



UNIVERSITI PUTRA MALAYSIA

NEW FORMULATION OF BOBA USING SWEET POTATO FLOUR

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ABSTRACT

Boba phenomenon is extensively popular by all generations from youngest to the eldest. Boba which known as tapioca pearls are originally made up of tapioca starch which then is served with milk tea. Sweet potato (*Ipomoea batatas*) has low calories than tapioca which can give benefits to the consumer since it has a lot of nutritional value such as high β -carotene, rich in vitamin C, high value of dietary fiber, antioxidants level and protein content. Therefore, in this research sweet potato flours were prepared in three sample where sweet potato flour was substituted with 50% SPF and 50% TF and another two sample consist of 100% SPF with added of two types of gelatin (fish or bovine gelatins) to make the boba pearls. There are a few analysis being run to these substitutions which are pH, textural properties which are chewiness and chewing energy and water holding capacity. According to the results, the pH all samples lies in acidic condition where in range of 4.52 – 5.71. For textural properties, the result of sample C which consists of 100 % SPF with fish gelatin showed lower value of chewiness with 217.678 ± 3.8 g and 4136.833 ± 39.1 g.% of chewing energy compared to other samples. Sample C also shows high water holding capacity with value of 0.9 g water/ g dry matter due to presence of gelatin itself. The sensory analysis conducted shows that sample C has low chewiness which being the most important parameters and thus being chosen to be the most sample the like. Therefore, with the growing of boba phenomenon, boba lovers able to be consume boba in for all generation without any hesitation while utilizing all the benefits exist in the sweet potato.

ABSTRAK

Fenomena Boba sangat digemari oleh semua generasi dari generasi kanak-kanak hingga generasi tua. Boba yang dikenali sebagai bebola ubi kayu pada mulanya terdiri dari pati ubi kayu yang kemudian disajikan dengan teh susu. Ubi keledak (*Ipomoea batatas*) mempunyai kalori yang rendah daripada ubi kayu yang dapat memberi manfaat kepada pengguna kerana ia mempunyai banyak nilai pemakanan yang tinggi seperti β -karoten, kaya dengan vitamin C, nilai serat makanan yang tinggi, kadar antioksidan dan kandungan protein yang banyak. Oleh itu, dalam penyelidikan ini tepung ubi keledak disediakan dalam tiga sampel di mana tepung ubi keledak digantikan dengan gabungan 50% tepung ubi keledak dan 50% tepung ubi kayu serta dua sample yang lain terdiri daripada 100% tepung ubi keledak dengan penambahan dua jenis gelatin (gelatin ikan atau sapi) untuk buat boba. Terdapat beberapa analisis yang dijalankan untuk penggantian ini seperti pH, sifat tekstur yang merupakan kenyal dan tenaga mengunyah dan daya tahan air. Berdasarkan keputusannya, pH semua sampel berada dalam keadaan berasid anggaran antara 4.52 - 5.71. Untuk sifat tekstur, hasil sampel C yang terdiri daripada 100% SPF dengan gelatin ikan menunjukkan nilai kekenyalan lebih rendah iaitu 217.678 ± 3.8 g kenyal dan nilai tenaga mengunyah yang rendah iaitu 4136.833 ± 39.1 g.% berbanding dengan sampel-sampel yang lain. Sampel C juga menunjukkan daya tahan air yang tinggi dengan nilai 0.9 g air / g bahan kering kerana adanya gelatin itu sendiri. Analisis deria yang dilakukan menunjukkan bahawa sampel C telah dipilih untuk menjadi boba kegemaran kerana ia mempunyai tahap kenyalan yang rendah yang dianggap sebagai parameter yang penting dalam pembuatan boba. Oleh itu, dengan berkembangnya fenomena boba, pencinta boba dapat menikmati boba tanpa batasan

untuk semua generasi sambil memanfaatkan semua kebaikan yang terdapat dalam ubi keledak.

