medium scale food industry.

In this project design, the product, material flow and the material balance were determined by calculations and estimations. Operation process chart and the flow process chart of the ready-to-eat banana traditional dessert were referred to do the calculations and estimations. These proposed chart used to present the process in a more specific way.

### **3.6 Cost Estimation**

For the proposed project, two main elements of costing were estimated, which are the capital cost and operating cost of the processing plant. These two type of costing are really important in order to build a good processing plant and to ensure the smoothness of the plant daily operation. An acceptable project design must capable to show that the process that is capable of operating under condition that will yield a profit.

### 3.6.1 Capital Cost

Capital costs are consist of factory building cost, Inside Battery Limits(ISBL), Outside Battery Limits(OSBL), working capital, contingency and home office cost. All of these costs are fixed and one-time purchase expenses incurred on the purchase. The ISBL costs were calculated by determining the total of major equipment involved in this processing plant times by 3 of lang factor for modern food processing plant that includes modern instrumentation and process control and sophisticated environmental protection and cost for minor equipment.

Outside battery limits (OSBL) is important component in palnt cost. OSBL costs were calculated as a percentage of ISBL cost. Rule of thumb were applied in order to calculate the OSBL by using equation below:

$$Cf(OSBL) = 40\% \text{ of } Cf (ISBL) \dots\dots\dots(4)$$

Working capital cost is a cost that refer to maintaining daily operation at an organization. Working capital is the money need to get the plant running. For example, buying feedstocks, pay bills, etc., until product is sold & revenue begins. Simple rules estimate is between 5-30% of CF (ISBL):

$$CW = 15\% \text{ of } CF (ISBL) \dots\dots\dots(5)$$

Contingency charges allow for the unexpected variations during th construction process. This budget was calculated by assume 5%-10% of rate from the total budget to determine the contingency:

$$Contingency = 10\% \text{ of } [CF(ISBL) + CF(OSBL)] \dots\dots\dots(6)$$

### **3.6.2 Operating Cost**

Operating cost is a basic component of operating income that usually showed the plant income declaration. This cost is used by an organization as the cost of resource in order to maintain the organization continuation. In this study, operating costs are consist of fixed operating cost and variable operating cost.

Fixed operating cost is a cost that did not effected by the rise and decline in sales and product output . It consist of maintenance fee, insurance and taxes, loyalty, labour cost and environmental changes. Maintainance fee can be calculated as 4% of total ISBL costs. For insurance and environmental changes, 1% was assumed as the value times with ISBL cost at the capital costs of the plant. Loyalty were calculated by assumed 1% times by the total capital cost of the plant.

The most important component in fixed operational cost is labour cost of the plant. In this study, the daily working time has been set fo 8 hours without shift. Annually cost of labour was estimated by set 24 days of working days per month. First, the main worker position must be determined to fulfill the requirement to operate a new plant such as plant manager, supervisor, operator and technician. Then, number of worker were decide to estimated all labour costing by calculate the salary per month of one worker times with the number of the worker. 10% of E.P.F or Socso were also included in this labour costing.

Raw material cost is cost of gathering of all material expenses and it is frequently the biggest part of cost calculation. To find annual raw material cost, flow rate of each raw materials, unit cost of each raw material, and annual operating time must be determined.

For utilities cost of the processing plant, there were three main types of utilities that have been used, electricity, water and steam. But for and small and medium enterprise, almost all of the equipment are using electric as main source to operate. The annual utilities cost can calculate and estimate by determining power consumption per hour that required for the plant from each equipment used. Then, the cost of electric consumption for each month can be calculated by using Low Voltage Industrial Tarif (Tarif D) 033 for Small and Medium Enterprise. It was including the 6% of GST.



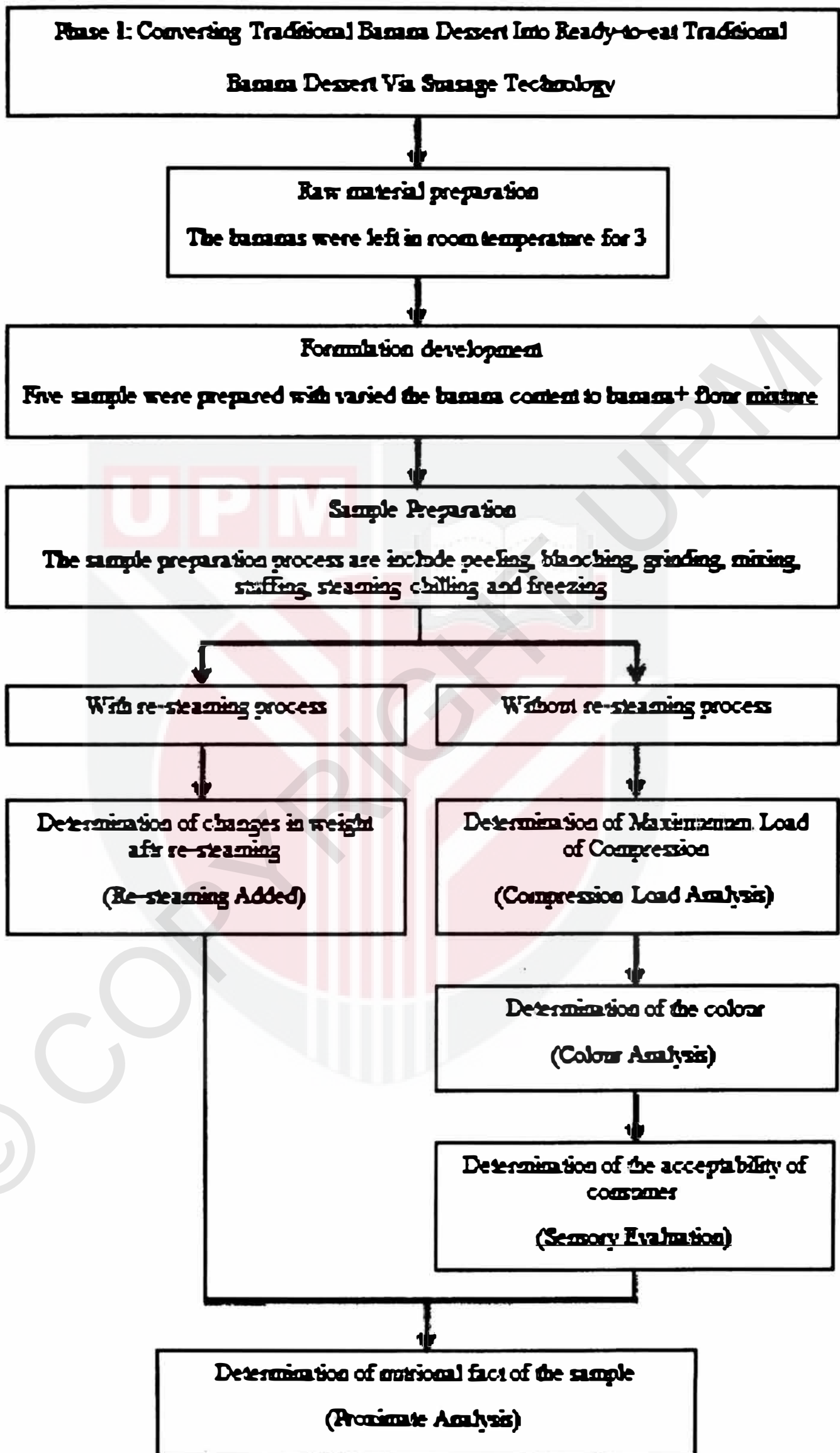


Figure 14 :Phase 1: Converting traditional banana dessert into ready-to-eat banana dessert via suasage technology process flow

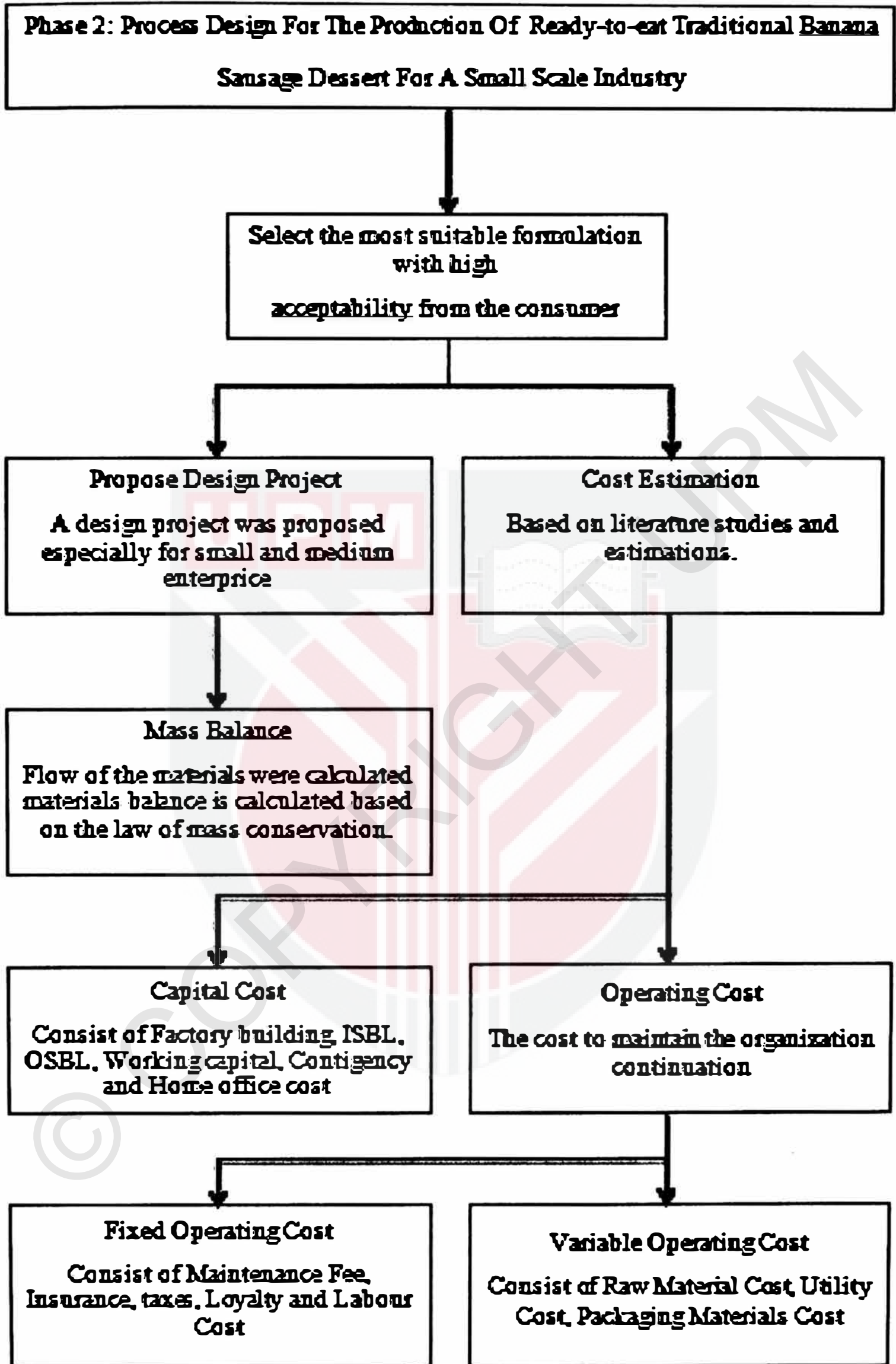


Figure 15 :Phase 2: Process design for the production of ready-to-eat banana sausage dessert for a small scale industry process flow

## **CHAPTER 4**

### **RESULT AND DISCUSSION**

#### **4.1 Phase 1: Converting Traditional Banana Dessert Into Ready-to-eat Banana Dessert Via Sausage Technology**

##### **4.1.1 Compression Load Analysis**

RTE banana dessert of different banana-starch ratios was undergone the compression load analysis. The compressive load test evaluates the behaviour of the samples under crushing loads and determines the breakpoint of each sample. Based on figure ( ), sample with 50% banana content has the highest compression load of 33.35 N, followed by sample with 60% banana content (18.98 N), sample with 70% banana content (12.54 N) and sample with 80% banana content (11.85 N). There are no breakpoint for sample with 90% of banana content due to the form of the sample that was too soft and has a mushy texture. The result shows the deterioration of maximum compressive load (N) as the percentage of banana content decrease. This might be due to the moisture content of each sample. The greater the moisture

content in the sample, the lower the measurement of maximum compressive load (N) and the mechanical strength of samples. According to Gil, 1997, the mixture of flour, water and air, 50% water content is not suitable for mixture formation and effect the mechanical strength of the sample.

This finding can also be explained by the amount of gluten formation in all samples. Formation of gluten needs hydration. Less water cause less gluten formation that resulting the proteins to dilute and restricts the interaction. Lesser banana content in the sample means higher starch content that can undergo the gelatinization and retrogradation process during sample preparation and increase the gumminess to the sample (Wilderjans, Pareyt, Goesart, Brijs, & Delcour, 2008). Retrogradation process will result the sample to have a more compact structure and requires more load to break it.

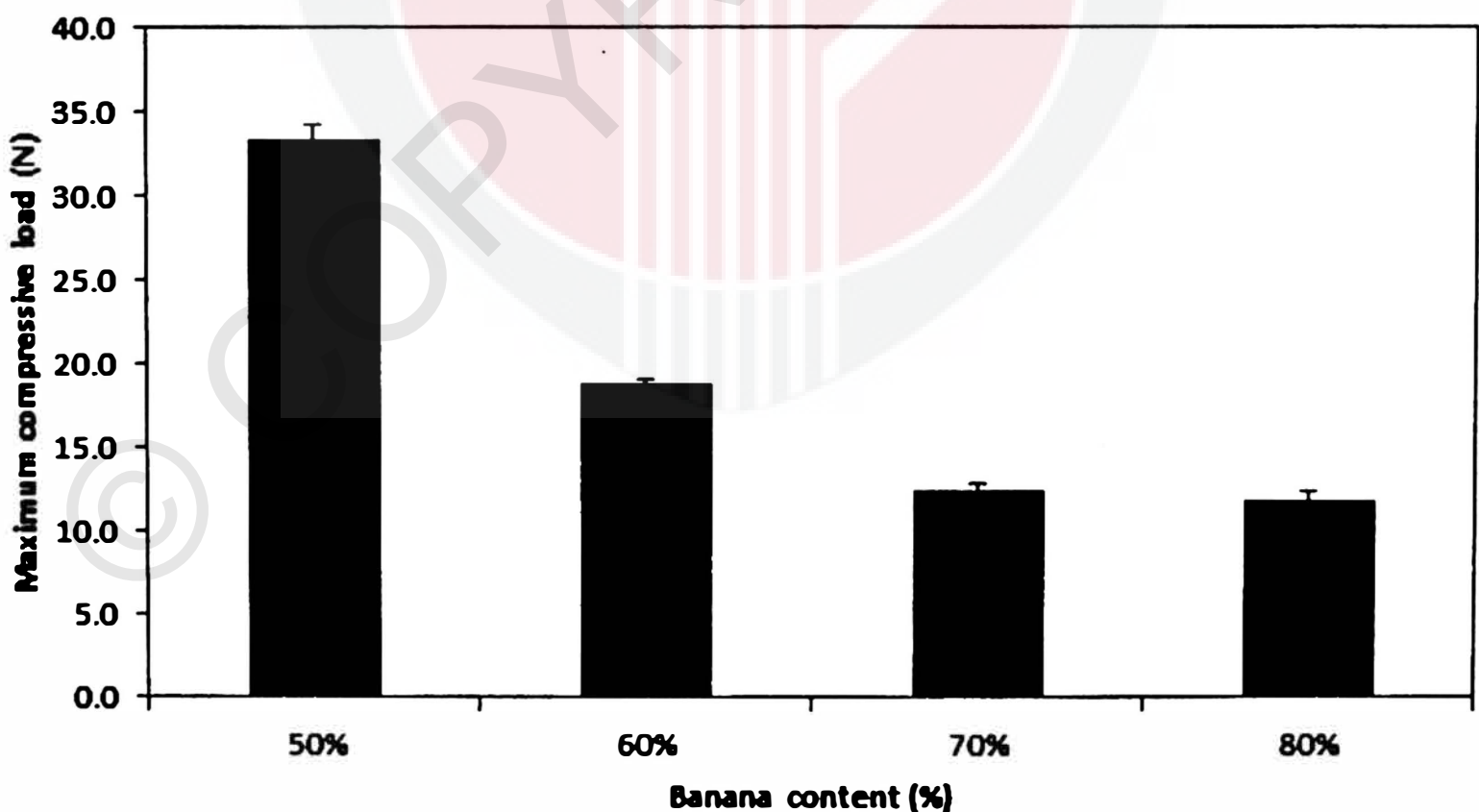


Figure 16: Maximum compression load of both samples

#### **4.1.2 Moisture Content Analysis**

Moisture content is one of the most important element can affects sensory attributes of the samples (Yap, Fernando, Brennan, Jayasena, & Coorey, 2017). The changes in moisture content can cause alteration in mechanical strength properties (Ramdhonee & Jeetah, 2017). Figure 17 shows that the moisture content was slightly increased followed by the increment of the banana content percentage. Sample (50% banana) has 41.55 % percent of moisture content followed by sample (60% banana) has 43.72 %, sample (70% banana) has 43.75 %, sample (80% banana) has 46.26 % and sample (90% banana) has 55.37 %. All of these differences are due to the different banana content of each sample.

During mixing process, water is essential to form the gluten and give the dough consistency and function as solvent to solute the substances such as salt, sugar and coconut milk powder. During the manufacture of these samples, the formulation use 15 % of coconut milk of the total weight of the banana-flour mixture (1kg) as mixing solvent plus the moisture content that are already existed in the fruit. According to Gil, 1997, optimum water content ranges in mixture of three essential ingredient, flour, air and water are between 40 and 46%. . Dough or mixture do not form perfectly at water contents below 35% and are excessively fluid and difficult to handle at water contents above 50%. But, for sample (90% banana), the water content is above 50% that cause the difficulty during process to handle the mixture especially during stuffing process (Gil et al., 1997).

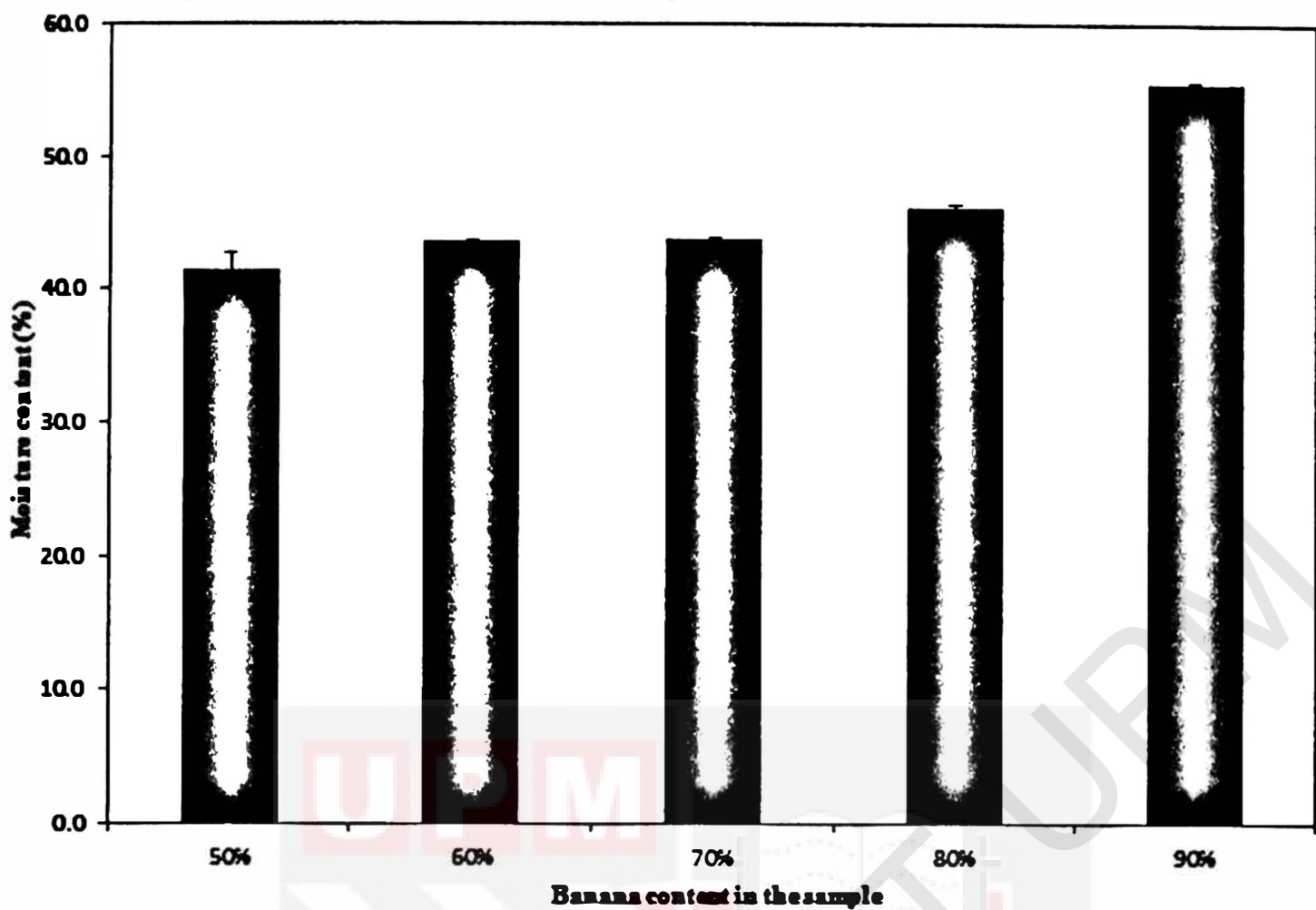


Figure 17: Moisture content of the samples after 2 hours defrost process

#### 4.1.3 Colour Parameter

Based on the table 2, the  $L^*$ ,  $a^*$  and  $b^*$  values (lightness, redness, and yellowness, respectively) for the sample 90% and 80% banana content were have slightly the same value and higher than the other sample. This might be due to the high presence of carotenoid and sugar in the sample which have affected its the color properties (Monteiro et al., 2017). In term of lightness ( $L^*$  values) showed the increment from sample (50% banana) to sample (80% banana) (from 38.4 to 42.8) then decrease at sample (90% banana) (41.5) due to texture inside of the sample that is irregular and too soft that effect the color of the sample become more darker. Increment in yellow and red colour in term of ( $a^*$  values) and ( $b^*$  values ) of the five sample as the increase of percentage of banana content might be also due to the increment value of carotenoid and sugar in the samples. Figure () shows the colour of the cross-section of the samples

Table 2: Effect of banana percentage on lightness (L\*), redness (a\*) and yellowness (b\*) of the samples

Values	Banana content (%)				
	50%	60%	70%	80 %	90%
L*	38.4±0.2	38.6±0.1	41.6±0.3	42.8±0.4	41.5±1.0
a*	5.5±0.1	7.2±0.2	7.5±0.1	11.4±0.2	9.6±0.3
b*	20.8±0.5	27.6±0.1	29.5±0.1	30.9±0.4	31.4±1.0

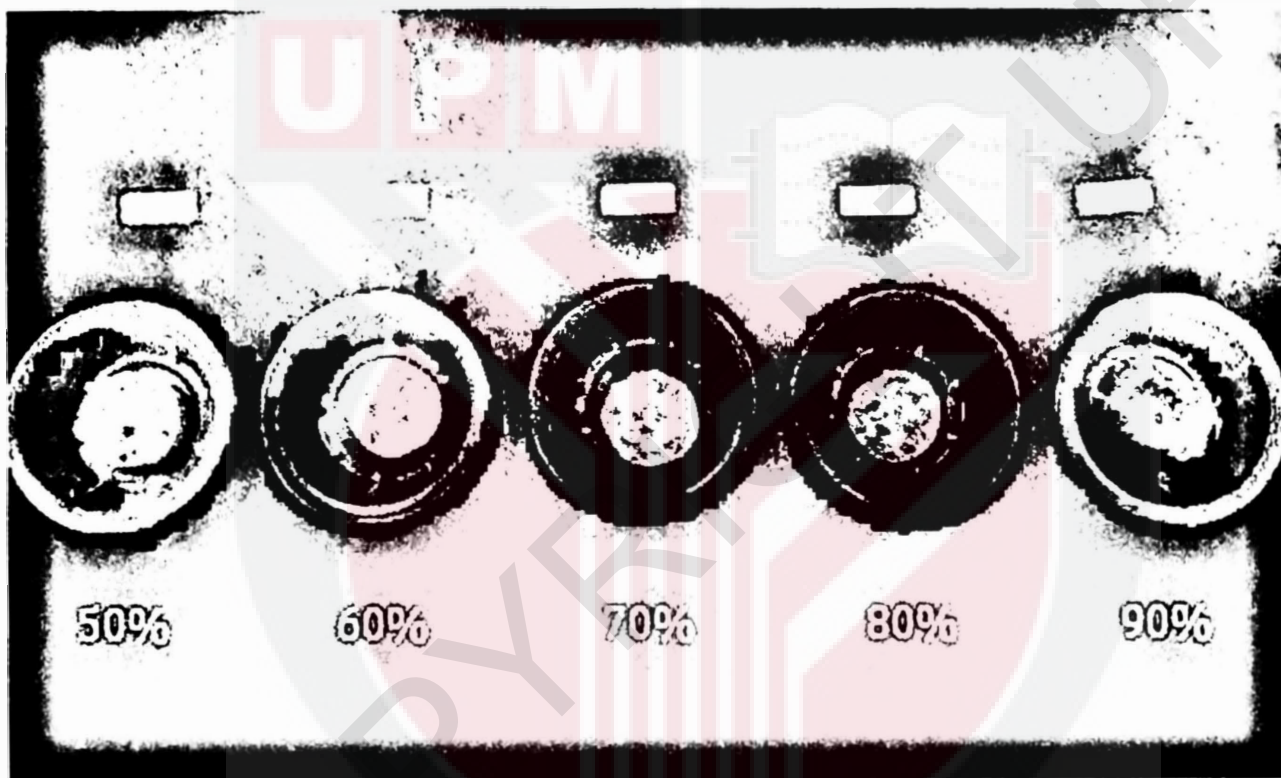


Figure 18: Cut section of banana dessert samples

#### 4.1.4 Re-steaming Added

This analysis is to determine the percentage of water absorb during re-steaming of each sample due to the amount of flour in all samples. Table 3 exhibits that the sample with high volume of flour, sample (50% banana) has been absorb the highest amount of water (9.72%) during re-steaming process compared to other samples. Water bound is distributed in flour as follows: Starch has 46% of bound water, Protein has 31%, 23% to pentosans and additional 15% for formation of

gluten network (Gil et al., 1997). The higher the flour amount used in the sample, the higher the water absorbance during re-steaming process of the sample. Starch gelatinization also effected the water absorbance in samples. Gelatinization is the process that allowing the hydrogen bonding sites (the hydroxyl hydrogen and oxygen) to engage more water in starch that cause to a swelling phenomenon during heating process (Lund, 1989). So, high quantity of starch, lead to the gelatinization that can absorb more water during the formation (Ratnayake & Jackson, 2008)

Table 3: Increasing percentage of samples weight after re-steaming process.

Values	Banana content (%)				
	50%	60%	70%	80 %	90%
Percentage increase after re-steaming(%)	9.72±0.2	7.70±0.1	7.00±0.1	3.63±0.0	2.40±0.2



Figure 19: Re-steaming process on frozen RTE banana dessert

#### **4.1.5 Sensory Evaluation**

The scores of each attribute during the sensory evaluation are shown in Fig. 4. Based on the results, panellists have scored sample with 80% banana with a higher score in most of the attributes excluding the appearance and texture. For appearance, panelist have scored sample (70% banana) with higher score (5.75) because the sample has average greenish and yellowish in color that cause the sample become slightly more attractive than the other samples.

For aroma, sample (80% banana) has the highest score (6.4) followed by sample (70% banana) that has slightly same amount of score (6.375). The 80% and 70% banana samples are contain high amount of banana that resulted more banana aroma to them. Sample (90% banana) also has high amount of banana but because of its mushy form during the servings, the panelists perception about this sample dropped and has affected the score for this sample. The ratings for flavor show the sample (80% banana) has been voted with the highest score with 7.2 out of 9 hedonic scale. This result show that sample with high banana content has more banana flavor than other sample except for sample (90% banana). Even it has the highest amount of banana content, the ratings for flavor still the lowest because good taste is often associated with good texture and it has the lowest ratings for texture (Parsons, 2017)

The highest ratings for texture descriptive among different type of samples is sample (70% banana). It shows that 70% of banana content produce the most desirable texture. Less banana content produce tough and more gummy texture and high banana content produce soft and mushy texture. For overall acceptability, sample (80% banana) has gained the highest score (6.8) and the lowest ratings for overall acceptability was sample (90% banana). Generally, better taste and texture

are really important in food industries and measured the level of acceptability for that food product.

Based on all the findings in Phase 1, it is concluded that the 80% banana content sample has the most potential to be commercialized. Thus this formulation (later known as RTE banana dessert) has been chosen for the subsequent proximate analysis and was used for the proposed project design in the Phase 2 of this study.

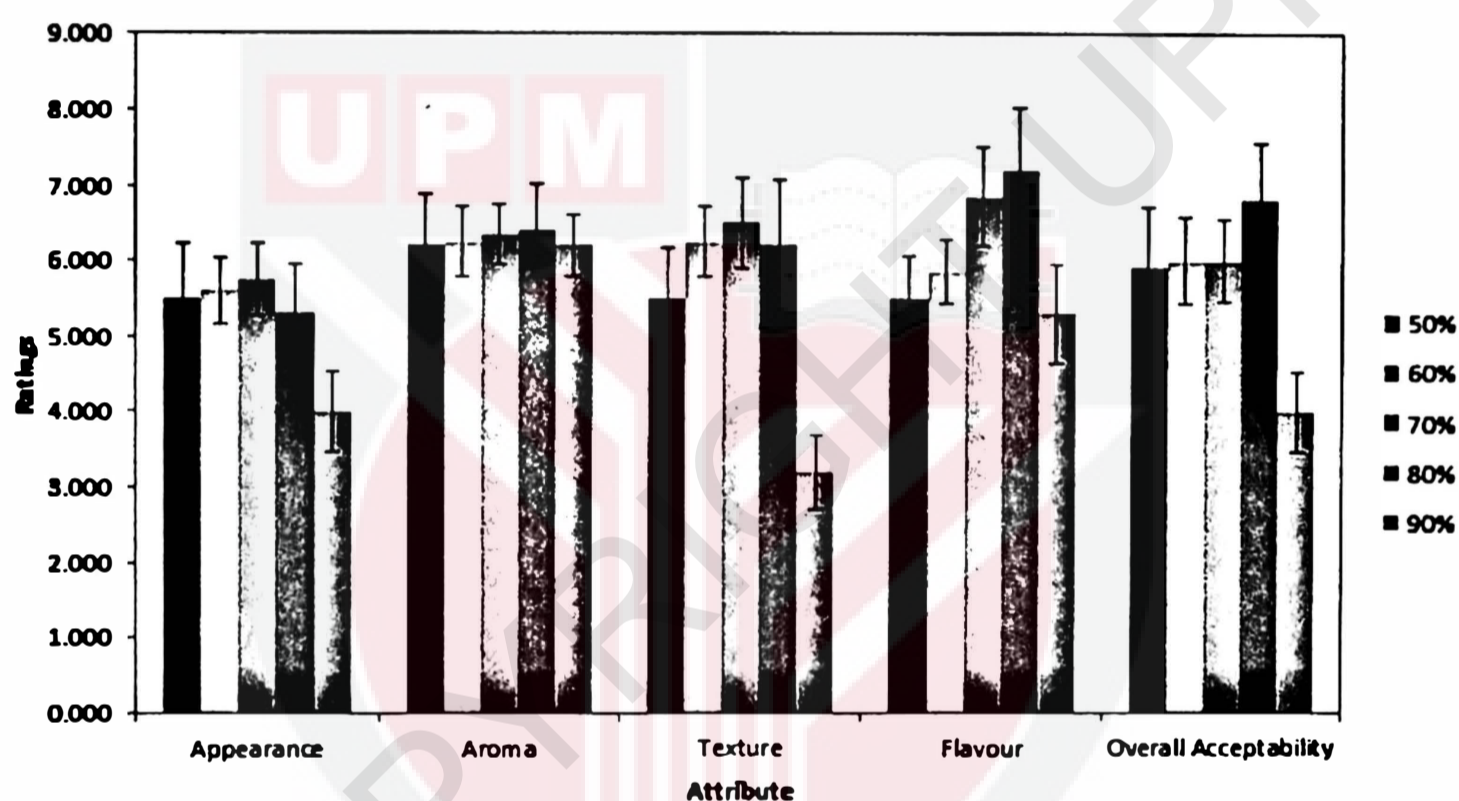


Figure 20: Sensory evaluation on 20 untrained panellist

#### 4.1.6 Proximate Analysis

Proximate analysis was developed in 1860 by Henneberg and stohman in Germany. This analysis is for the quantitative analysis of the different micronutrients in a substances. This technique used in order to estimate the relative amounts of moisture content, ash and fibes, fats, protein and carbohydrate in a substance especially in food materials. In Table (), the result of proximate component of RTE Banana Dessert (of 80% banana content) has been summerised with 3.3% of protein, 0.1% of fat, 37.2% of carbohydrate, 0.4% of ash, and 59.0% of moisture content.

**Table 4: Nutritional fact for 80% banana content of RTE Banana Dessert**

<b>Physiochemical Component (g/100g)</b>	<b>Concentration (%)</b>
Protein	3.3
Fat	0.1
Carbohydrate	37.2
Ash	0.4

The result obtained for ash is 0.4 %. The ash content reflect the mineral content of RTE banana dessert such as calcium and potassium. Generally, ash content for natural food product must have below 5% of ash while in process food the ash content can ranging over 10% (Agbo et al., 2005). Although, RTE banana dessert can be categorised as processed food, there is no any food and color additive was added in the formulation which can effect the mineral content in the sample (International Food Information Council & U.S. Food and Drug Administration, 2010). So, the percentage of ash content of this sample still in acceptable level which is below than five percent.

The crude protein content in RTE banana dessert sample was 3.3%. The natural product such as banana and wheat flour is a plant natural product, it is considered as a moderate source of protein. This result shows that the existence of protein in the sample indicates that this product can contribute in providing a nutritionally valuable and healthy diet to the consumers.

The content of fats of RTE Traditional Banana Dessert was considered low with the percentage of 0.1 % per 100g which is probably due to the coconut milk used in the formulation. Lipid is excellent source of energy and required by the body to function especially in human brain system. But high intake of fat can increase the

percentage of body fat (PBF) that lead to a metabolic disorder or obesity. This may also lead to cardiovascular diseases, diabetes, and joint problems (Zeng, Dong, Sun, Xie, & Cui, 2012).

The analysis shown that the percentage of carbohydrate in 100g per serving of RTE banana dessert sample was 37.2 %. Component in carbohydrate is consist of sugars, complex carbohydrates, and starch. In this sample, the biggest contributor in the carbohydrate especially in total sugar component is the overripped banana that has almost 7.12 % of total sugar in overripped banana. Meanwhile, in overripped banana, starch is the lowest among the other stages of banana ripeness (Yap et al., 2017). So, the main contributor of starch in this product is wheat flour that is almost 68% of starch content. This high percentage of starch is caused by the endosperm part in wheat that gives wheat flour a high starch content (Sestili, Botticella, & Lafiandra, 2014).

## **4.2 Phase 2: Process Design For The Production Of Ready-to-eat Traditional Banana Sausage Dessert For A Small Scale Industry**

### **4.2.1 Material Balance in Production Of Banana Sausage Dessert For A Small Scale Industry**

For each process in production of ready-to-eat food, materials balance is calculated based on the law of mass conservation. The mass balance provided was based on the weight of raw materials per batch. The mass of each components in the mass balance was estimated based on the percentage obtained during the lab-scale production of the sample in Phase 1 of this study.

#### **4.2.1.1 Peeling Process**

In peeling process, the total mass is equal to the mass of skinless banana fruit plus mass of banana peel. Since this study are proposing a process design for the small scale industry, the raw material (fresh banana) used as the startup in the balance was 62.50 kg. This is based on the assumption that the proposed process design will produced 63.193 kg/hr amount of frozen RTE banana dessert per hour. Based on the lab-based production of the sample in Phase 1 of this study, peel represented 37% of the fresh banana fruit. Thus, 39.62 kg/hr of skinless fruit will be obtained after the peeling process.