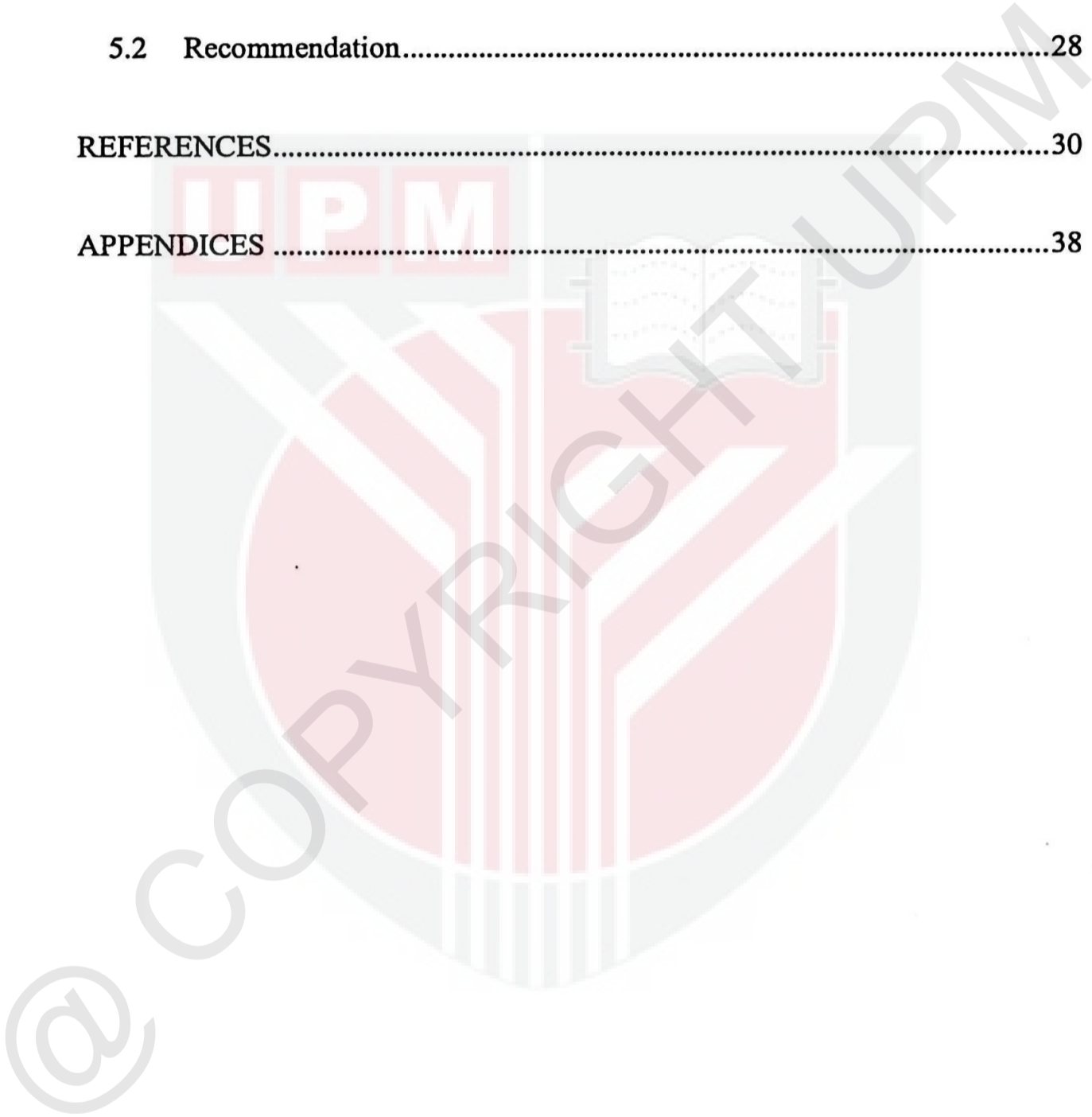


TABLE OF CONTENT

APPROVAL.....	ii
PERMISSION.....	iii
ACKNOWLEDGEMENT	iv
ABSTRACT.....	v
ABSTRAK.....	vi
TABLE OF CONTENT.....	viii
LIST OF TABLES.....	xi
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS.....	xiii
CHAPTER 1 INTRODUCTION.....	1
1.1 Background	1
1.2 Problem Statement	2
1.3 Objectives.....	3
1.4 Scope of the Study.....	3
CHAPTER 2 LITERATURE REVIEW.....	4

2.1	Overview of Sweet Potato	4
2.1.1	Sweet Potato (<i>Ipomoea batatas</i>).....	4
2.1.2	Benefits of Sweet Potato	6
2.2	Overview of Gelatine	9
CHAPTER 3 METHODOLOGY.....		11
3.1	Raw Materials.....	11
3.2	Preparation of Boba.....	12
3.3	Determination of pH Value	14
3.4	Determination of Textural Properties.....	14
3.5	Water Holding Capacity.....	14
3.6	Sensory Analysis	15
CHAPTER 4 RESULTS AND DISCUSSION		16
4.1	pH Value.....	16
4.2	Textural Properties	17
4.2.1	Chewiness.....	17
4.2.2	Chewing Energy	19
4.3	Water Holding Capacity.....	21