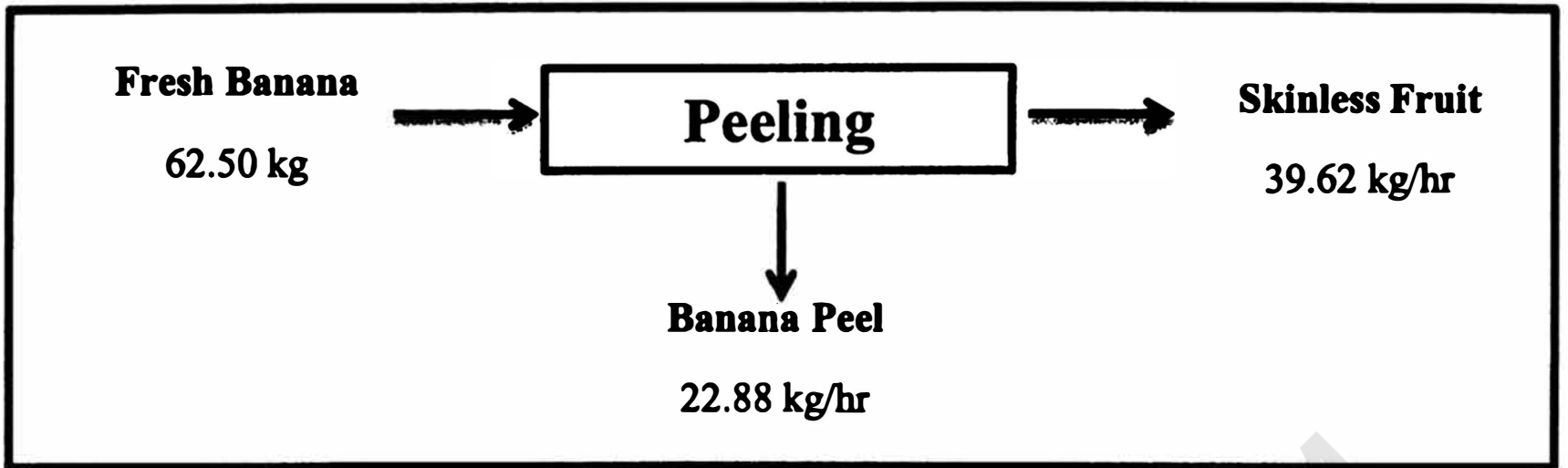


Figure 21: Mass balance for peeling process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{freshfruit}}$	=	$m_{\text{bananapeel}} + m_{\text{skinlessfruit}}$
62.50 kg/hr	=	22.88 kg/hr + $m_{\text{skinlessfruit}}$
$m_{\text{skinlessfruit}}$	=	39.62 kg/hr

### 4.2.1.2 Blanching Process

After blanching process is done, the total mass of fruit that has been blanched is 6.80 kg. The weight was increased from 39.63 kg/hr to become 42.50 kg/hr after the blanching process due to the water absorbed (6.78%) into the fruit when it was immersed in the warm water at 60°C.

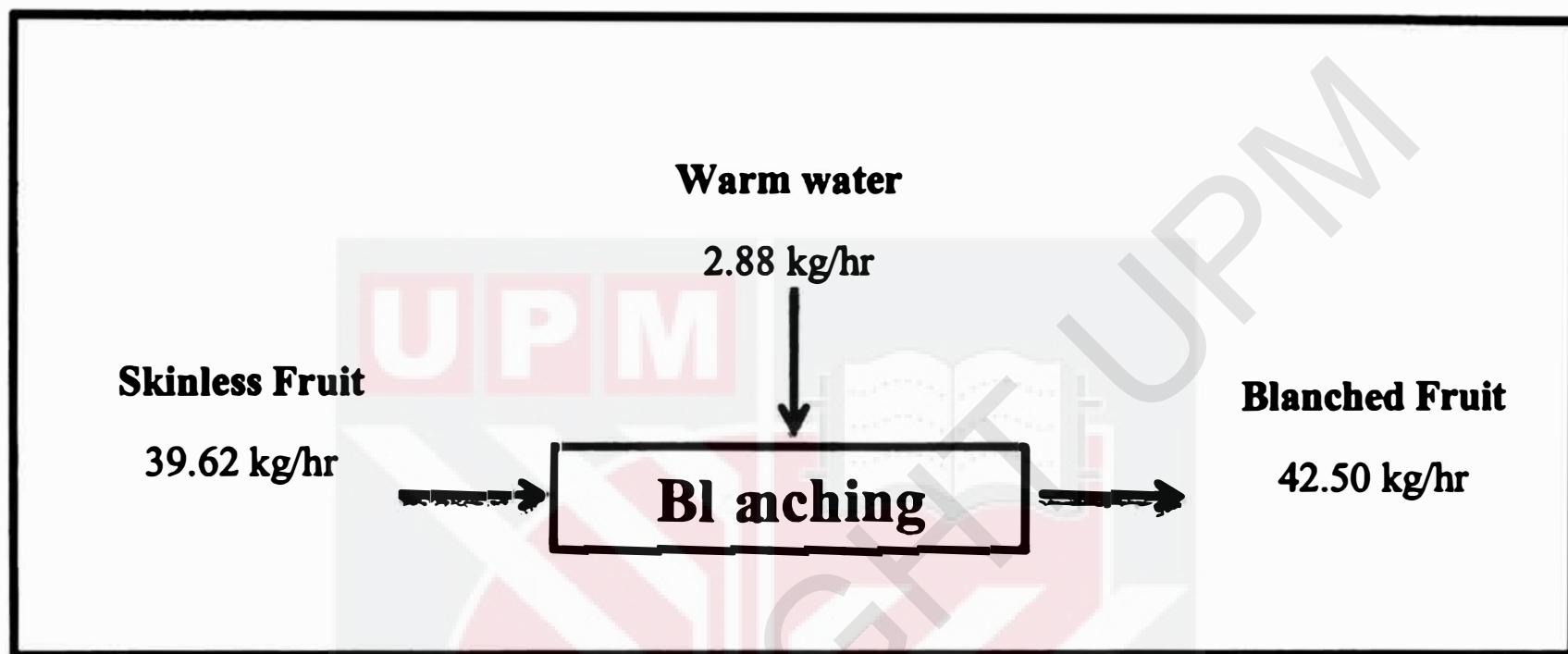


Figure 22: Mass balance for blanching process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{skinlessfruit}}$	=	$m_{\text{blanchedfruit}} - m_{\text{warmwater}}$
39.62 kg/hr	=	$m_{\text{blanchedfruit}} - 2.88 \text{ kg/hr}$
$m_{\text{blanchedfruit}}$	=	42.50 kg/hr

### 4.2.1.3 Grinding Process

In the grinding process, the total mass of banana puree produced is estimated to be 41.87 kg/hr with 1.50% of wastage. The waste was considered due to the remaining banana puree left inside grinder after the process and will be cleaned prior to next batch of production.

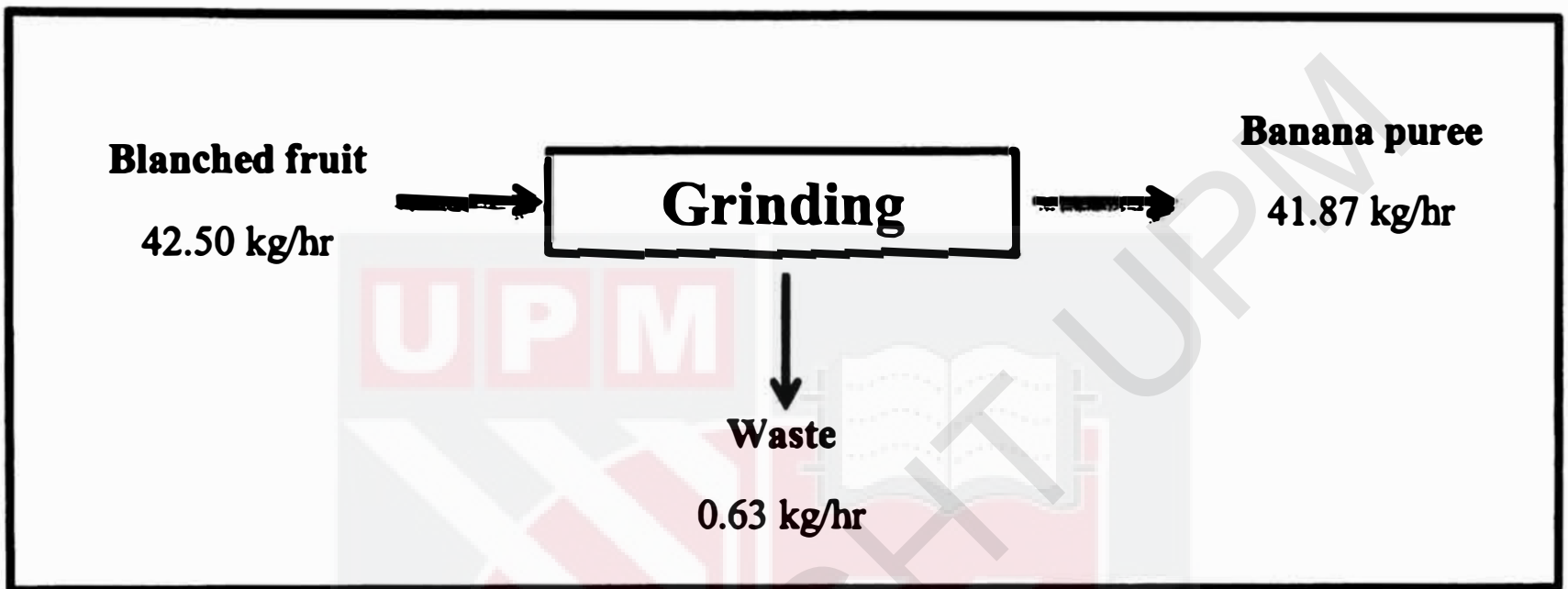


Figure 23: Mass balance for grinding process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{blanchedfruit}}$	=	$m_{\text{bananapuree}} + m_{\text{waste}}$
42.50 kg/hr	=	0.63 kg/hr + $m_{\text{bananapuree}}$
$m_{\text{bananapuree}}$	=	41.87 kg/hr

#### 4.2.1.4 Mixing Process

In mixing process , the total mass of formulated mixture is equal to the mass of others ingredient plus mass of banana puree and is estimated to be 65.53 kg/hr. In this process, flour, coconut milk, sugar and salt is added to the banana puree in 80% of formulation of banana content to flour plus banana mixture. The 80% of formulation of banana content to flour was selected based on the findings in Phase 1.

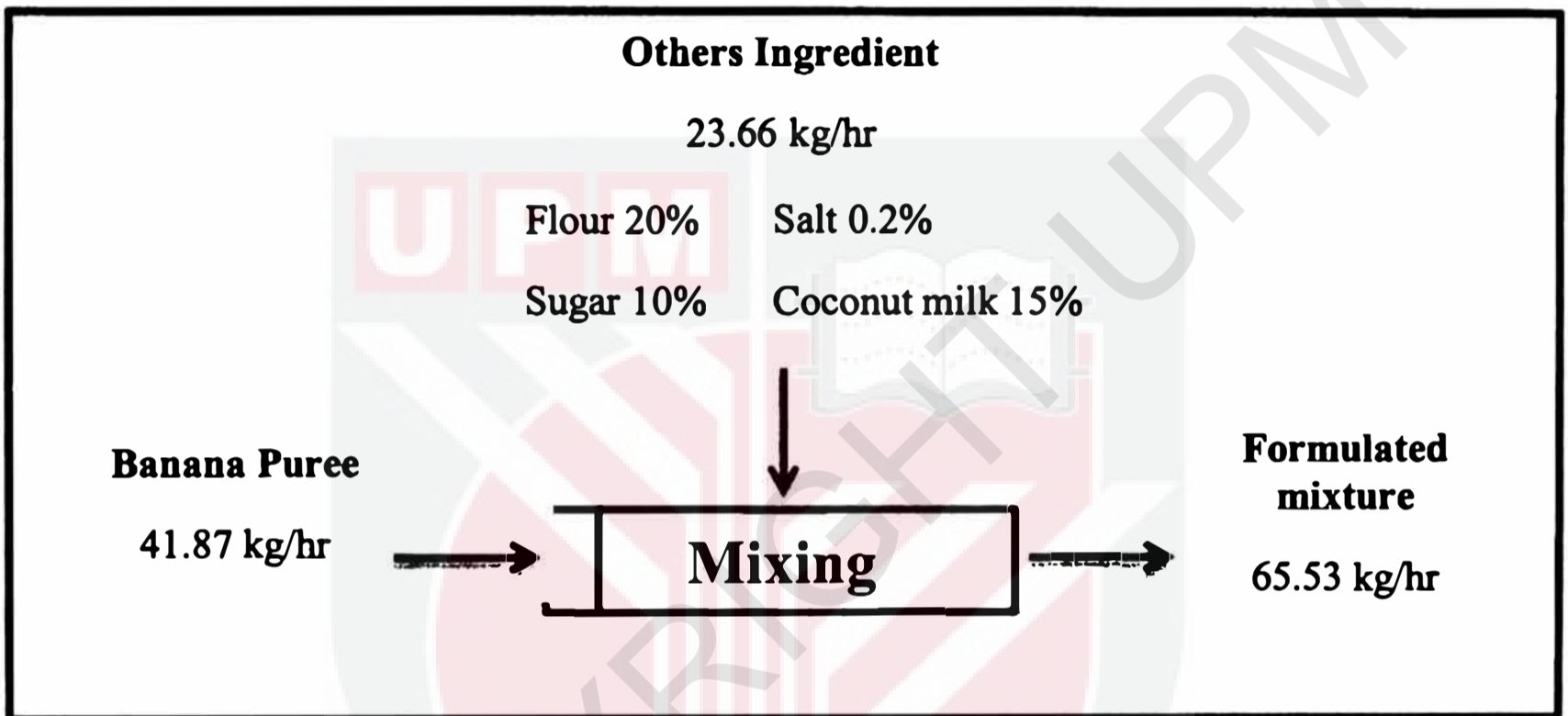


Figure 24: Mass balance for mixing process

#### Ingredient mass balance

Total mass of input = Total mass of output

$m_{\text{flour}} + m_{\text{sugar}} + m_{\text{salt}} + m_{\text{coconutmilk}} = \text{Total mass of output}$

$10.47 \text{ kg/hr} + 0.1(52.34\text{kg/hr}) + 0.002(52.34\text{kg/hr}) + 0.15(52.34\text{kg/hr})$

= 23.66 kg/hr

## Total mass balance

$$\begin{aligned} \text{Total mass of input} &= \text{Total mass of output} \\ m_{\text{bananapuree}} &= m_{\text{Formulatedmixture}} - m_{\text{Motheringredient}} \\ 41.87 \text{ kg/hr} &= m_{\text{formulatedmixture}} - 23.66 \text{ kg/hr} \\ m_{\text{formulatedmixture}} &= 65.53 \text{ kg/hr} \end{aligned}$$



### 4.2.1.5 Stuffing Process

After went through stuffing process, the total mass of raw sausages is estimated to be 66.09 kg/hr. This is due to the addition of casings mass (0.85%) where the formulated mixture has been stuffed into them.

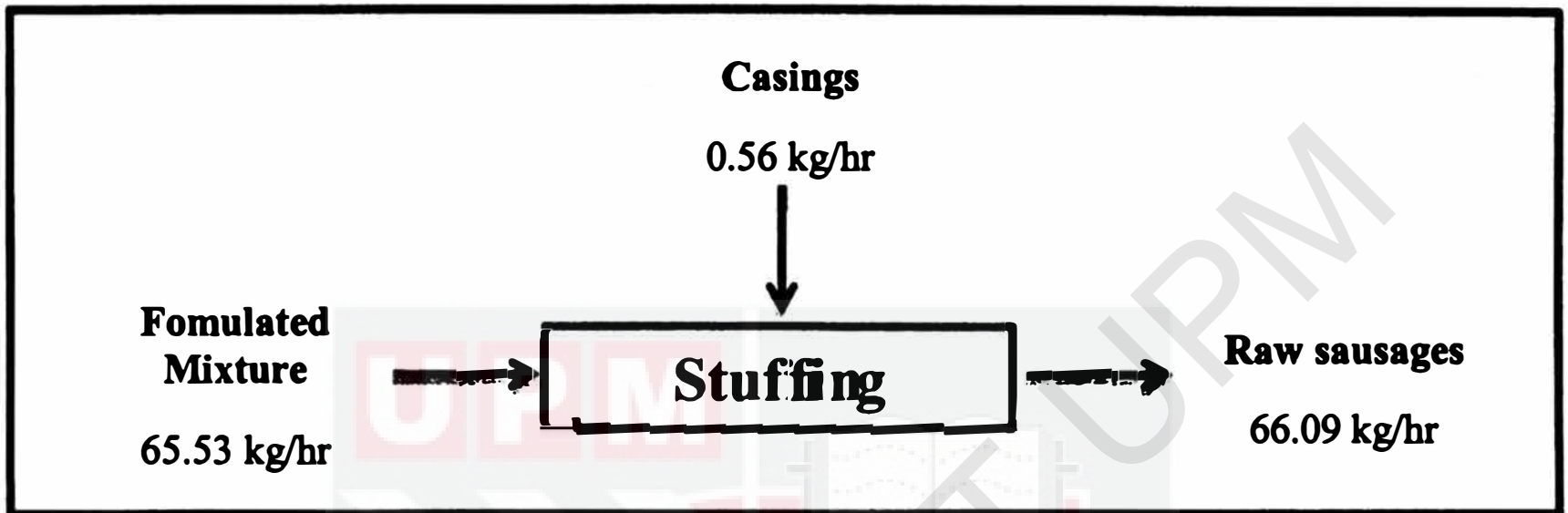


Figure 25: Mass balance for stuffing process

#### Total mass balance

<b>Total mass of input</b>	=	<b>Total mass of output</b>
$m_{\text{fomulatedmixture}}$	=	$m_{\text{rawsausages}} - m_{\text{casings}}$
65.53kg/hr	=	$m_{\text{rawsausages}} - 0.56 \text{ kg/hr}$
$m_{\text{rawsausages}}$	=	66.09 kg/hr

### 4.2.1.6 Steaming Process

When the steaming process is completed, the mass of the cooked sausages is measured to be 67.84 kg/hr. It is estimated that 2.58% of steam was absorbed into the sausage during this process that result in the increment of mass of the cooked product. This shows that about 1.75 kg/hr of steam was absorb into them