4.4 Sensory Analysis	23
CHAPTER 5 CONCLUSIONS AND RECOMMENDATION.....	27
5.1 Conclusion.....	27
5.2 Recommendation.....	28
REFERENCES.....	30
APPENDICES	38



LIST OF TABLES

- Table 1 – Formulation of Ratio Boba
- Table 2 – The pH Value of Formulation Boba



LIST OF FIGURES

- Figure 1 – *Ipomoea Batatas* Sweet Potatoes
- Figure 2 – Sweet Potato Flour
- Figure 3 – Preparation steps of boba
- Figure 4 – Chewiness of the sample
- Figure 5 – Chewing energy of the sample
- Figure 6 – Water Holding capacity of the sample
- Figure 7 – Sensory evaluation for appearance parameters
- Figure 8 – Sensory evaluation for taste parameters
- Figure 9 – Sensory evaluation for chewiness parameters
- Figure 10 – Sensory evaluation for sample like the most
- Figure 11 – Sensory evaluation for considering to change current boba

LIST OF ABBREVIATIONS

SP	– Sweet potato
SPF	– Sweet potato flour
TF	– Tapioca flour
BG	– Bovine gelatin
FG	– Fish gelatin
WHC	– Water holding capacity
W_0	– Weight of the sample
W_1	– Sum of weight of centrifuge tube
W_2	– Sum of weight of centrifuge tube and sediments

CHAPTER 1

INTRODUCTION

1.1 Background

“If you have never tasted it, it is best to start with a basic boba milk tea of any flavor that you are particularly inclined toward such as strawberry or coconut” (Chris, 2019). A quick tip by Chris which retrieved from MyDomaine.com indicates the reasons of high growth of boba drinks. Chris also believed that the boba itself gives the unique taste to any flavor of drinks that is chosen. Generally, when you discover something strong and chewy in your beverage, it is an ideal opportunity to require the waiter however that is the thing that boba drinks are all about (Jeffrey, 2001).

Boba which also known as tapioca balls or tapioca pearls originally discover from Taiwan in the early of 1980s and is obtained by extracting the starch from cassava. But lately, there has been an ascent in the trend where people from all generations feel the “addictive” and “pleasurable” when they chew a soft texture ball shape in their mouth which is boba. Commonly, boba will be served with milk tea which known as Bubble Milk Tea (BMT). BMT become one of young generations favorite drinks as abundant franchises with different brands provide seats to their shop, so they can sit down and having a good chat while chewing the gummy boba inside their mouths.

1.2 Problem Statement

Nowadays, Boba has been one of the most popular topping added into the drinks such as tea, coffee and smoothies. There are many bubble tea stores can be located anywhere such as Tealive, Daboba, Xing Fu Tang and others. Commercialize boba which in small ball shape is made up of tapioca starch that is boiled in the boiling water to produce chewy balls which then will be added to cold beverages such as smoothies, tea and blended beverages. According to Weil (2012), online nutrition facts claim that this boba beverages has high amounts of sugar. This claim then is supported by a research on the calorific value of boba drinks that show in 16-ounce serving of boba milk tea contain between 200 - 450 calories depending on the type of additional ingredients is added (FatStraws, 2015; Weil 2012; Carey 2015). A study by Jae, David, and Loan (2016) found that in 60 grams of tapioca balls, the total of calories found is 77.9 calories with total sugar content in 2.6 grams.

In practicing a healthy lifestyle, the ingredients used to make boba which is from tapioca can be replace by using sweet potato. Sweet potato contains many good nutritional values such as rich in beta carotene and vitamin C also high in dietary fiber which the product produced from this sweet potato variety can be claimed as a good supplement food (Mohd Hanim, Chin, & Yusof, 2014). According to Nutritionix website, for 60 grams of sweet potatoes, the calories found in sweet potato is approximately 54 calories which is lower than calories in tapioca. Besides, the fiber contain in VitAto is insoluble, hence this advantage can be applied to diabetes patients where this insoluble fiber is basically promoting insulin sensitivity that will regulate the amount of sugar in the blood.