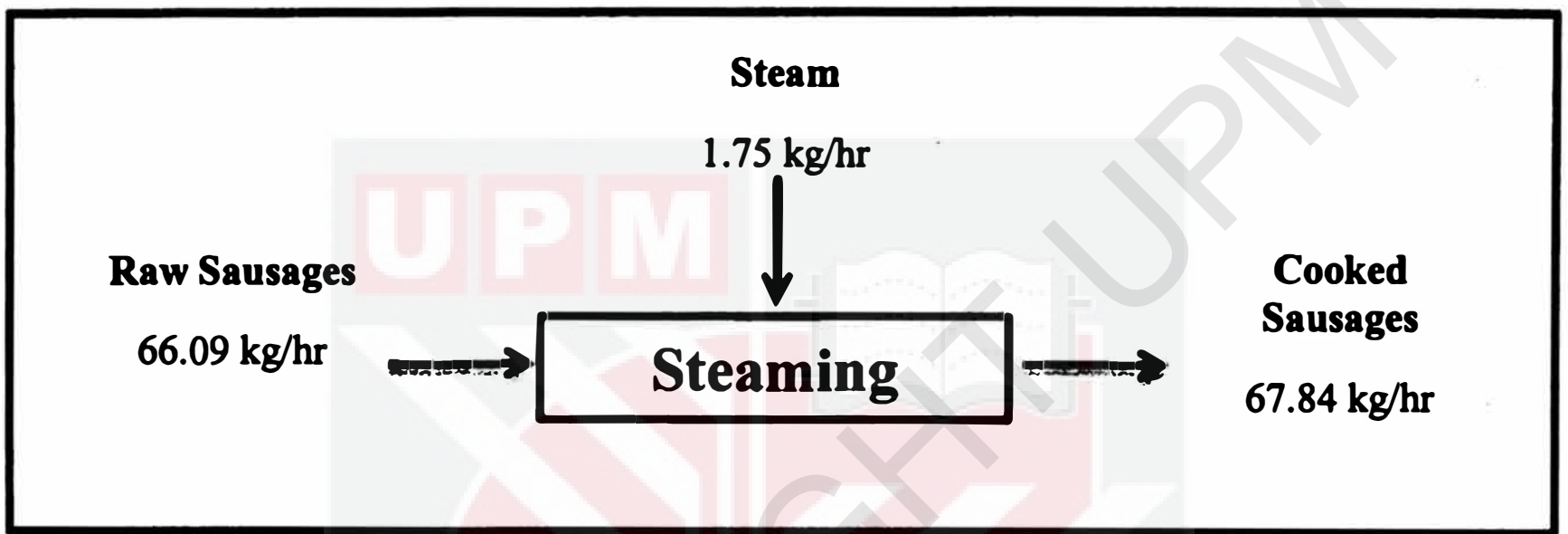


Figure 26: Mass balance for steaming process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{rawsausages}}$	=	$m_{\text{cookedsausages}} - m_{\text{steam}}$
66.09 kg/hr	=	$m_{\text{cookedsausages}} - 1.75 \text{ kg/hr}$
$m_{\text{cookedsausages}}$	=	67.84 kg/hr

### 4.2.1.7 Chilling Process

In chilling process , 68.65 kg/hr of chilled sausage was estimated from total of 67.84 kg/hr of cooked sausage and 0.81 kg/hr of cold water. The weight increment of chilled sausage in result of absorbtion of water (1.18%) during the chilling process. The sausage has been submerge into the cold water in order to chill and to facilitate separation from the casings

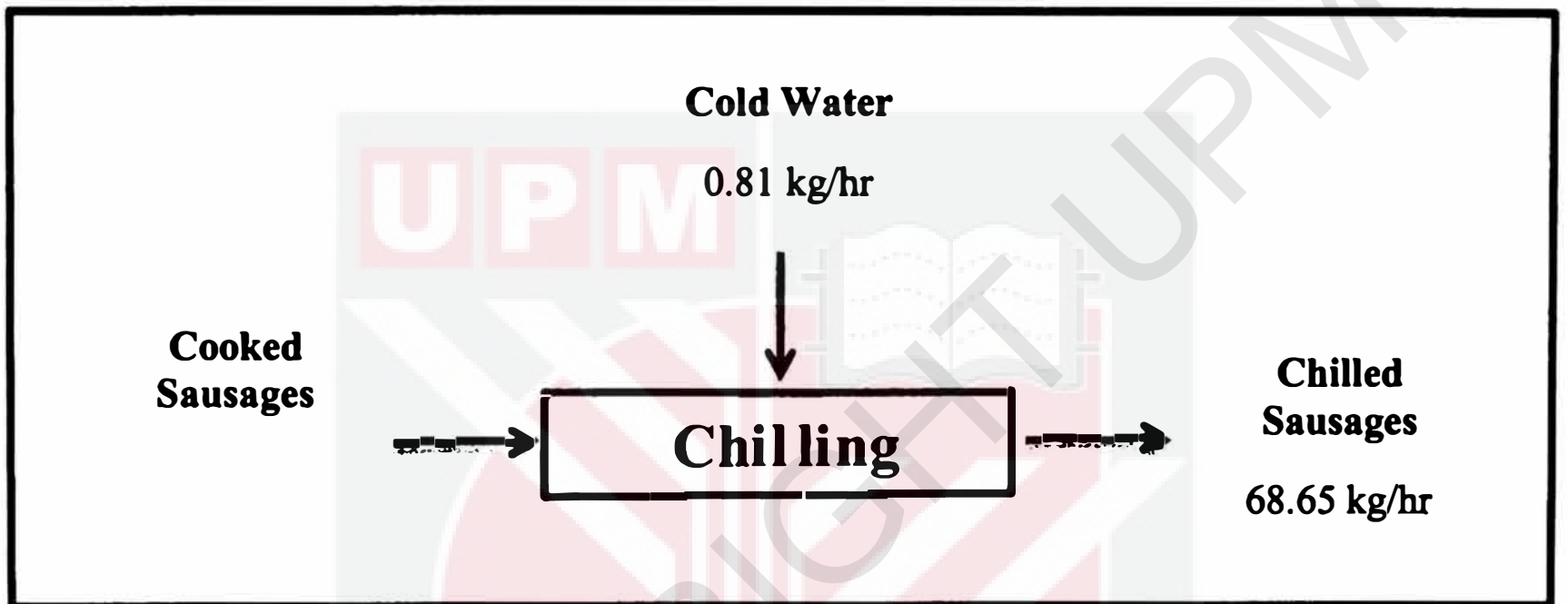


Figure 27: Mass balance for chilling process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{cookedsausages}}$	=	$m_{\text{chilledsausages}} - m_{\text{coldwater}}$
67.84 kg/hr	=	$m_{\text{chilledsausages}} - 0.81 \text{ kg/hr}$
$m_{\text{chilledsausages}}$	=	68.65 kg/hr

### 4.2.1.8 Peeling Process

In peeling process, the total mass of skinless sausage is equal to the mass of chilled sausage minus mass of the casings (0.82%) that have been removed in this process. This process leads to the decrease in weight of banana sausage by removing the inedible cellulose casings.

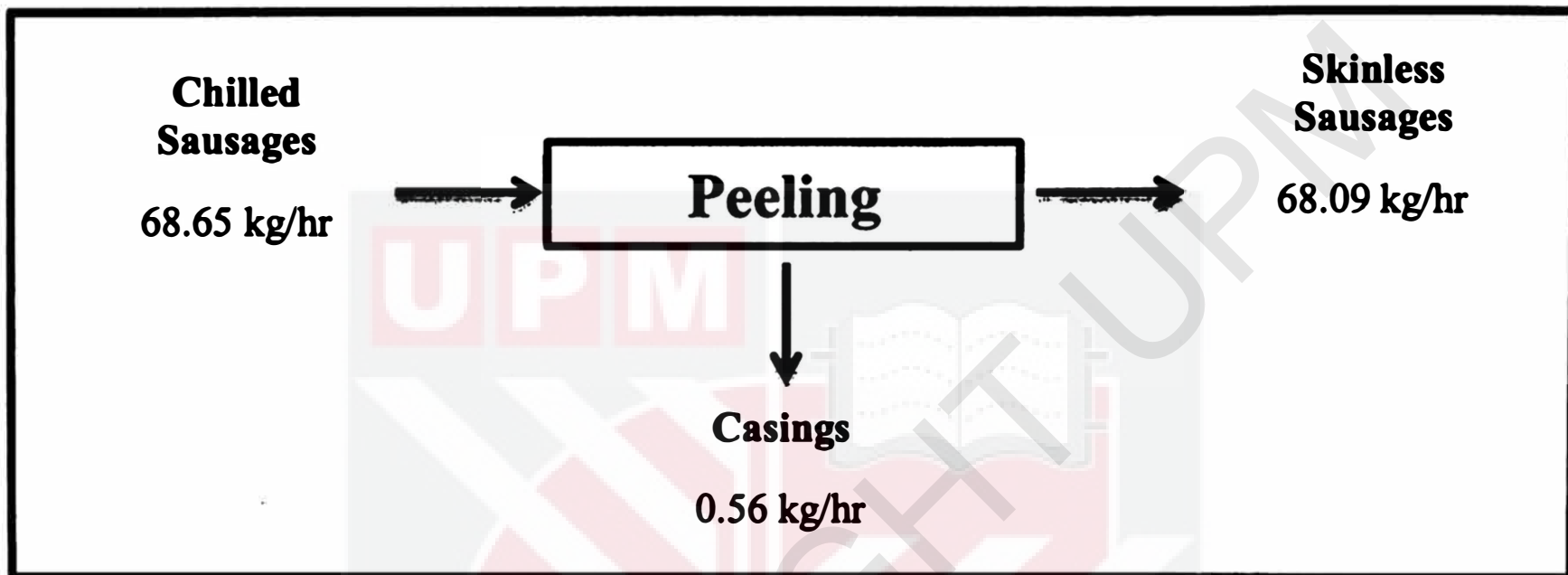


Figure 28: Mass balance for peeling process

#### Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{chilledsausages}}$	=	$m_{\text{skinlesssausages}} + m_{\text{casings}}$
68.65 kg/hr	=	$m_{\text{skinlesssausages}} + 0.56 \text{ kg/hr}$
$m_{\text{skinlesssausages}}$	=	68.09 kg/hr

#### 4.2.1.9 Freezing Process

Freezing process in this study show some drop in weight of the input which is skinless sausage after it has been frozen for 2 hours in the freezer storage. It show 0.56 kg/hr (0.83%) different in weight between skinless sausage and frozen sausage. The water has been freeze and change their state from liquid to the solid state which is water in solid state has lower density than water in liquid state. Beside, the excess water may also drop and separate during the storage.

As for overall, from 62.50 kg/hr of fresh banana, it is estimated that the proposed process design will produce 67.53 kg/hr of RTE banana dessert. Furthermore, by considering the average weight of the RTE banana dessert of 0.0704 kg/piece, the proposed mass balance in this study will produced 959 pieces of the product per hour.

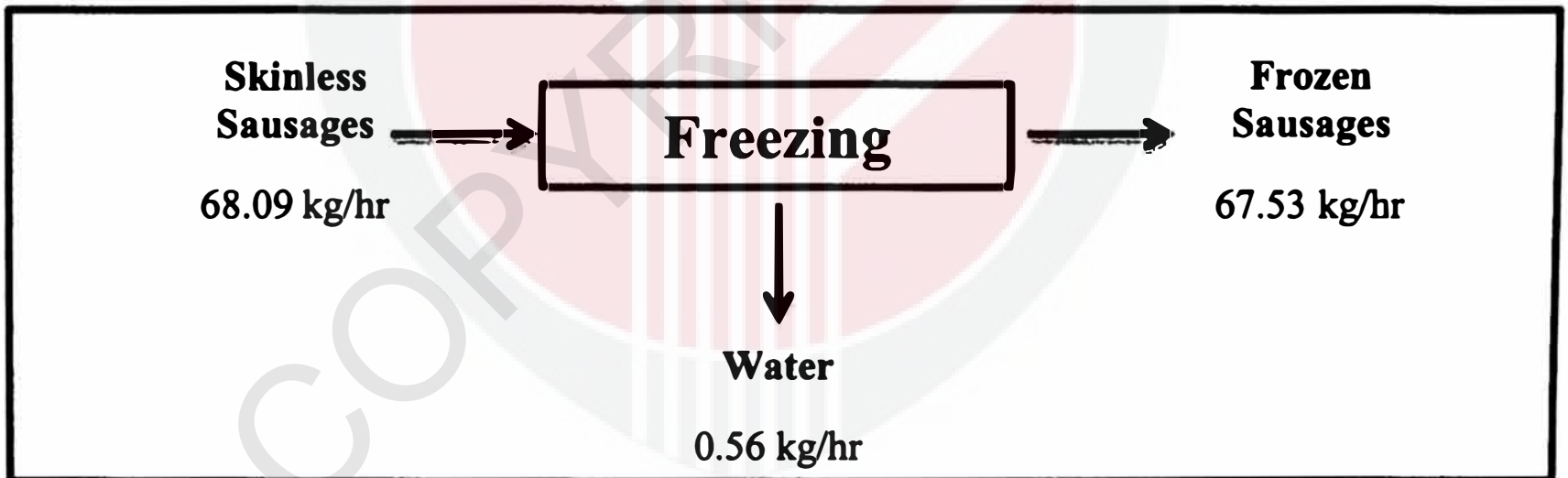


Figure 29: Mass balance for freezing process

Total mass balance

Total mass of input	=	Total mass of output
$m_{\text{skinless sausage}}$	=	$m_{\text{frozen sausage}} + m_{\text{water}}$
68.09 kg/hr	=	$m_{\text{frozen sausage}} + 0.56 \text{ kg/hr}$
$m_{\text{frozen sausage}}$	=	67.53 kg/hr

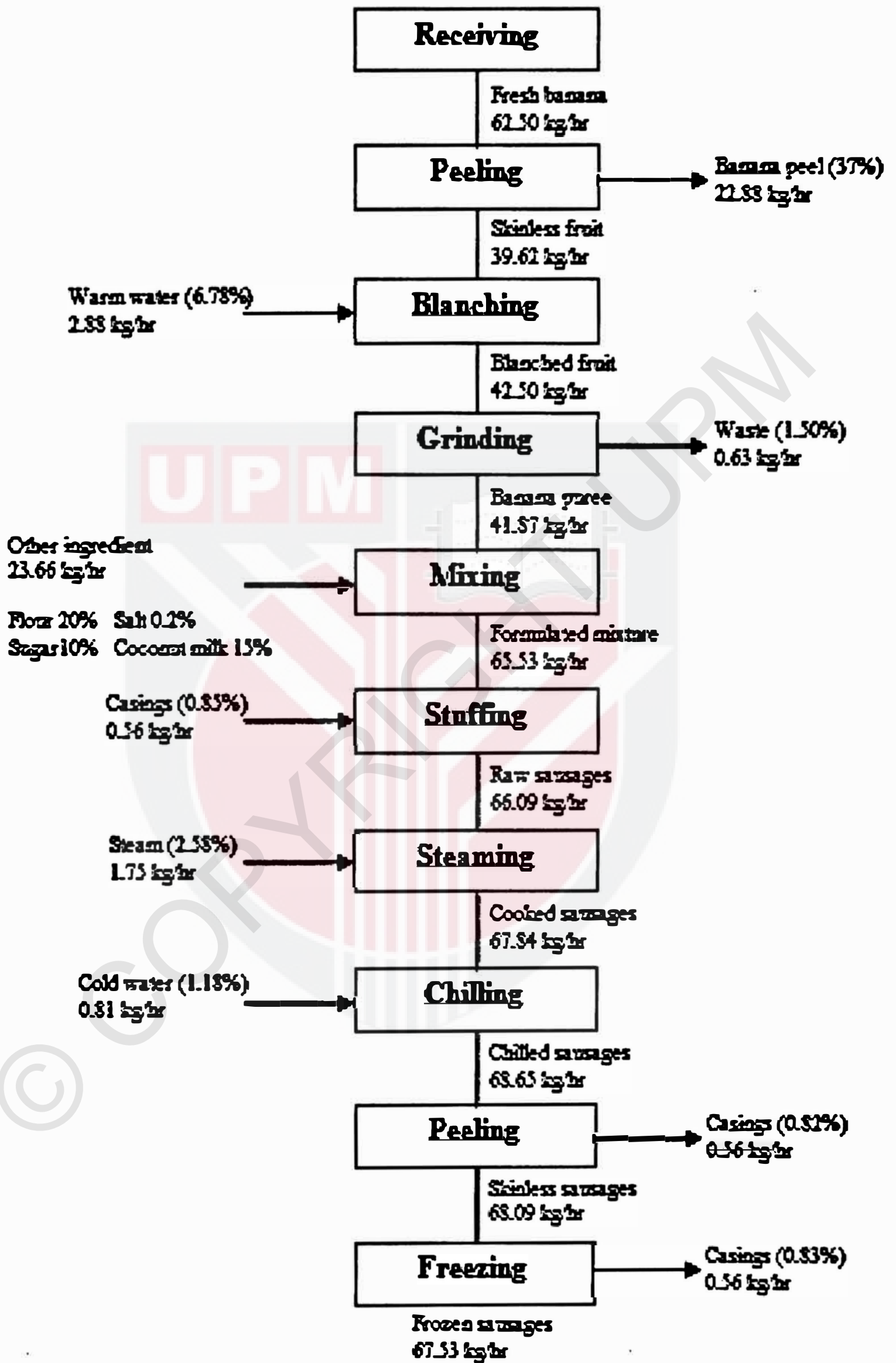


Figure 30: Overall mass balance for production of RTE banana dessert

## 4.2.2 Processing Plant Costing

In this study, the costing involved for the proposed process design were also included which can be divided into two major areas; capital cost and processing cost. The subsequent sub-sections will be discussing on the overall cost for each areas, however, the detail calculations of each components involved in estimating the related cost can be obtained at the Appendix part of this thesis.

### 4.2.2.1 Capital Cost of the Processing Facility

The capital costs of the processing plant are estimated at RM 1,303,470.83 as shown below: The major expenditure is the grinding, mixing, stuffing and freezing plant which can further be referred at the Appendix C

Table 5: Total capital cost

<b>CAPITAL COST</b>	<b>RM</b>
1. Factory Building (size)	354,725.00
2. Cf (ISBL)*	499,339.91
3. Cf (OSBL)*	199,735.96
4. Working Capital	74,900.99
5. Contingency	69,907.59
6. Home Office Cost	104,861.38
<b>TOTAL</b>	<b>RM 1,303,470.83</b>

### 4.2.3 Annual Ready-to-eat Banana Dessert Output and Operating Cost

Based on the proposed mass balance discussed previously, the annual production of the RTE banana dessert is estimated at 144,035.02 kg by considering the operation hours of 8 hours perday; 5 working days per week.

#### 4.2.3.1 Annual Output

Mass production of RTE Banana Dessert per hour = 67.53 kg/hr

Annual mass production of RTE Banana Dessert = 67.53 kg/hr \* 8hr/day \* 24  
day/month \* 12 month/yr  
= 155,589.12 kg/yr

#### 4.2.3.2 Total Annual Operating Cost

The total annual operating cost is estimated to be RM 2,098,345.15 where it involved two main elements such as fixed operating cost and variable operating cost. Details of the calculations of each elements in this costing can be found at Appendix C.

Table 6: Total operating cost

OPERATING COST	CATEGORY	AMOUNT (RM)
	Maintenance Fee	RM 19,973.60
	Insurance, taxes	RM 4,993.40
Fixed Operating Cost	Loyalty	RM 13,034.71
	Labour cost	RM 361,680.00
	Raw Material Cost	RM 1,640,263.68
Variable Cost	Operating Utility Cost	RM 49,782.55
	Packaging Material Cost	RM 8,617.21
	<b>TOTAL</b>	<b>RM 2,098,345.15</b>

Processing Costs per kg of RTE Banana Dessert = RM 2,098,345.15/ 155,589.12  
kg/yr

**= RM 13.49 / kg**

Hence the processing cost of RTE banana dessert is RM13.49 /kg. Since each sausage weight of 0.0704 kg/piece, the operation cost for each sausage is RM 0.96.

#### **4.2.4 Proposed Project Financial Aspects**

##### **4.2.4.1 Revenue**

Table 7 : Revenue estimation

Amount of RTE banana dessert produced (kg/yr)	155,589.12
Amount of RTE banana dessert produced per year (piece/yr)	2,210,072.73
Price (RM/ piece)	1.20
Revenue (RM/year)	2,652,087.28

From the previous part in the operating cost, the amount of RTE banana dessert that produce every year was estimated 155,589.12 kg/yr. This amount produce 2,210,072.73 piece/yr of RTE banana dessert annually. By setting the price of each piece of yogurt at RM 1.20, the annual gross sale of the by product is RM 2,652,087.28 / year.

#### 4.2.4.2 Profitability Estimation

The profitability estimates show that even at price of RM 1.20 per piece, the project generates gross profit of RM 553,742.13 per year. At higher prices, the project will generate substantially higher profits. The summary for overall project profitability shows in table below.

Table 8: Overall project profitability

Category	RM
Gross Margin	RM 1,011,823.60
Cash Cost Of Production	RM 2,098,345.15
Gross Profit	RM 553,742.13
Net Profit	RM 442,993.70
Pay Back Time	3 years
Return of Investment	33.96%

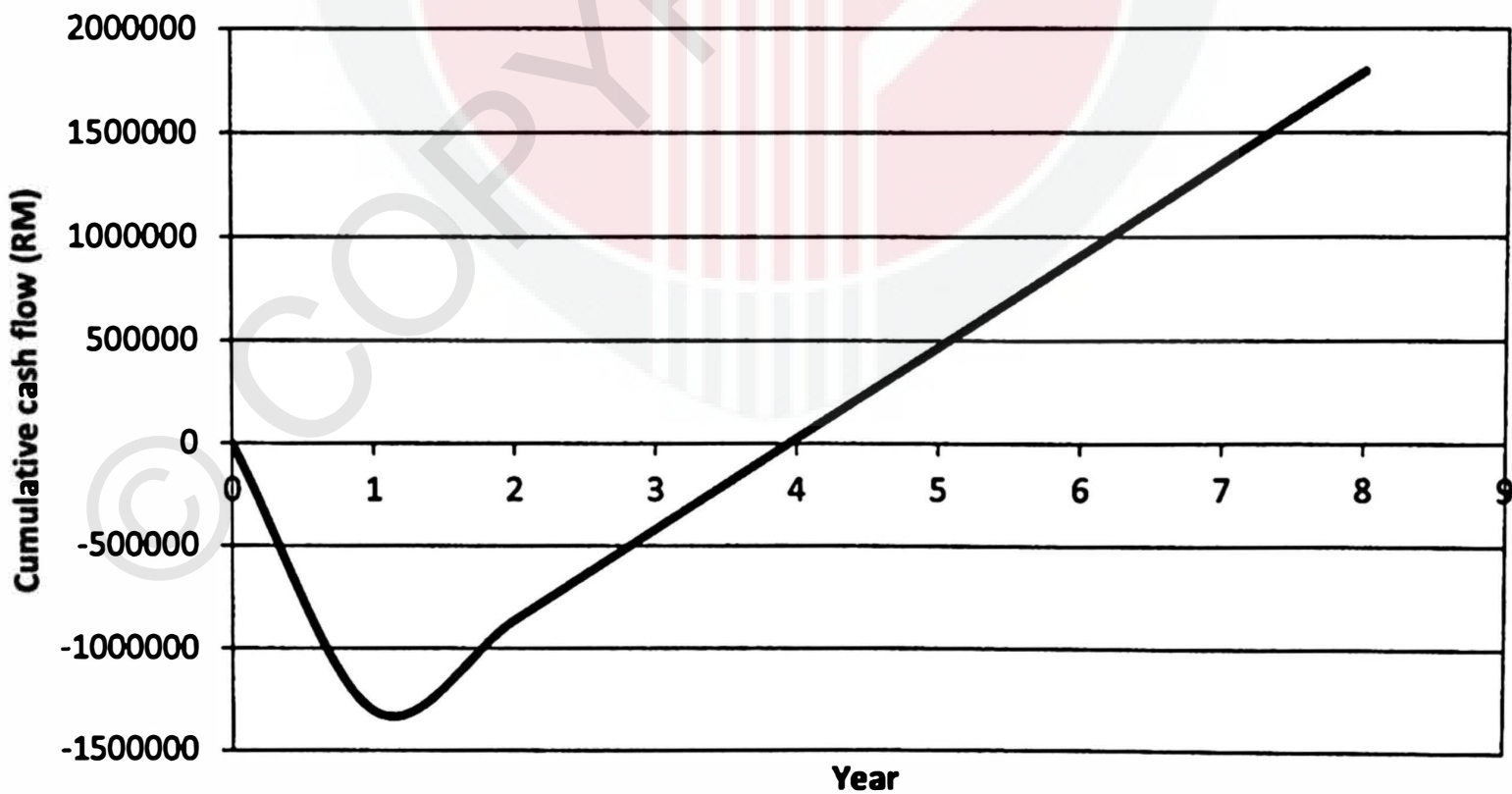


Figure 31 : The payback period of the project

## **CHAPTER 5**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1 Conclusion**

This project involves the production of ready-to-eat Traditional Banana Dessert by adopting sausage technology. That is included the development of new formulation for banana traditional dessert to adapt with combination of sausage technology in the production process. This proposed project accomplished the first objective of this study, which was to develop a new product by converting banana-based traditional dessert to a ready-to-eat food via sausage technology

The product produced in this proposed project is known as RTE banana traditional dessert uses only overripe banana and wheat flour as the main ingredient, coconut milk, sugar and salt. Five formulations have been developed to select the most suitable formation for this product.. Based on the findings, a higher amount of banana in the formulation would result in a sample with a softer texture, higher

moisture content and darker color due to increase  $L^*$ (lightness) and  $b^*$ (yellowness) value. The sensory evaluation, analysis performed showed that the sample with a higher amount of banana in the formulation was more acceptable as to compare with the other sample, but too high volume of banana will result textures that are too soft and not favored among the sensory panelists. Less banana content mean high in flour content that form more gluten and cause gelatinization of starch that affect the mechanical properties of the sample. Based on all the obtained findings, this study proposed for the further development of the product with 80% of banana content to flour mixture for fulfill the second objective of this study.

The second objective of this study have been achieved by proposing a process design, particularly for a small scale industry with the production of 67.53 kg/HR RTE banana dessert from 62.05 kg/hour of fresh banana. It is expected that 959 sausage will be produced per hour. . The estimated cost for the process design, including RM 1,303,470.83 for the capital cost and RM 2,098,345.15for the annual operating cost.

## 5.2 Recommendation

As for recommendation in first phase of this study, the variation in the formation of RTE banana dessert can improvise by added flavor additive or brown sugar to get the desire flavor or samae flavor with the real banana traditional dessert such as '*lepat pisang*' and '*bingka pisang*'. Addition of colouring additive also needed in order to improve the non-attractive colour of this preliminary product. Besides, some further studies should be done to know in more specific microorganism activity pattern in this new product to serve a healthy and assured of its quality. It also really important to get a product that has longer shelf life.

In the second phase of this research, it was just based on literature studies and estimations. As for recommendations, some further detail studies and analysis should be done is each aspect of the project to get clear descriptions about the whole processes. Some aspects that were not included in this report should be emphasized such as the specification of all the machines and minor equipment, the waste management of the plant, inspection and cleaning system , and product quality control. The final form of this product also can be varied in order to attract the consumers such as in frozen form or the form of the product that has been coated with chocolate and pack one by one.

Based on the findings in this study, converting the banana-based local traditional dessert to become a ready-to-eat food seems promising, however, further explorations are required in order to improve the product such as the appearance of the sample that really need transformation for customers' acceptance and commercialization purpose.

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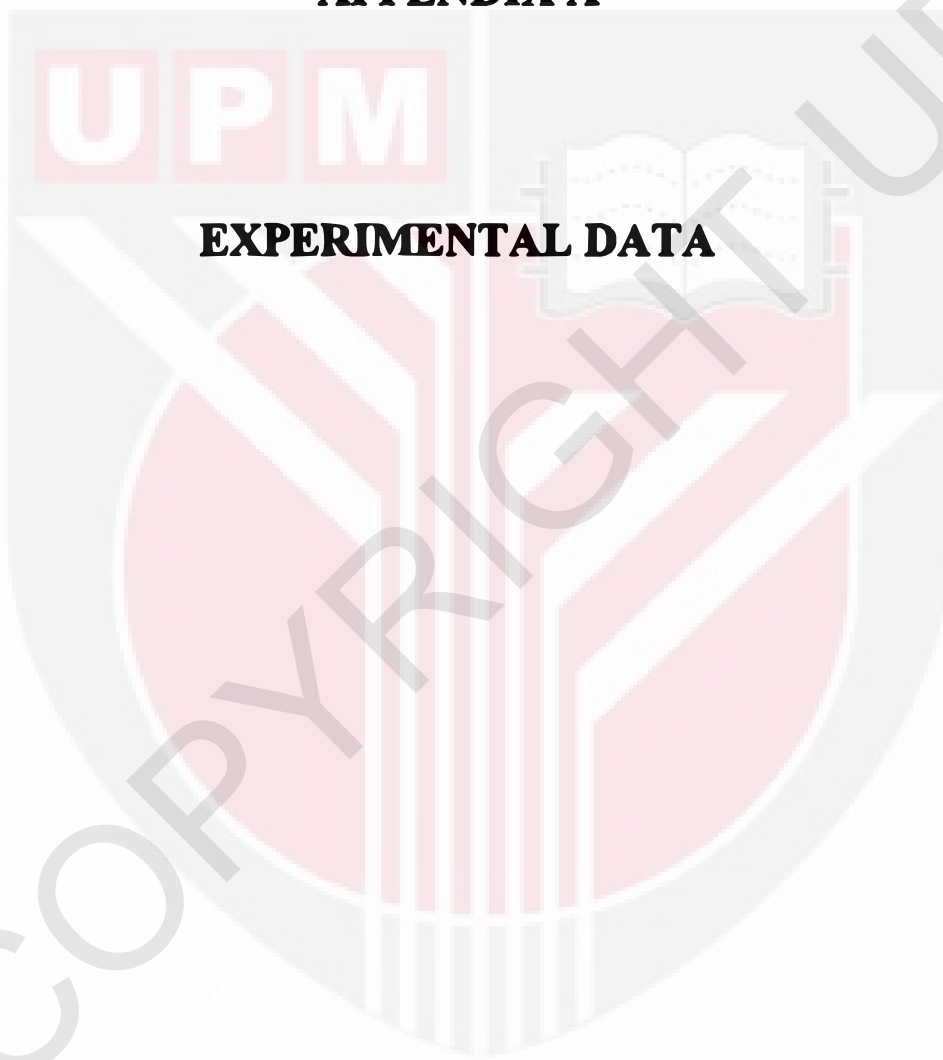
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**APPENDIX A**



## Appendix A1

### Compression Load Analysis

Table A1: Raw data for compression load analysis

	50%	60%	70%	80%
reading1	31.8	19.0	12.7	12.9
reading2	34.2	19.2	12.9	11.1
reading3	34.2	18.6	11.8	11.4
average	33.4	18.9	12.5	11.8
std dev	1.4	0.3	0.6	1.0
std error= stdev/ $5^{1/2}$	0.8	0.2	0.3	0.6

## Appendix A2

### Moisture Content

Table A2: Raw data for moisture analysis

	50%	60%	70%	80%	90%
reading1	43.8	43.6	43.9	46.1	55.8
reading2	40.5	43.7	43.3	46.2	55.4
reading 3	40.3	43.9	44.1	46.5	55.3
average	41.6	43.7	43.8	46.3	55.5
std dev	1.9	0.2	0.4	0.2	0.2
std error= stdev/ $5^{1/2}$	1.1	0.1	0.2	0.1	0.1

## Appendix A3

### Colour

#### 1. L-Value

Table A3 (a): Raw data for L\* value in colour analysis

	50%	60%	70%	80%	90%
reading1	38.4	38.5	41.3	42.8	41.7
reading2	38.6	38.7	41.6	42.4	42.4
reading 3	38.2	38.5	41.8	43.2	40.5
average	38.4	38.6	41.6	42.8	41.5
std dev	0.2	0.1	0.3	0.4	1.0

#### 2. a-Value

Table A3 (b): Raw data for a\* value in colour analysis

	50%	60%	70%	80%	90%
reading1	5.6	7.4	7.6	11.3	9.3
reading2	5.4	7.1	7.5	11.2	9.9
reading 3	5.5	7.1	7.5	11.6	9.5
average	5.5	7.2	7.5	11.4	9.6
std dev	0.1	0.2	0.1	0.2	0.3

### 3. b-Value

**Table A3 (c): Raw data for b\* value in colour analysis**

	50%	60%	70%	80%	90%
reading1	21.4	27.6	29.4	30.7	32.6
reading2	20.5	27.7	29.4	30.6	32.5
reading 3	20.5	27.6	29.6	31.4	29.5
average	20.8	27.6	29.5	30.9	31.5
std dev	0.5	0.1	0.1	0.4	1.8

### Appendix A4

#### Re-steaming Added

**Table A4: Raw data for re-steaming added**

	50%	60%	70%	80%	90%
reading1	9.8	7.7	6.9	3.6	2.3
reading2	9.8	7.7	7.1	3.6	2.3
reading 3	9.5	7.6	7.0	3.7	2.5
average	9.7	7.7	7.0	3.6	2.4
std dev	0.2	0.1	0.1	0.0	0.2

## Appendix A5

### Sensory Evaluation

#### 1. Appearance

Table A5 (a): Raw data for appearance attribute

	50%	60%	70%	80%	90%	average	std dev	std error= stdev/ $5^{1/2}$
Panellist 1	6	6	5	5	4	5.2	0.8	0.4
Panellist 2	4	5	6	4	3	4.4	1.1	0.5
Panellist 3	8	6	6	7	6	6.6	0.9	0.4
Panellist 4	7	6	5	5	4	5.4	1.1	0.5
Panellist 5	4	5	4	4	4	4.2	0.4	0.2
Panellist 6	8	6	5	5	3	5.4	1.8	0.8
Panellist 7	5	5	7	8	4	5.8	1.6	0.7
Panellist 8	5	5	6	7	5	5.6	0.9	0.4
Panellist 9	4	4	5	4	2	3.8	1.1	0.5
Panellist 10	4	6	5	4	3	4.4	1.1	0.5
Panellist 11	4	5	7	4	3	4.6	1.5	0.7
Panellist 12	8	7	6	7	5	6.6	1.1	0.5
Panellist 13	4	4	5	4	3	4.0	0.7	0.3
Panellist 14	7	7	8	5	4	6.2	1.6	0.7
Panellist 15	8	8	7	5	4	6.4	1.8	0.8
Panellist 16	6	6	7	5	5	5.8	0.8	0.4
Panellist 17	5	6	6	7	6	6.0	0.7	0.3
Panellist 18	4	5	5	4	3	4.2	0.8	0.4
Panellist 19	5	5	6	8	6	6.0	1.2	0.5
Panellist 20	4	5	4	4	3	4.0	0.7	0.3

average	5.5	5.6	5.8	5.3	4.0
std dev	1.6	1.0	1.1	1.5	1.2
std error= stdev/ 5 <sup>1/2</sup>	0.7	0.4	0.5	0.7	0.5

## 2. Aroma

Table A5 (b): Raw data for aroma attribute

	50%	60%	70%	80%	90%	average	std dev	std error= stdev/ 5 <sup>1/2</sup>
Panellist 1	5	6	6	7	5	5.8	0.8	0.4
Panellist 2	4	6	5	5	6	5.2	0.8	0.4
Panellist 3	9	9	7	8	7	8.0	1.0	0.4
Panellist 4	6	6	7	8	8	7.0	1.0	0.4
Panellist 5	6	6	7	4	6	5.8	1.1	0.5
Panellist 6	5	5	6	7	6	5.8	0.8	0.4
Panellist 7	8	7	6	6	7	6.8	0.8	0.4
Panellist 8	7	7	8	8	9	7.8	0.8	0.4
Panellist 9	5	5	6	6	7	5.8	0.8	0.4
Panellist 10	7	7	5	5	7	6.2	1.1	0.5
Panellist 11	9	6	6	8	7	7.2	1.3	0.6
Panellist 12	6	7	7	4	7	6.2	1.3	0.6
Panellist 13	8	7	6	6	6	6.6	0.9	0.4
Panellist 14	5	6	7	6	8	6.4	1.1	0.5
Panellist 15	7	6	6	5	7	6.2	0.8	0.4
Panellist 16	7	7	8	8	7	7.4	0.5	0.2
Panellist 17	5	6	6	7	7	6.2	0.8	0.4
Panellist 18	6	6	7	8	8	7.0	1.0	0.4

Panellist 19	4	4	5	5	6	4.8	0.8	0.4
Panellist 20	5	6	6	7	7	6.2	0.8	0.4
average	6.2	6.3	6.4	6.4	6.9			
std dev	1.5	1.0	0.9	1.4	0.9			
std error= stdev/ 5 <sup>1/2</sup>	0.7	0.5	0.4	0.6	0.4			

### 3. Texture

Table A5 (c): Raw data for texture attribute

	50%	60%	70%	80%	90%	average	std dev	std error= stdev/ 5 <sup>1/2</sup>
Panellist 1	7	6	7	8	4	6.4	1.5	0.7
Panellist 2	3	5	6	7	2	4.6	2.1	0.9
Panellist 3	7	6	7	8	4	6.4	1.5	0.7
Panellist 4	4	5	6	8	4	5.4	1.7	0.7
Panellist 5	7	5	5	3	2	4.4	1.9	0.9
Panellist 6	5	7	8	8	5	6.6	1.5	0.7
Panellist 7	7	8	8	6	3	6.4	2.1	0.9
Panellist 8	4	5	5	7	4	5.0	1.2	0.5
Panellist 9	5	7	8	3	2	5.0	2.5	1.1
Panellist 10	6	5	4	4	3	4.4	1.1	0.5
Panellist 11	6	8	7	4	2	5.4	2.4	1.1
Panellist 12	7	6	5	6	4	5.6	1.1	0.5
Panellist 13	4	6	7	7	4	5.6	1.5	0.7
Panellist 14	7	7	8	8	3	6.6	2.1	0.9
Panellist 15	7	6	7	8	5	6.6	1.1	0.5
Panellist 16	7	6	4	3	1	4.2	2.4	1.1

Panellist 17	5	8	8	8	3	6.4	2.3	1.0
Panellist 18	4	7	8	7	3	5.8	2.2	1.0
Panellist 19	3	6	6	7	4	5.2	1.6	0.7
Panellist 20	5	6	6	4	2	4.6	1.7	0.7
average	5.5	6.3	6.5	6.2	3.2			
std dev	1.5	1.0	1.4	1.9	1.1			
std error= stdev/ 5 <sup>1/2</sup>	0.7	0.5	0.6	0.9	0.5			