1.3 Objectives

The purpose of this project is listed as below:

- I. To develop a formulation from various ratio of tapioca flour and sweet potato flour with added of variety gelatins
- II. To evaluate the chewiness, chewing energy and sensory analysis of new formulation of boba.
- III. To analyzed the pH value and water holding capacity of new formulation of boba

1.4 Scope of the Study

This project is to develop the formulation of boba from sweet potato to be compared the textural analysis with commercialize boba. This project also studies the effect of gelatin presence in combination of sweet potato flour in boba development.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview of Sweet Potato

2.1.1 Sweet Potato (*Ipomoea batatas*)

Sweet potato (*Ipomoea batatas*) is perennial shrubs that originate in the tropics of ideal continent of America which is planted in sandy soils or soil that contain high absorption of water (Izalin, Meriam & Hassan, 2014). Sweet potato has the characteristics which large in size, starchy, originally sweet-tasting and tuberous root where their shoots or young leaves usually can be eaten as greens (Williams, 1968). This sweet potato, normally found in orange fleshed colour that playing important roles in human health. Figure 1 shows the sweet potato of *Ipomoea batatas* variety.

Sweet potato is important crop for developing countries by their growing period where this sweet potato required a short period of growing which usually in 90 – 120 days (Mohd Hanim et al., 2014). Besides being one of the basic foods in certain country such as Soloman Islands, this sweet potato playing a very important roles in human diets

where they consist a lot of nutritional value. These nutritional qualities are mostly required and meeting nutritional need by humans such as carbohydrate, fiber, vitamin A and C and high protein contents (Mais and Brennan, 2008).

Mohd Hanim et al., (2014), stated that in Malaysia, according to the tubers crop popular ranks, sweet potato is the second most popular next to cassava and has been developed on a small scale since 17th century. It is usually being used as one of basic ingredients in producing snacks and commonly well known in traditional confectionery such as *onde-onde*, *bingka* and *keria*. Maleki (2001) stated that this sweet potato also can be used as supplementary food for infants and can be compared to other cereal baby foods that usually contain wheat that causing hypoallergenic effect to the babies due to wheat content. This statement is supported by Sabeetha et al., (2016) that adding as this sweet potato also free-gluten contents that usually caused allergic and digestion problems to the babies.



Figure 1: *Ipomoea batatas* Sweet Potatoes

SP is found to be suitable to use in food products that require continuous thermal processing such as food for children and elderly (Aprianita et al., 2009). This may be due to the presence of high protein content that prolonged the starch swelling process that proceeded to increase in velocity. Continuous thermal processing products are defined as products that undergo a process with combination of temperature and time required to eliminate a desired number of microorganisms from a food product continuously. For example, baby food products required continuous heating process to ensure the microorganisms in food is killed and safe to be consumed.

2.1.2 Benefits of Sweet Potato

Ipomoea batatas is one of variety of sweet potato that contain high nutritional value compared to other varieties. The texture of this sweet potato which is creamy and soft enhanced people to be included in merely dessert ingredients. Besides, *Ipomoea batatas* is found to be rich in nutrient such as minerals, vitamins, fibers and β -carotene due to their original flesh orange color (Christine et. al., 2012).

SP is an important source of vitamin A due to high levels of β -carotene (Van et. al., 2005). This vitamin A is essential to fight body infections and remain resistant to prevent further infections. There are many serious illnesses around the world due to vitamin A deficiency including decrease resistance for infectious diseases and increased the mortality for both pregnant and lactating women and their children (West, 2003). Therefore, by consuming this SP, the β -carotene content is transformed into vitamin A in the liver where according to Gurunadh et. al, (2005) for every one molecule of β -carotene produced two molecules of vitamin A.

Next, SP is categorized as low to high glycemic index scale depending on how the SP is prepared. However, several studies shown that SP able to minimize insulin secretion and both low and high blood sugar levels for diabetics (McClelland, Allen & Zakir, 2007). The glycemic index is defined as a scale that provide ranks of 0-100 for carbohydrates content in food which able to indicate the reaction of the food intake of a person that can cause rises in blood sugar level. For low glycemic index of SP indicates that the sugar release into the bloodstream are low which make it differ to other starchy food. Therefore, the blood sugar of consumer able to be control which it does not go low or high due to this steady release of sugar (Bernard, Beatrice and Giovanni, 2004).

According to Slavin (2013), SP is one of the examples of high fiber food which able to lower the blood sugar level of individuals suffering type I diabetics. This statement is supported by Adam et. al., (2015) where in the range between 10-15% of the fiber in this SP consists of pectin which is insoluble fiber that show significant effects in reducing the food consumption and increase level of blood sugar. Most of the fiber content in this SP are insoluble which plays their own roles to fight diabetes. Approximately 77% of the fibers are insoluble which function to promote insulin sensitivity that helps to reduce blood sugar level (Weickert and Pfeiffer, 2008).