#### 4. Flavour

Table A5 (d): Raw data for flavour attribute

	50%	60%	70%	80%	90%	average	std dev	std error= stdev/ 5 <sup>1/2</sup>
Panellist 1	5	5	7	8	6	6.2	1.3	0.6
Panellist 2	4	5	4	6	5	4.8	0.8	0.4
Panellist 3	8	8	7	7	6	7.2	0.8	0.4
Panellist 4	4	5	7	9	7	6.4	1.9	0.9
Panellist 5	6	6	4	3	3	4.4	1.5	0.7
Panellist 6	6	6	8	9	6	7.0	1.4	0.6
Panellist 7	5	6	7	9	6	6.6	1.5	0.7
Panellist 8	5	7	8	8	6	6.8	1.3	0.6
Panellist 9	7	6	5	6	5	5.8	0.8	0.4
Panellist 10	5	6	7	7	6	6.2	0.8	0.4
Panellist 11	7	6	7	6	5	6.2	0.8	0.4
Panellist 12	5	6	9	9	7	7.2	1.8	0.8
Panellist 13	6	5	5	3	1	4.0	2.0	0.9
Panellist 14	8	7	8	7	4	6.8	1.6	0.7

Panellist 15	5	7	8	8	5	6.6	1.5	0.7
Panellist 16	4	4	5	6	4	4.6	0.9	0.4
Panellist 17	4	5	8	9	5	6.2	2.2	1.0
Panellist 18	6	6	7	9	6	6.8	1.3	0.6
Panellist 19	5	6	8	8	7	6.8	1.3	0.6
Panellist 20	5	5	8	7	6	6.2	1.3	0.6
average	5.5	5.9	6.9	7.2	5.3			
std dev	1.2	0.9	1.5	1.8	1.5			
std error= stdev/ 5 <sup>1/2</sup>	0.6	0.4	0.7	0.8	0.7			

## 5. Overall Acceptability

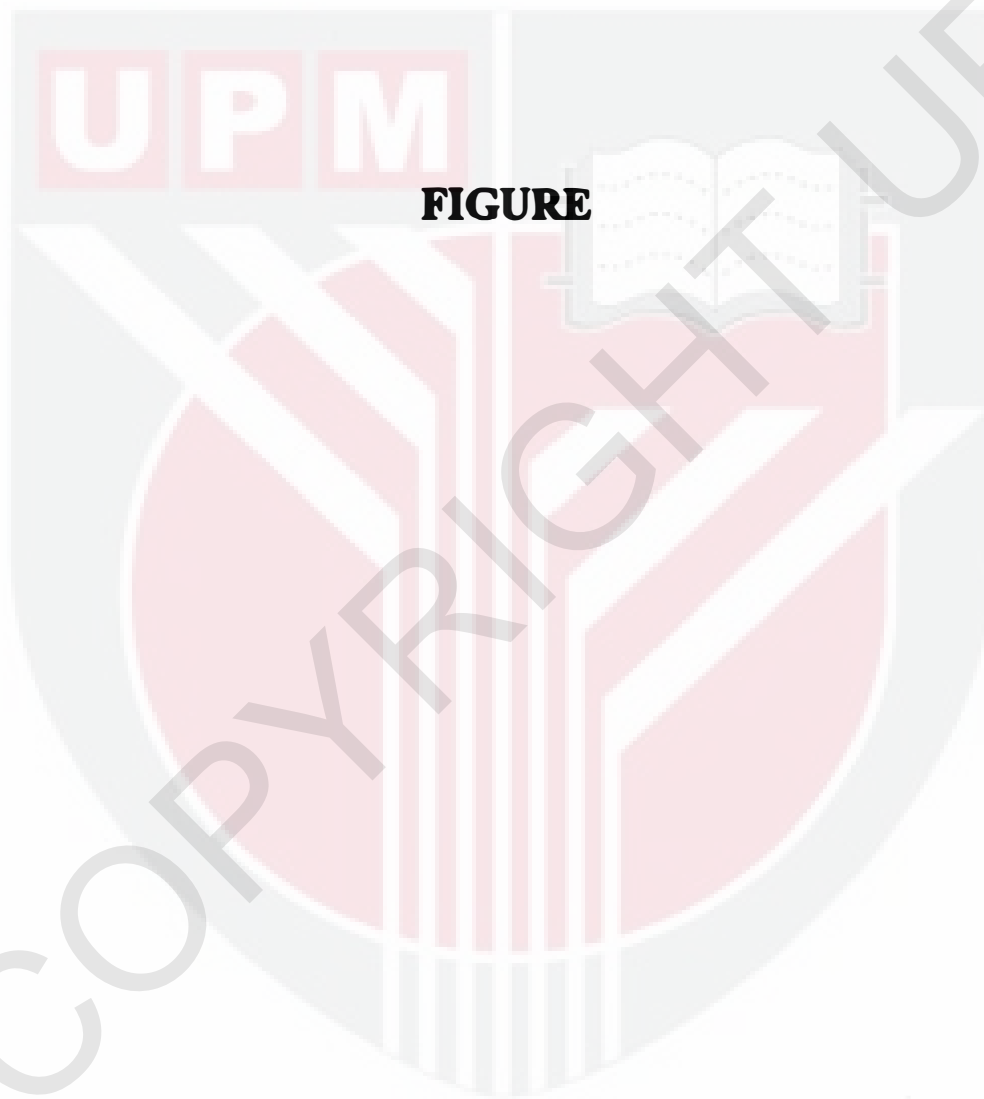
Table A5 (e): Raw data for overall acceptability

	50%	60%	70%	80%	90%	average	std dev	std error= stdev/ 5 <sup>1/2</sup>
Panellist 1	5	5	6	7	4	5.4	1.1	0.5
Panellist 2	3	3	4	6	4	4.0	1.2	0.5
Panellist 3	9	8	7	8	6	7.6	1.1	0.5
Panellist 4	5	6	5	7	3	5.2	1.5	0.7
Panellist 5	8	6	5	5	2	5.2	2.2	1.0
Panellist 6	5	6	6	9	4	6.0	1.9	0.8
Panellist 7	7	7	8	9	5	7.2	1.5	0.7
Panellist 8	4	5	6	8	4	5.4	1.7	0.7
Panellist 9	7	6	6	4	3	5.2	1.6	0.7
Panellist 10	6	6	7	5	2	5.2	1.9	0.9
Panellist 11	5	6	6	7	5	5.8	0.8	0.4
Panellist 12	9	7	6	7	6	7.0	1.2	0.5

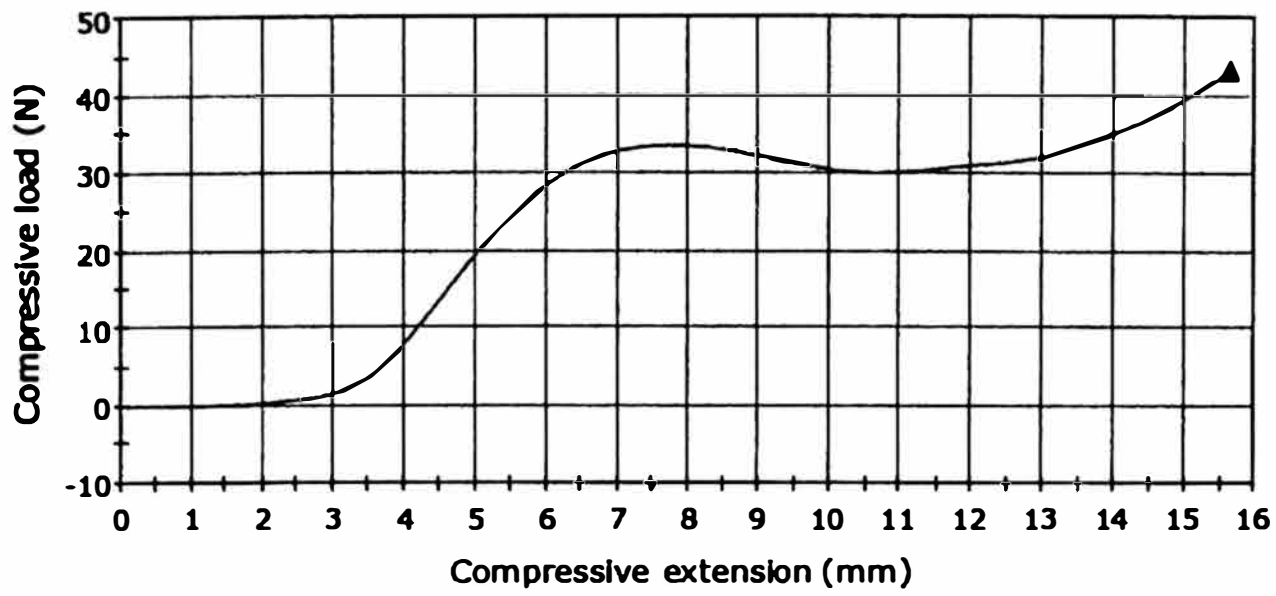
<b>Panellist 13</b>	<b>8</b>	<b>8</b>	<b>9</b>	<b>9</b>	<b>5</b>	<b>7.8</b>	<b>1.6</b>	<b>0.7</b>
<b>Panellist 14</b>	<b>7</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>3</b>	<b>5.6</b>	<b>1.7</b>	<b>0.7</b>
<b>Panellist 15</b>	<b>7</b>	<b>8</b>	<b>4</b>	<b>4</b>	<b>3</b>	<b>5.2</b>	<b>2.2</b>	<b>1.0</b>
<b>Panellist 16</b>	<b>6</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>5</b>	<b>6.4</b>	<b>1.1</b>	<b>0.5</b>
<b>Panellist 17</b>	<b>4</b>	<b>4</b>	<b>5</b>	<b>9</b>	<b>4</b>	<b>5.2</b>	<b>2.2</b>	<b>1.0</b>
<b>Panellist 18</b>	<b>5</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>4</b>	<b>5.0</b>	<b>0.7</b>	<b>0.3</b>
<b>Panellist 19</b>	<b>5</b>	<b>5</b>	<b>6</b>	<b>8</b>	<b>5</b>	<b>5.8</b>	<b>1.3</b>	<b>0.6</b>
<b>Panellist 20</b>	<b>3</b>	<b>5</b>	<b>6</b>	<b>6</b>	<b>3</b>	<b>4.6</b>	<b>1.5</b>	<b>0.7</b>

<b>average</b>	<b>5.9</b>	<b>6.0</b>	<b>6.0</b>	<b>6.8</b>	<b>4.0</b>
<b>std dev</b>	<b>1.8</b>	<b>1.3</b>	<b>1.2</b>	<b>1.7</b>	<b>1.2</b>
<b>std error= stdev/ 5<sup>1/2</sup></b>	<b>0.8</b>	<b>0.6</b>	<b>0.5</b>	<b>0.8</b>	<b>0.5</b>

**APPENDIX B**

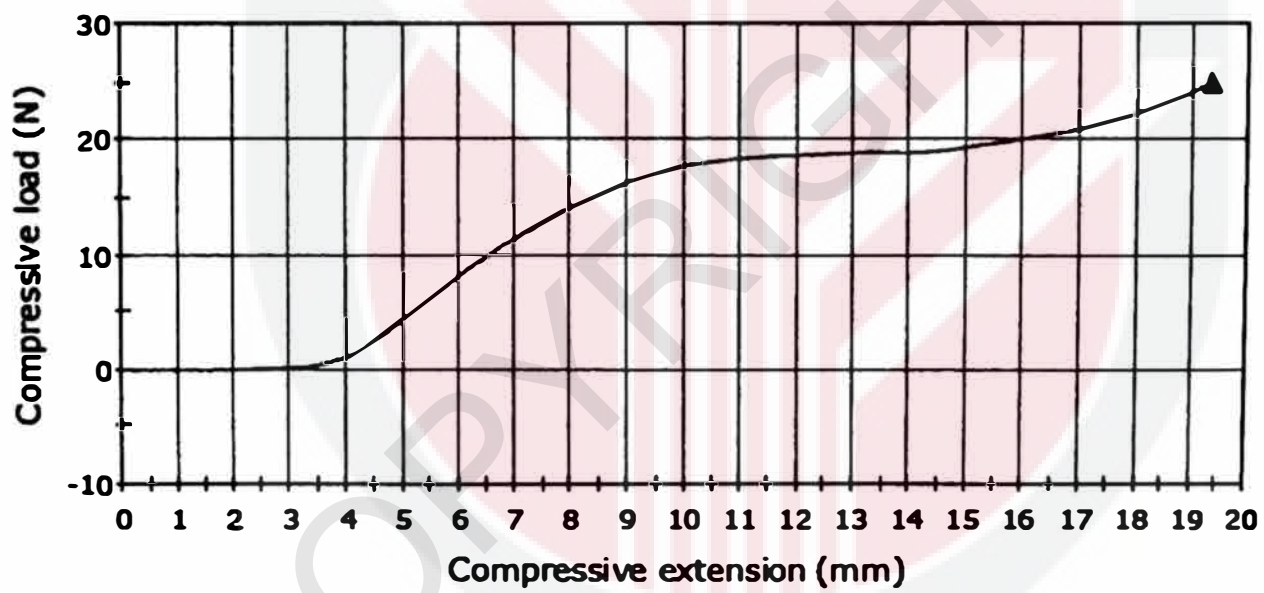


**FIGURE**



Specimen #  
1

Figure B1 :Maximum compression load for 50% of banana to banana plus flour mixture



Specimen #  
1

Figure B2 :Maximum compression load for 60% of banana to banana plus flour mixture

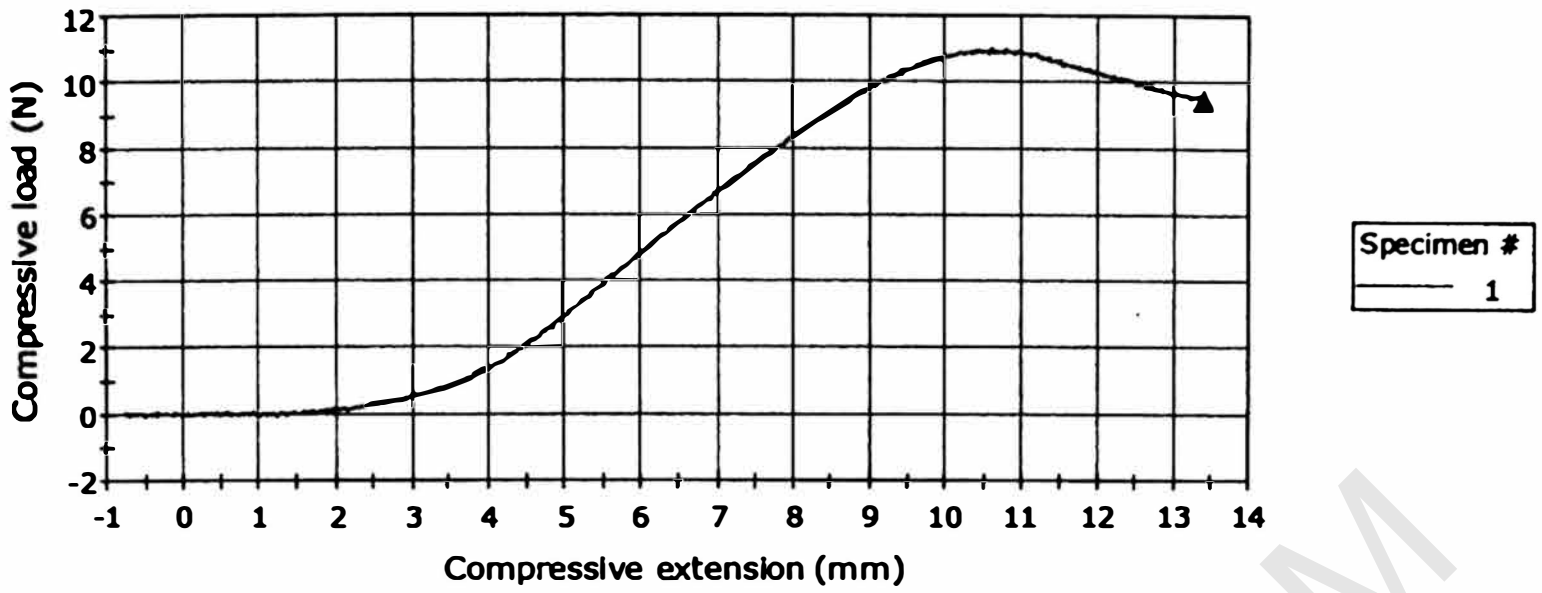


Figure B3 :Maximum compression load for 70% of banana to banana plus flour mixture