Despite of the benefits of vitamins and fibers contents for diseases, consuming SP able to release stress levels in body. A.F. Sanoussi et. al., (2016) found that one of the minerals in SP is essential to control body functioning which are magnesium. Magnesium is proved to be able reducing level stress and anxiety is a person (Emily, 2011). Studies by Walker et. al., (1998), De Souza et. al., (2000), and Felice et. al., (2010) found that lacks of magnesium in a person due to modern diet resulted in higher

cases of depression as reported across the world. A study conducted by Emily (2011) stated that the levels of anxiety and depression after a traumatic injury able to be controls and protects by increasing the magnesium intake. Besides of anxiety and depression, magnesium helps to reduce the insomnia in older generation (Abbasi et. al., 2012). Due to insomnia, it triggered stress and able to lead to depression problem due to difficult to sleep.

Besides having of high nutritional value, the SP flour granules also significantly has larger surface area that allowing to produce a product with smooth texture. Therefore, this SP flour can be applied to several different processing products in food industry that required a starch having smaller size of granules (Huang, Lin, & Wang, 2006). A snack food that is being produced from fine granules usually having higher binding strength which prevent the snack to be easily broken into pieces.

Lastly, according to a study by Aprianita, et. al., (2009) found that SP is suitable to use in food products that require continuous thermal processing such as food for children and elderly. This may due to the presence of high protein content that prolonged the starch swelling process that proceed to increase in velocity. Continuous thermal processing products are defined as products that undergo a process with combination of temperature and time required to eliminate a desired number of microorganisms from a food product continuously. For example, baby food products required continuous heating process to ensure the microorganisms in food is killed and safe to be consume.

2.2 Overview of Gelatine

Gelatin is a derivation natural structural protein called collagen which majorly can be found in connective tissue of animals and others tissue (Balian and Bowes, 1977; Belitz and Schieberle, 2004; DeMan, 1999). Gelatin is one of the most generally utilized biopolymers and is included to nourishments, drugs, beautifying agents and gelling agent (Gudmundsson, 2002; Karim and Bahat, 2009; Yang et al., 2007; Zhou and Regenstein, 2004). Gelatin usually used to increase the viscosity system to viscosity gel and being one of the useful characteristics described as melt-in-the mouth.

Gelatin not only made out of one size of collagen portion or peptide chain, however is a blend of numerous divisions shifting in size, including the entire α -chain of the tropocollagen atom and hydrolytic pieces of parts of the α -chains of various lengths (Eastoe and Leach, 1977). Gelatin gels for the most part have a softening temperature under 35°C , that is, underneath human internal heat level, which makes gelatin exceptional as far as its tangible viewpoints, particularly flavor discharge which is especially wanted for some food applications (Boran and Regenstein, 2009).

Gelatin is a gelling operator that can frame thermo reversible gels, which implies that when the gelatin gel is warmed, it softens and again transforms into a fluid. At that point, it can reverse back the gel structure when the arrangement is cooled once more (Stainsby, 1977). The most important characteristic is the gel strength of the fish gelatin is the highest compared to most of the gelling which usually obtained from vegetables (Badii and Howell, 2006). The difference between melting and gelling temperature of gelatin gels is little than that of other gelling operators, which be one of the benefits for

some specific application such in food applications including jams and custards (Jones, 1997).



3.1 Raw Materials

The sweet potato flour (Azuri, Malaysia) was purchased from a bakery shop located at Subang Jaya while tapioca flour (Cap Kapal ABC, Malaysia) was bought from nearby supermarket located at Serdang, Selangor. Fish and bovine gelatins were obtained from supplier (Phywon System Ingredient Sdn. Bhd., Malaysia).



Figure 2: Sweet Potato Flour

3.2 Preparation of Boba

The sweet potato flour was mixed formulated with tapioca flour and gelatin which function as gelling agent. The formulations of the mixture are shown in Table 1. There were 3 important steps in boba preparation.

Firstly, sweet potato flour, tapioca flour and gelatin powder were weighted into a bowl. Then, 50 mL of filtered water was boiled inside a small size pot until it reached boiling point, 100°C. Next, pour 13.2 mL of boiled water slowly while stirring continuously by using a spoon until they started to stick together. Then, the batter was kneaded using hands to produce a thick dough.