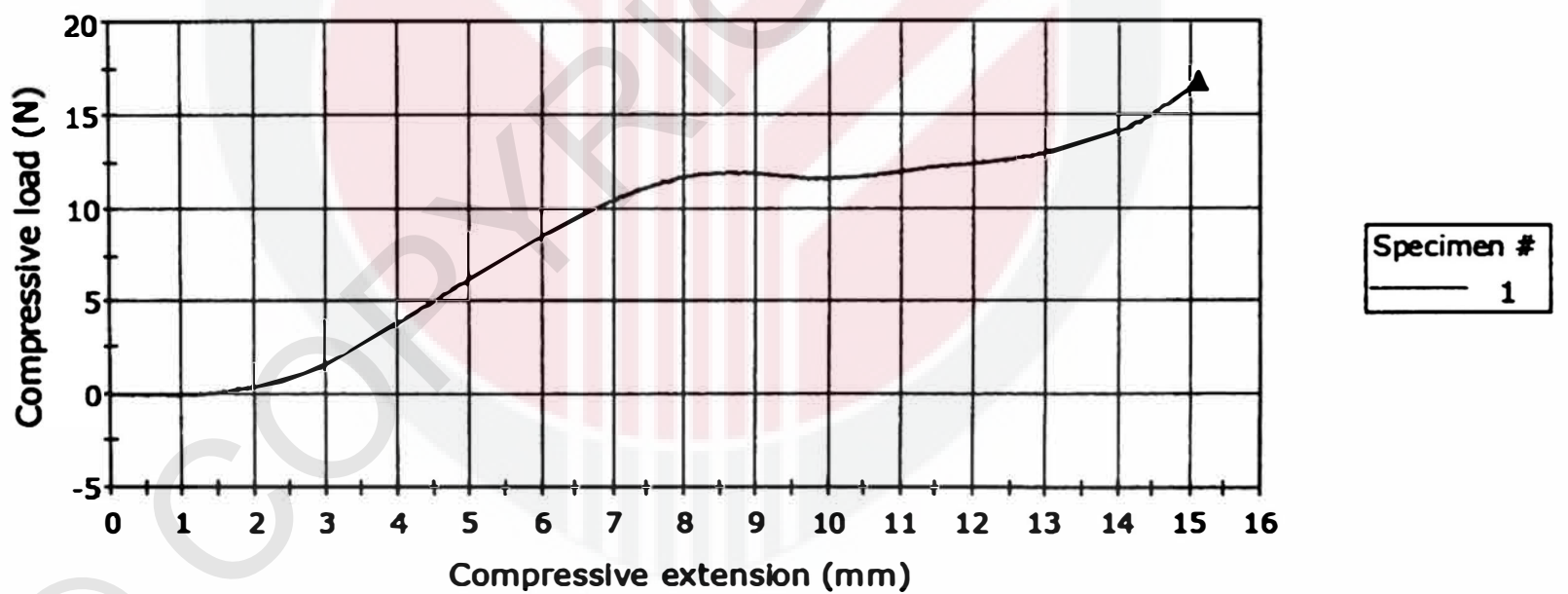
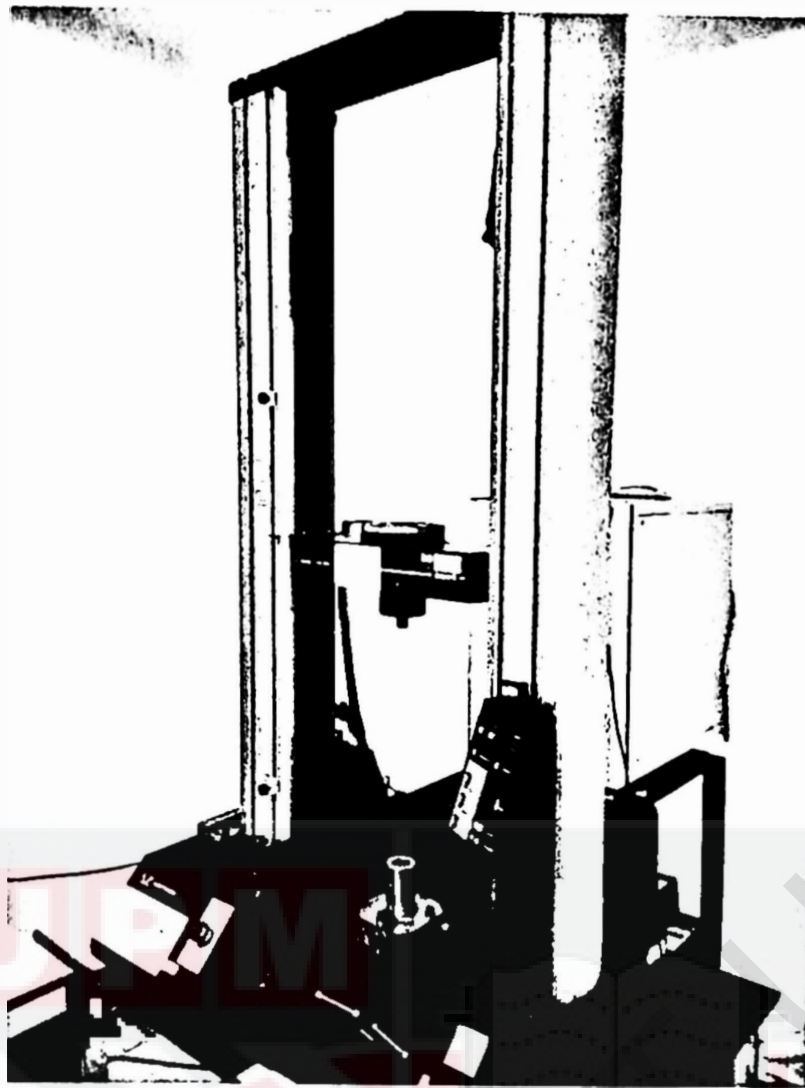
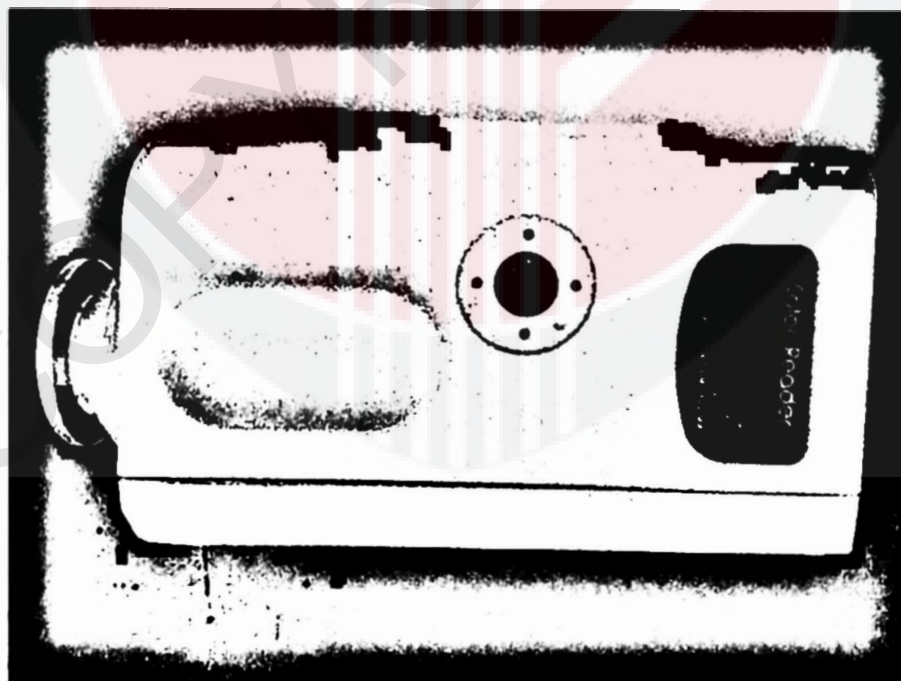


Figure B4 :Maximum compression load for 80% of banana to banana plus flour mixture



**Figure B5 : Using Instron Universal Testing Machine (Instron, USA)**



**Figure B6: Hunterlab Miniscan TZ spectrophotometer**

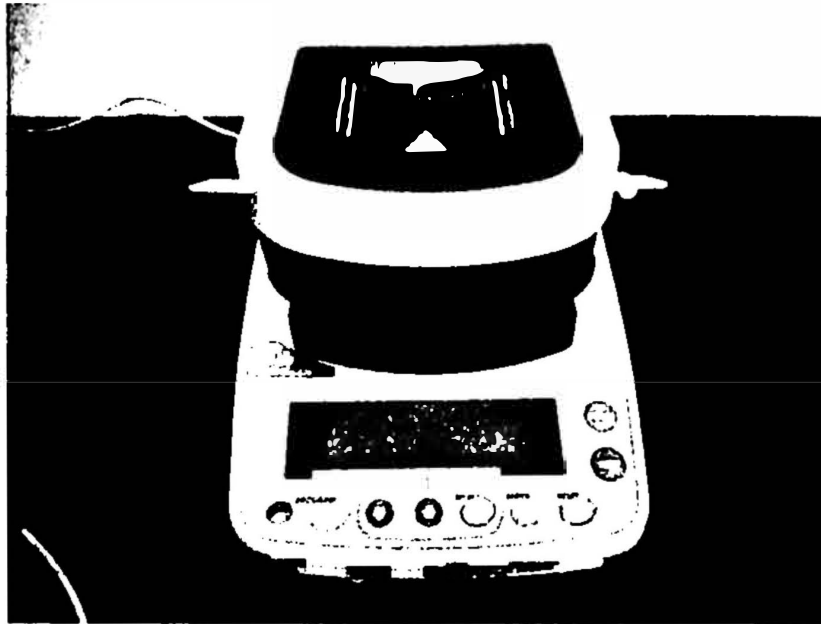
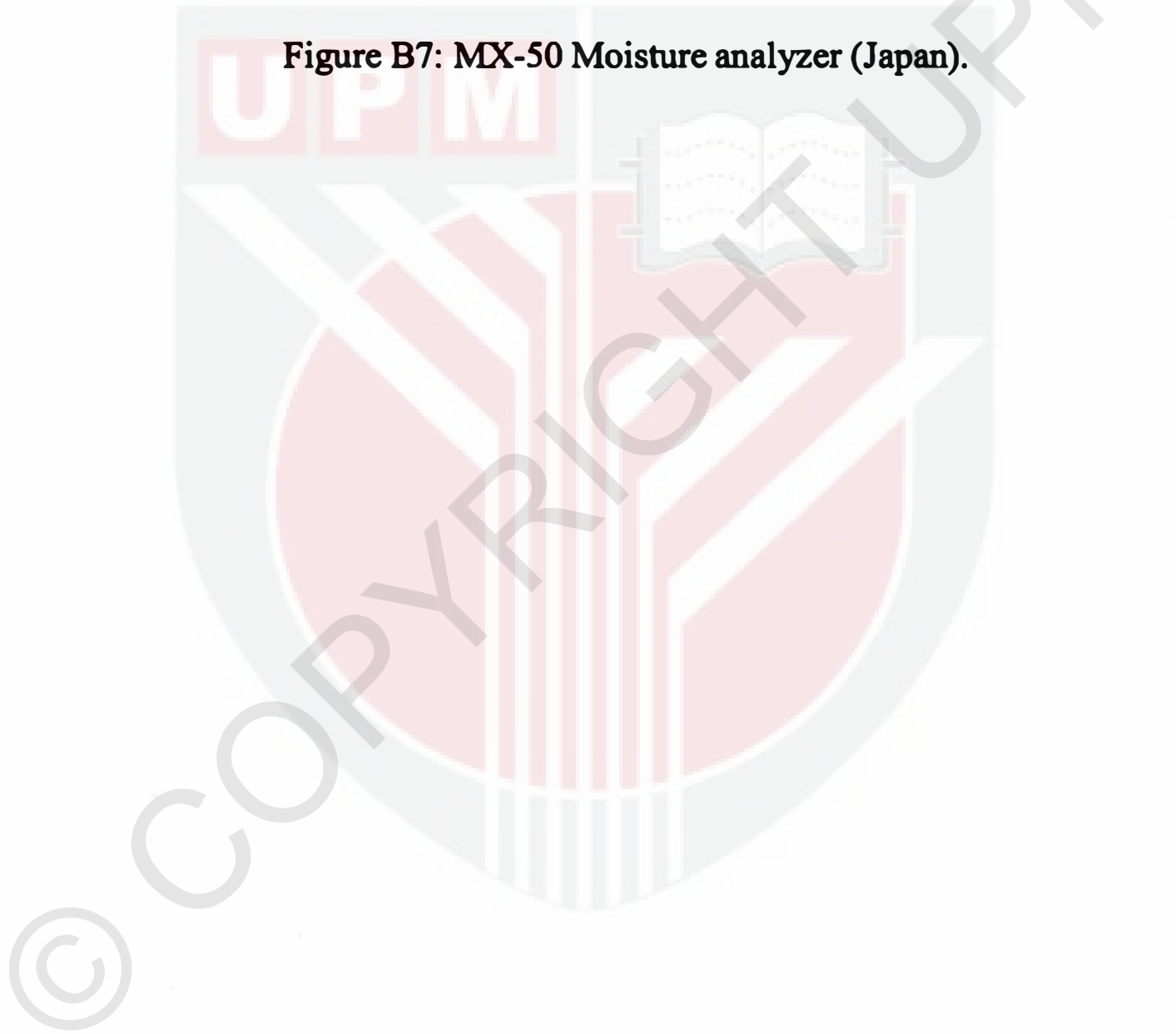


Figure B7: MX-50 Moisture analyzer (Japan).



**SCORE SHEET 1.1**  
**QUESTIONNAIRE FOR HEDONIC SCALE**

PANEL NO./NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

PRODUCT : Banana Dessert

Instruction:

As representative of the consuming population, quantify the degree of liking or disliking of the products one by one separately. Evaluate each given attribute one by one separately. Fill in the scale at the space provided. Don't forget to rinse your mouth with water in between the samples.

Scale      Description

- 9      Like extremely
- 8      Like very much
- 7      Like moderately
- 6      Like slightly
- 5      Neither like or dislike
- 4      Dislike slightly
- 3      Dislike moderately
- 2      Dislike very much
- 1      Dislike extremely

Sample Attributes	Sample Code					
	101	102	103	104	105	106
Colour						
Smell/Aroma						
Taste <i>Please give scale based on the taste that has similar/approaching taste to the traditional banana dessert</i>						
Texture						
Overall acceptability						

Comment :

\_\_\_\_\_

Figure B8 :Sensory evaluation form

# MATERIAL BALANCE CHART

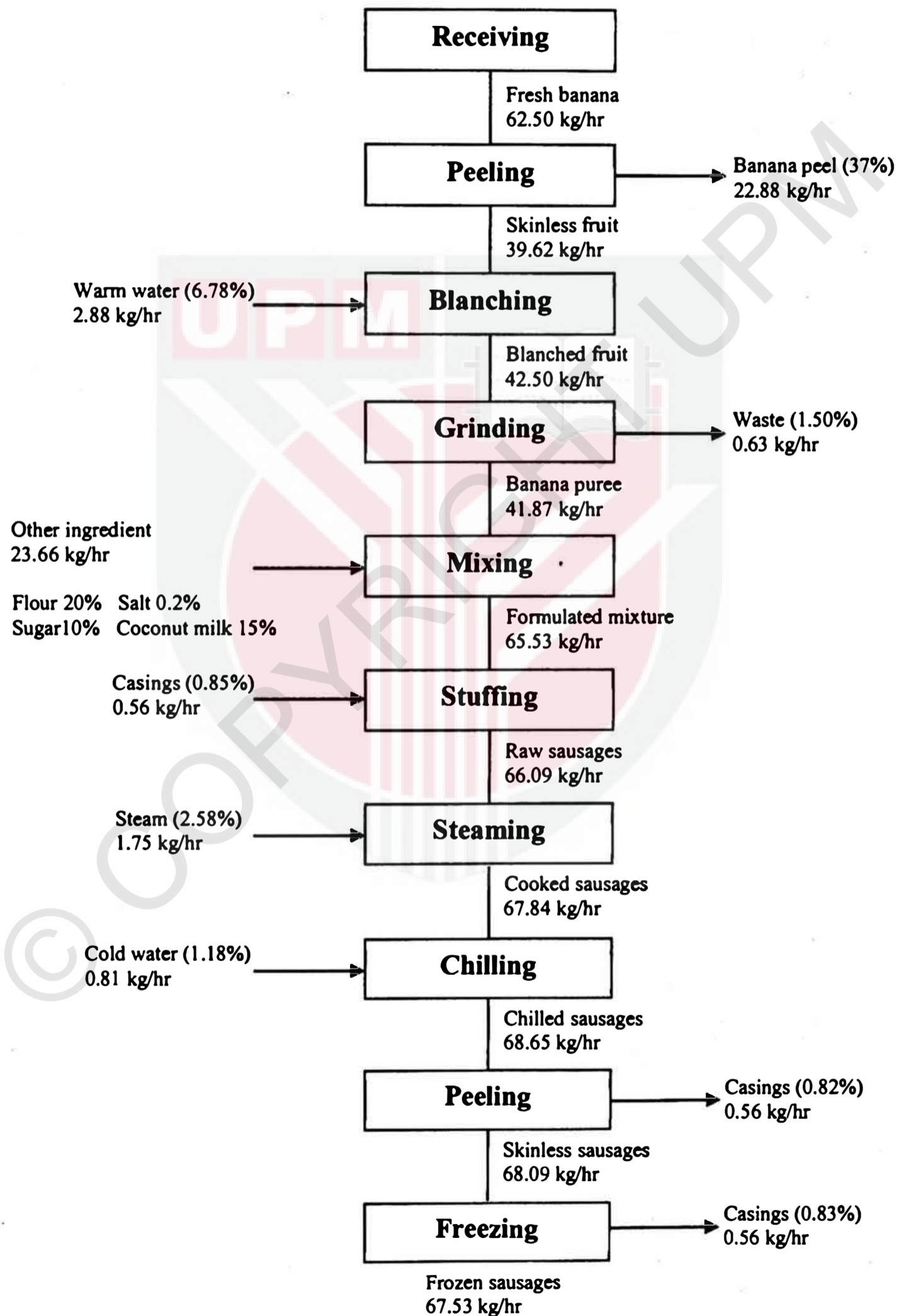
Subject charted : RTE banana dessert  
15/5/2018

Date :

Chart type : Material

By : Hasnim

Method : Proposed



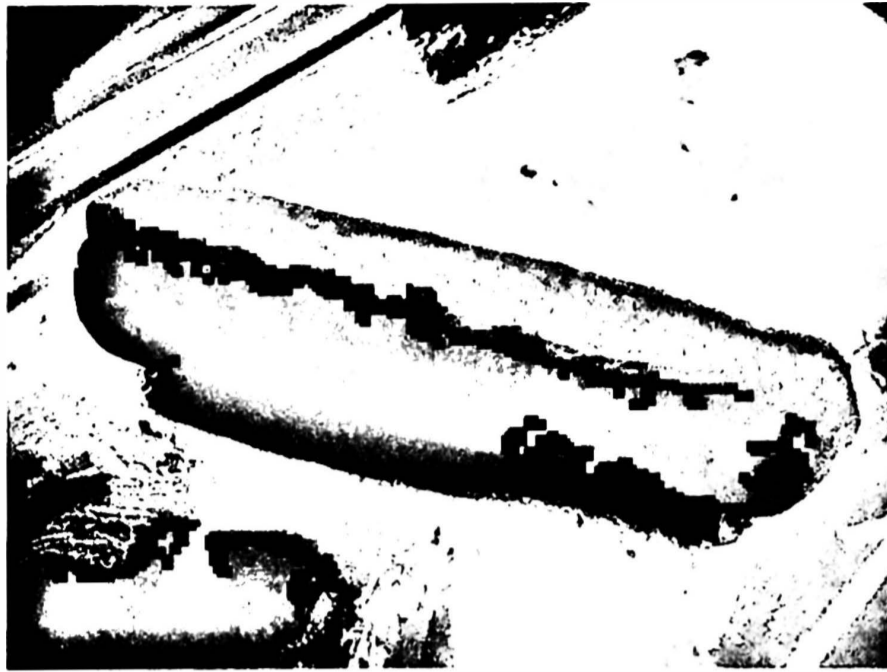


Figure B9: RTE banana dessert



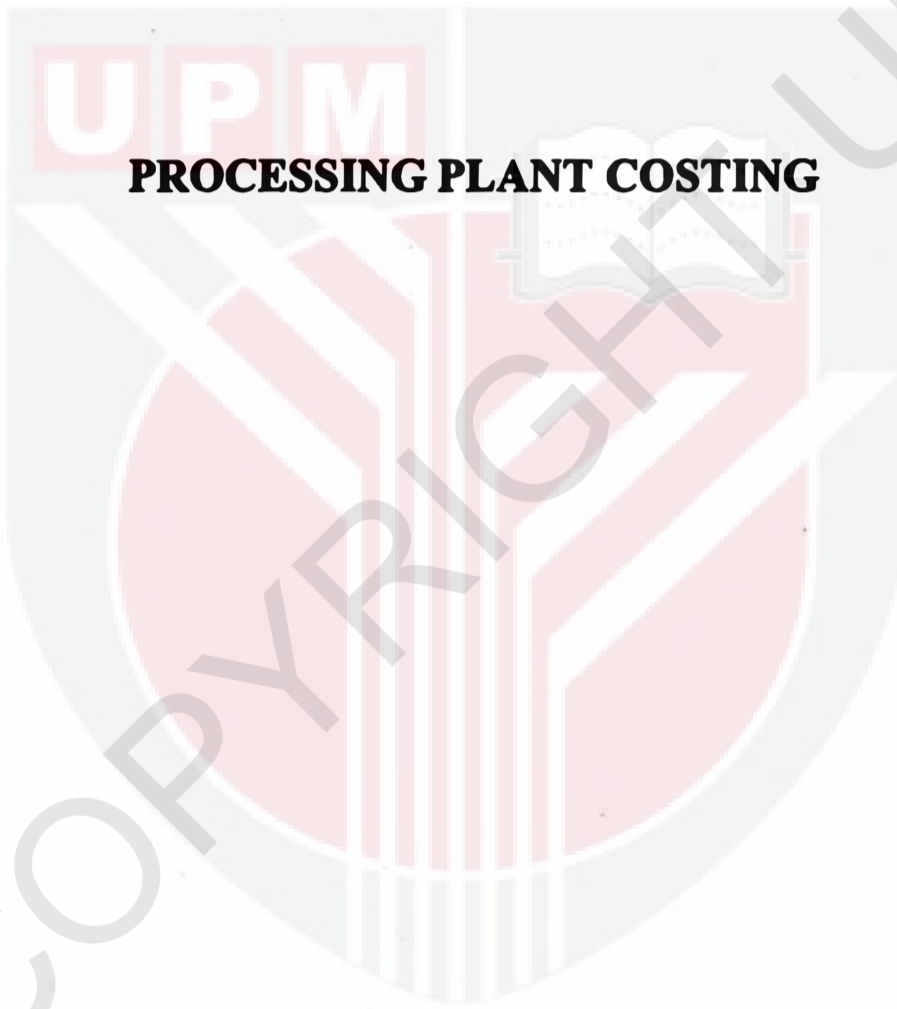
Figure B10: (a) 50% and; (b) 60% of banana content



Figure B11: (c) 70%; (d) 80% and; (e) 90% of banana content

**APPENDIX C**

**PROCESSING PLANT COSTING**



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## 1.0 Ready-to-eat Banana Dessert Processing Plant Costing

### 1.1 Capital Costs of Processing Facility

The capital costs of the processing plant are estimated as shown below: the major expenditure is the grinding, mixing, stuffing and freezing plant.