The thick dough was rolled and cut into 5 mm long batons. The batons were rolled between palms to make a round shape of boba.

Finally, 200 mL of filtered water was boiled again in a medium size pot. The raw boba was poured slowly into the pot as the water boiled vigorously. The boba was stirred continuously until they were completely tender. The boba was cooked around 15 min to ensure the boba is fully cooked. Then, the cooked boba was drain by using a scoop and poured into a plate to let them cool. The cooled boba were then kept inside an airtight container and stored at room temperature until further process took place.

Table 3.1: Formulation ratio of Boba

Sample	Formulation of boba batter	Mass of sweet potato flour (SPF), g	Mass of tapioca flour (TF), g	Mass of fish gelatin, g	Mass of bovine gelatin, g
A	50% SPF	10.0	10.0		
B	100% SPF	20.0			1.0
C	100% SPF	20.0		1.0	
D	Commercial boba				

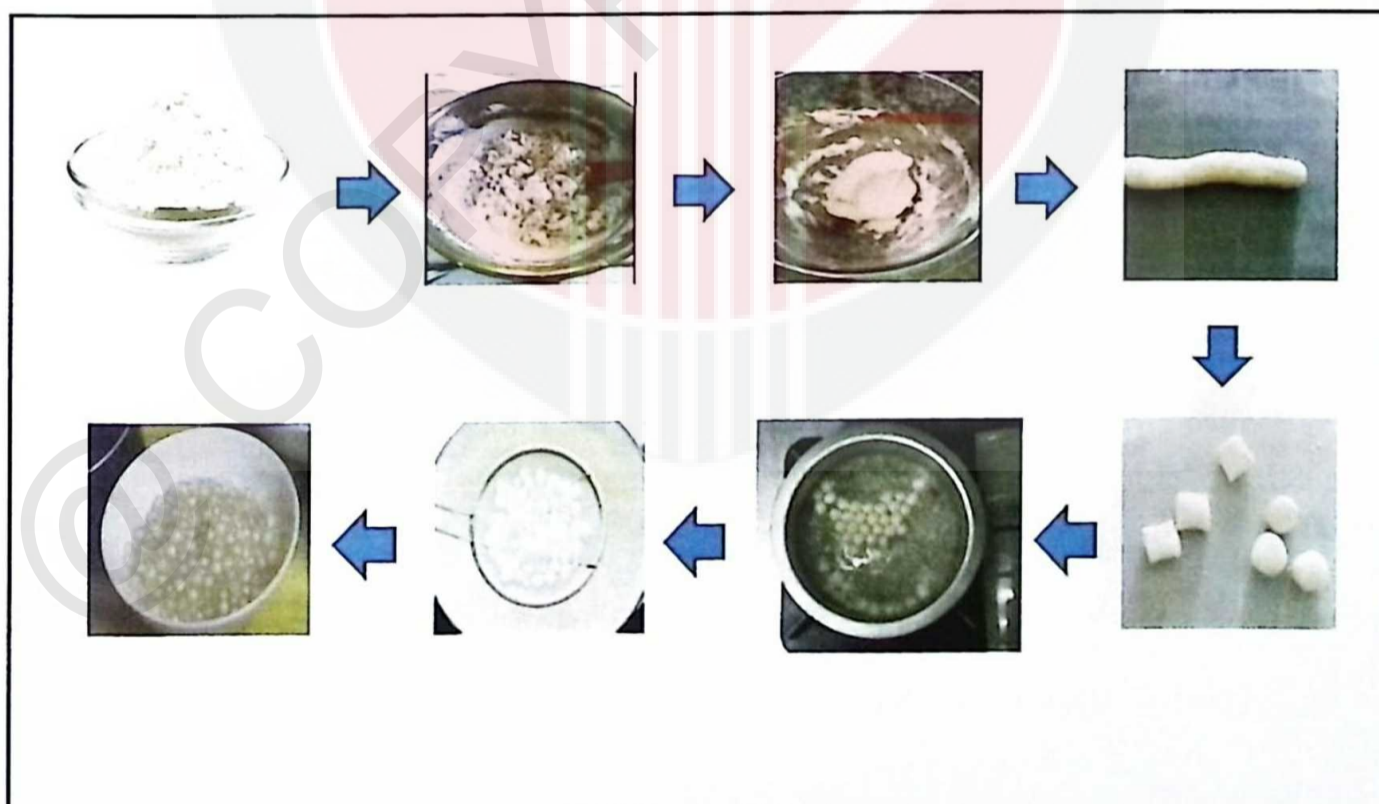


Figure 3: Preparation Steps of Boba

3.3 Determination of pH Value

Determination of pH value was following the method by Ashogbon (2014). Each of different formulation ratio with total weight of 5 g was filled into a beaker and mixed with 20 mL of distilled water. The resulting suspension was stirred for 5 min and left to settle for 10min. The pH of the supernatant was measured by using a calibrated digital pH meter (PB-10, Sartorius, Germany) in triplicates.

3.4 Determination of Textural Properties

The textural properties were determined by using Exponent Software that was installed in a texture analyser (TA-Xt plus, Stable Micro Systems Ltd, United Kingdom). Data such as chewiness, stiffness and chewing energy were determined by installed software in the texture analyser. The probe used to determine all the properties as mentioned above was SMS/Chen-Hoseney Dough Stickiness RiData. Produced boba was placed under the texture analyser to measure the listed properties which are chewiness and chewing energy. For each test, 5 bobas with same weight were chosen to be test and in triplicate.

3.5 Water Holding Capacity

One g sample was added with 5mL of distilled water and vortexed for 1 min to ensure the sample and water mix well. Next, the mixtures were centrifuged for 10 min at 3000g at room temperature in a centrifuge (Universal 320, Hettich Zentrifugen, Germany). The supernatant was then decanted carefully and the mass left in the tube was measured

using the electronic balance. The water holding capacity was calculated using the formula below:

$$\text{Water Holding Capacity} = \frac{W_2 - W_1}{W_0}$$

where W_0 is the weight of the sample, W_1 is the sum of weight of centrifuge tube and sample and W_2 is the sum of weight of centrifuge tube and sediments.

3.6 Sensory Analysis

Sensory analysis was done for all the samples A, B and C which were prepared in the lab and sample D was bought from online store. The analysis was conducted by 50 untrained panelist who were randomly selected among students at Faculty of Engineering, University Putra Malaysia. Every panelist was given 4 samples each which are samples A, B, C and D and an evaluation form for them to fill in. This analysis was carried out to analyze consumer's acceptability on several criteria and parameters such as appearance, texture, taste and chewiness. The analysis additionally asked the panelists on which test they like the most, why they like the chosen test and finally, will they consider to change the normal boba to their chosen decision.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 pH Value

The pH value of the three different formulation SPF ranged from 4.52 - 5.71 (Table 2). This pH value indicates that all of the three formulations lies in acidic condition. This result agreed and accepted as common pH value of sweet potato flour is 5.6 pH which reported by Adeleke and Odedeji (2010). Sample D shows slightly different to the other three samples where it has the highest acidic level. According to Riaz (2016), the pH value of a good quality of tapioca starch is in range between pH of 4.7-5.3. In this state, the tapioca starch able to produce high level of viscosity and plays role as an excellent binder. Moreover, the higher value of acidic pH in sample D may also being influenced by the sugar content in the sample. According to Symons (2018), sugar makes the pH level in the body imbalance lead to more acidic, hence, leading to more chronic diseases such as kidney stones and oxidative stress. Meanwhile, sweet potato generally contains 37% of ascorbic acid content as stated by United States Department of Agriculture (USDA, 2012), therefore this might be the reason of sweet

potato flours are slightly less acidic. Adeleke and Odedeji (2010) stated that acidic products tend to have a longer shelf life as the spoilage bacteria do not grow in acidic condition. This statement then is proved when Smith and Stratton (2007) claimed that a pH of 4.6 and lower will not support the growth of *Clostridium botulinum* in food preservation for longer shelf- life of product.

Table 2: The pH value of formulation Boba

Sample	pH value	Condition
A	5.50 ± 0.025	Low acidic
B	5.71 ± 0.023	
C	5.41 ± 0.005	
D	4.52 ± 0.013	High acidic

4.2 Textural Properties

4.2.1 Chewiness

Chewiness is the energy required to chew a solid food until it is ready for swallowing. Figure 4 shows the graph of chewiness, g food of four samples which A represents mixture of 50% SPF and 50% tapioca flour, B represents 100% SPF with added of bovine gelatin, C represents 100% SPF with added of fish gelatin and D

represents commercialize boba which being compared with the formulated boba in three readings.