#### 1.1.1 Factory Building

The factory building is chosen are suitable and related to small and medium enterprise. A building for plant processing with affordable price has been selected, RM 354,725.00.

#### 1.1.2 ISBL (Inside Battery Limits)

It is a fixed investment which is needed to supply the necessary plant facilities. It includes total cost of designing, constructing, installing a plant, including associated modification. The equipment cost is as shown in table below:

Table C1: Major equipment costing

Major Equipment	Unit Price	Quantity	Amount
Fruit And Vegetable Blancher	RM 21,041.11	1	RM 21,041.11
Fruit Grinder Machine	RM 19,595.00	1	RM 19,595.00
Mixing Tank	RM 11,757.00	1	RM 11,757.00
Powder Mixing Tank	RM 9,797.50	1	RM 9,797.50
Electric Sausage Stuffer	RM 22,821.36	1	RM 22,821.36
Food Steamer	RM 16,232.50	1	RM 16,232.50
Refrigerant Water Chiller	RM 15,676.00	1	RM 15,676.00

Air Blast Freezer	RM 35,271.00	1	RM 35,271.00
		<b>TOTAL</b>	<b>RM 152,191.47</b>

Therefore,  $CF (ISBL) = fL (Ceq)$ , where  $fL = \text{Lang factor} = 3$  for modern food processing plant that includes modern instrumentation and process control and sophisticated environmental protection,

$$\begin{aligned}
 CF (ISBL) &= fL (Ceq) \\
 &= RM 152,191.47 (3) \\
 &= \underline{RM 456,574.41}
 \end{aligned}$$

Table C2: Minor equipment costing

Minor Equipment	Unit Price	Quantity	Amount
Pump	RM 8,460.00	4	RM 33,840.00
Flow transmitter	RM 1,305.00	3	RM 3,915.00
Level transmitter	RM 516.00	3	RM 1,548.00
Temperature transmitter	RM 126.90	5	RM 634.50
Pressure transmitter	RM 748.00	1	RM 748.00
Flow valve	RM 400.00	4	RM 1,600.00
Manual Valve	RM 240.00	2	RM 480.00
		<b>TOTAL</b>	<b>RM 42,765.50</b>

$$\begin{aligned}
 \text{Therefore, Total CF (ISBL)} &= RM 456,574.41 + RM 42,765.50 \\
 &= \underline{RM 499,339.91}
 \end{aligned}$$

### 1.1.3 OSBL

$$\begin{aligned}\text{CF (OSBL)} &= 40\% \text{ of CF (ISBL)} \\ &= 40\% \text{ of RM } 499,339.91 \\ &= \underline{\text{RM } 199,735.96}\end{aligned}$$

### 1.1.4 Working Capital, CW

Working capital is the money need to get the plant running. For example, buying feedstocks, pay bills, etc., until product is sold & revenue begins. Simple rules estimate is between 5-30% of CF (ISBL):

$$\begin{aligned}\text{CW} &= 15\% \text{ of CF (ISBL)} \\ &= 15\% \text{ of RM } 499,339.91 \\ &= \underline{\text{RM } 74,900.99}\end{aligned}$$

### 1.1.5 Contingency

Contingency charges allow for the unexpected variations can be caused by:

- 1) Scope change
- 2) Change in economic scenario
- 3) Currency fluctuations
- 4) Labor disputes, weather problems, subcontractor problems
- 5) Validity of cost estimate and vendor quotes

$$\text{Contingency} = 10\% \text{ of } [\text{CF (ISBL)} + \text{CF (OSBL)}]$$

$$= 10\% \text{ of } (\text{RM } 499,339.91 + \text{RM } 199,735.96)$$

$$= \underline{\text{RM } 69,907.59}$$

### 1.1.6 Home Office Cost

$$\text{Home office cost} = 15\% \text{ of } [\text{CF (ISBL)} + \text{CF (OSBL)}]$$

$$= 15\% \text{ of } (\text{RM } 499,339.91 + \text{RM } 199,735.964)$$

$$= \underline{\text{RM } 104,861.38}$$

### 1.1.7 Total Capital Cost

Table C3: Capital cost estimation

<b>CAPITAL COST</b>	<b>RM</b>
1. Factory Building	354,725.00
2. Cf (ISBL)	499,339.91
3. Cf (OSBL)	199,735.96
4. Working Capital	74,900.99
5. Contingency	69,907.59
6. Home Office Cost	104,861.38
<b>TOTAL</b>	<b>RM 1,303,470.83</b>

## 1.2 Annual Operating Costs

The annual output of ready-to-eat Traditional Banana Dessert from 144,000.00 kg/yr of overripened banana is estimated to be 155,589.12 kg/yr

### 1.2.1 Fixed Operating Cost

Some costs are incurred regardless of the level of production / output rate. In addition, the plant must also generate enough cash flow to pay off the initial capital investment. The fixed operating cost includes:

#### 1.2.1.1 Maintenance Fee

Maintenance Fee = 4% of CF (ISBL)  
= 4% of RM 499,339.91  
= RM 19,973.60

#### 1.2.1.2 Insurance and taxes

Insurance, taxes = 1% of CF (ISBL)  
= 1% of RM 499,339.91  
= RM 4,993.40

### 1.2.1.3 Loyalty

$$\begin{aligned}\text{Loyalty} &= 1\% \text{ of CF} \\ &= 1\% \text{ of RM } 1,303,470.83 \\ &= \underline{\text{RM } 13,034.71}\end{aligned}$$

### 1.2.1.4 Labor cost

The labor requirements and costs are estimated as follows:

- The plant operates at 24 days per month and 12 months per year.
- The workers work for 8 hours per day without shift.

Table C4: Labor cost

<b>Designation</b>	<b>No. Required</b>	<b>Salary (RM/Month)</b>	<b>Amount (RM/Month)</b>	<b>Annual Labor cost (RM/y)</b>
Plant Manager	1	RM7,000	RM 7,000	RM 84,000
Supervisor	3	RM1,500	RM 4,500	RM 54,000
Operators	9	RM 1,000	RM 9,000	RM 108,000
Technicians	3	RM 2,300	RM 6,900	RM 82,800
				<b>RM 328,800</b>
		E.P.F Socso (10%).		RM 32,880
		<b>TOTAL</b>		<b>RM 361,680</b>

### 1.2.1.5 Environmental changes

Environmental changes = 1% of RM 1,303,470.83

= **RM 13,034.71**

### 1.2.2 Variable Cost

#### 1.2.2.1 Raw Material Cost

- 500 kg of banana is used for daily raw materials for 8 hours per day
- 959 piece of sausages are produced every one hours
- Length sausage casings need for one item is 0.18 m

Table C4: Raw materials cost

Raw Materials	Flowrate (kg/hr)	Unit cost (RM/kg)	Material Cost (RM/hr)
Banana	62.50	3.25	203.13
Wheat flour	10.47	2.46	25.76
Coconut milk powder	3.93	35.30	138.73
Sugar	5.23	1.13	5.91
Salt	0.11	0.49	0.05
	Length (meter/h)	Unit cost (RM/meter)	Material Cost (RM)
Casings	172.62	1.96	338.34
<b>TOTAL PER HOUR</b>			<b>RM 711.92</b>

Total raw material cost per year.

$$= \text{RM } 711.92 / \text{hr} * 8 \text{ hr} / \text{day} * 24 \text{ day} / \text{month} * 12 \text{ month} / \text{year}$$

$$= \underline{\text{RM } 1,640,263.68}$$

### 1.2.2.2 Utilities

Table C5: Utilities cost

Utility	Requirement	Annual Cost
Electricity	47.4 Kwh	RM 49,782.55
	<b>TOTAL</b>	<b>RM 49,782.55</b>

### 1.2.2.3 Packaging Material Cost

From the mass balance, the mass Ready-to-eat Traditional Banana Dessert produced per year

$$= 0.0704 \text{ kg/piece} * 959 \text{ pieces/hr} * 8 \text{ hr/day} * 24 \text{ day/month} * 12 \text{ month/year}$$

$$= \text{155,551.33 kg / yr}$$

Total piece that the plant produce for every year

$$= 959 \text{ pieces/hr} * 8 \text{ hr/day} * 24 \text{ day/month} * 12 \text{ month/year}$$

$$= \text{2,209,536 piece / yr}$$

$$\text{Mass of one piece of RTE Banana Dessert} = 0.0704 \text{ kg/piece}$$

One pack of product consist 10 piece of frozen RTE traditional Banana Dessert. So weight for one pack of product is:

$$= 0.704 \text{ kg/pack}$$

Prices of one piece of packaging material = RM0.039/ pack

Total piece that the plant produce for every year (1 pack consist 10 piece of product)

= 2,209,536 piece / yr / 10

= 220,954 packs / yr

Therefore, the packaging material cost = 220,954 packs / yr \* RM0.039/ pack

= RM 8,617.21

#### 1.2.2.4 Overheads

Overheads = 50% of Labor Cost

= 50% of RM 361,680

= RM 180,840.00

### 1.2.2.5 Total Operating Cost

Table C6: Total annual operating cost

OPERATING COST	CATEGORY	AMOUNT (RM)
	Maintenance Fee	RM 19,973.60
	Insurance, taxes	RM 4,993.40
Fixed Operating Cost	Loyalty	RM 13,034.71
	Labor cost	RM 361,680.00
	Raw Material Cost	RM 1,640,263.68
Variable Cost	Utility Cost	RM 49,782.55
	Packaging Material Cost	RM 8,617.21
	<b>TOTAL</b>	<b>RM 2,098,345.15</b>

### 1.2.3 Annual RTE Banana Dessert Output and Processing Cost

Annual Output

Annual mass production of RTE Banana Dessert = 155,589.12 kg/yr

Processing Costs per kg of RTE Banana Dessert = RM 2,098,345.15 / 155,589.12

kg/yr

= **RM 13.49 / kg**

**APPENDIX D**

**PROPOSED PROJECT FINANCIAL ASPECT**



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## 1.1 Revenue

It is an income generated from sales of main product and by product.

From the mass balance, the amount of RTE banana dessert produced per year

$$= 67.53 \text{ kg/hr} * 8\text{hr/day} * 24 \text{ day/month} * 12 \text{ month/yr}$$

$$= 155,589.12 \text{ kg/yr}$$

Mass of one piece of RTE banana dessert

$$= 0.0704 \text{ kg/piece, Prices of one piece of RTE banana dessert} = \text{RM1.20/piece}$$

Amount of RTE banana dessert produced per year

$$= 155,589.12 \text{ kg/yr} / 0.0704 \text{ kg/piece}$$

$$= 2,210,072.73 \text{ piece/yr}$$

By setting the price of each piece of yogurt at RM 1.20, the annual gross sale of the by product is RM 2,652,087.28 / year.

## 1.2 Income And Expenditure Projection

### 1.2.1 Gross Margin

Gross Margin = Revenues – Raw Materials Costs

$$= \text{RM } 2,652,087.28 - \text{RM } 1,640,263.68$$

$$= \text{RM } 1,011,823.60$$

### **1.2.2 Cash Cost Of Production**

**CCOP = Variable Costs + Fixed Costs**

**= RM 2,098,345.15**

### **1.2.3 Gross Profit**

**Gross profit = Revenues – CCOP**

**= RM 2,652,087.28 – 2,098,345.15**

**= RM 553,742.13**

### **1.2.4 Net Profit**

**Net Profit = Gross Profit – Taxes (20% OF Gross Profit)**

**= RM 1,216,754.95 – (0.2 \* RM 1,216,754.95)**

**= RM 442,993.70**

## 1.2.5 Project Cash Flow

Table D1 : Project Cash Flow

Year	Capital investment (RM)	Annual cost (RM)	Annual revenue (RM)	Annual tax charge (RM)	Net cash flow (RM)	Cumulative cash flow (RM)
0	0	0	0	0	0	0
1	1,303,470.83	0	0	0	1,303,470.83	-1,303,470.83
2	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	-860,477.13
3	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	-417,483.43
4	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	25,510.27
5	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	468,503.97
6	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	911,497.67
7	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	1,354,491.37
8	0	2,098,345.15	2,652,087.28	110,748.43	442,993.70	1,797,485.08

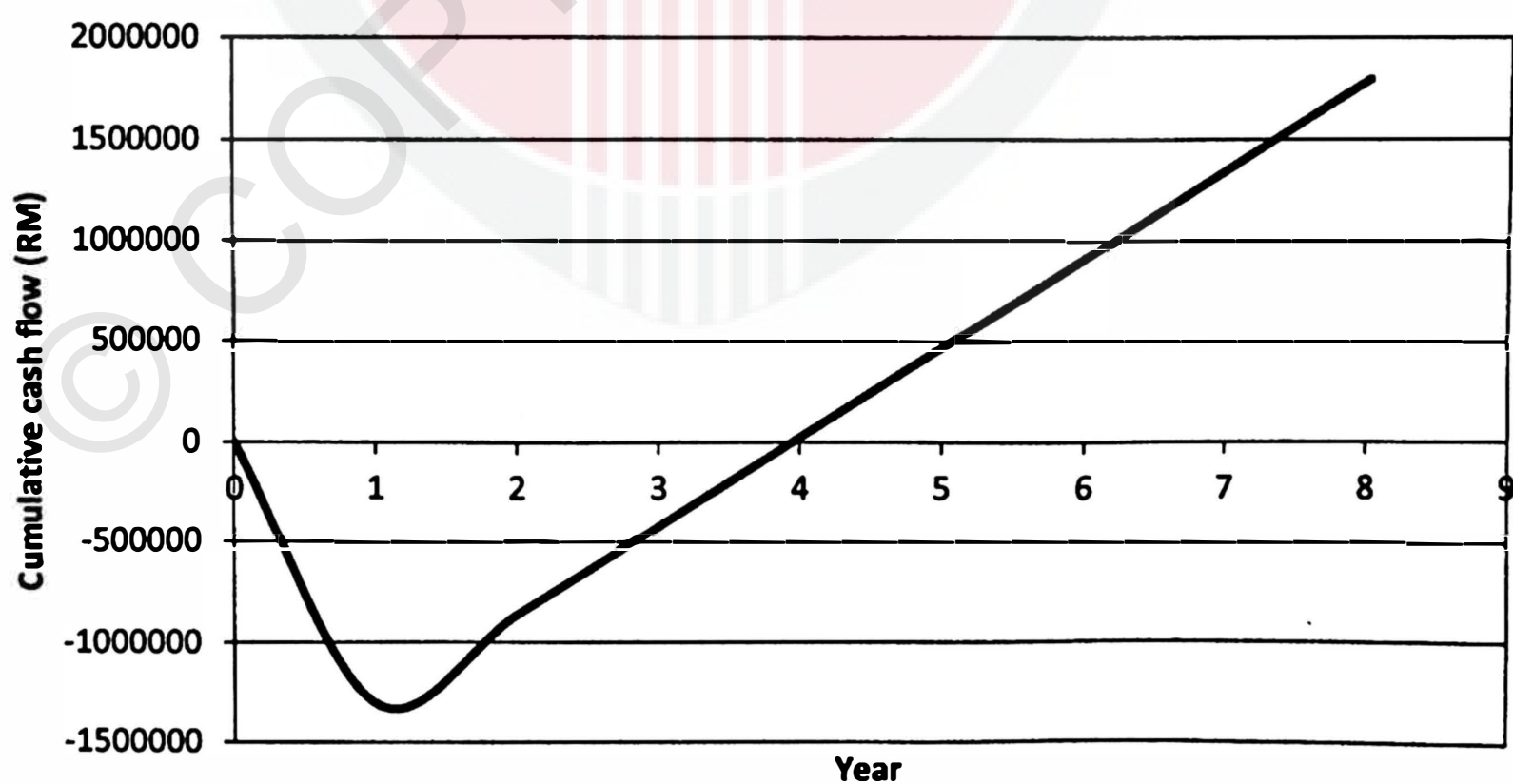


Figure D1 : The payback period of the project

### 1.3 Return On Investment

$$\text{ROI} = \frac{\text{Net Annual Cash Flow}}{\text{Total Capital Cost}}$$

$$\text{ROI} = \frac{442,993.70}{1,303,470.83}$$

$$= 33.96\%$$

### 1.4 Payback Period

$$\text{Payback period} = \frac{\text{Total Capital Cost}}{\text{Net Annual Cash flow}}$$

$$\text{Payback period} = \frac{1,303,470.83}{442,993.70}$$

$$= 3 \text{ years}$$