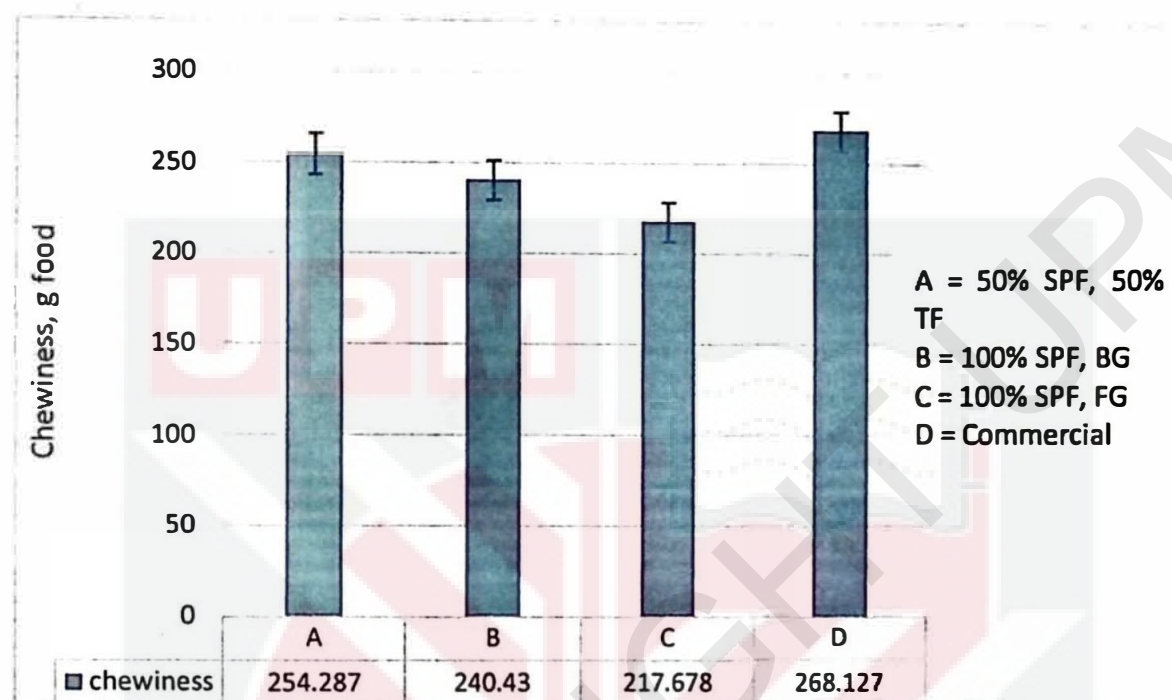


Figure 4: Chewiness of the samples

Sample D which is commercialized boba has the highest value of chewiness (268.127 ± 3.803 g food) compared to other samples. According to Bhaduri et. al., (2015), the chewiness of food products can be determined by the value of their cohesiveness. Adhesiveness is the work reaction required to move the food particle in adhered matrix manner such as from mouth to teeth, tongue and palate. From a studied done by Bulathgama et. al., (2020), they found that the adhesiveness of the cooked tapioca starch is the highest with the value of 0.5 Pa compared to other starch.

Sample C that is formulated between 100% SPF and added with fish gelatin shows the best result where the chewiness value is 217.678 ± 3.803 g food, produced the lowest value compare to other samples. The super-helix structure of gelatin gel is

stabilized by the steric restrictions which play role to form hydrogen bond between the imino acid (Te Nijenhuis, 1997). Fish gelatin has low gelling effect due to lower content of imino acid (Haug et. al, 2004a), hence, being the reason of low chewiness value.

4.2.2 Chewing Energy

Chewing is described as an action of making the food intake to be easier to swallow. The action of chewing all the food taken can be considered as a compulsory action to prevent any harmful effect such as choke.

Referring to the Figure 5, it shows a graph of chewing energy required to chew all the samples prepared. Sample C has lower chewing energy required (4136.833 ± 39.08382 g.%) while sample D has the highest energy needed to chew (4604.681 ± 39.08382 g.%). A study conducted by Haug et. al. (2004a) found fish gelatin contain low gelling and melting temperature due to lower content of proline and hydroxyproline. This statement is supported by Muyonga et. al (2004) where they stated that the proline and hydroxyproline content for fish gelatin lies in range of 22-25% compared to mammalian gelatin which is 30%. Therefore, sample C with mixture of SPF and fish gelatin produces lower chewing energy as the fish gelatin easy to denature at low melting point due to lower imino acid contents (proline and hydroxyproline) (Grossman & Bergman, 1992) added with lower starch content in the SPF.

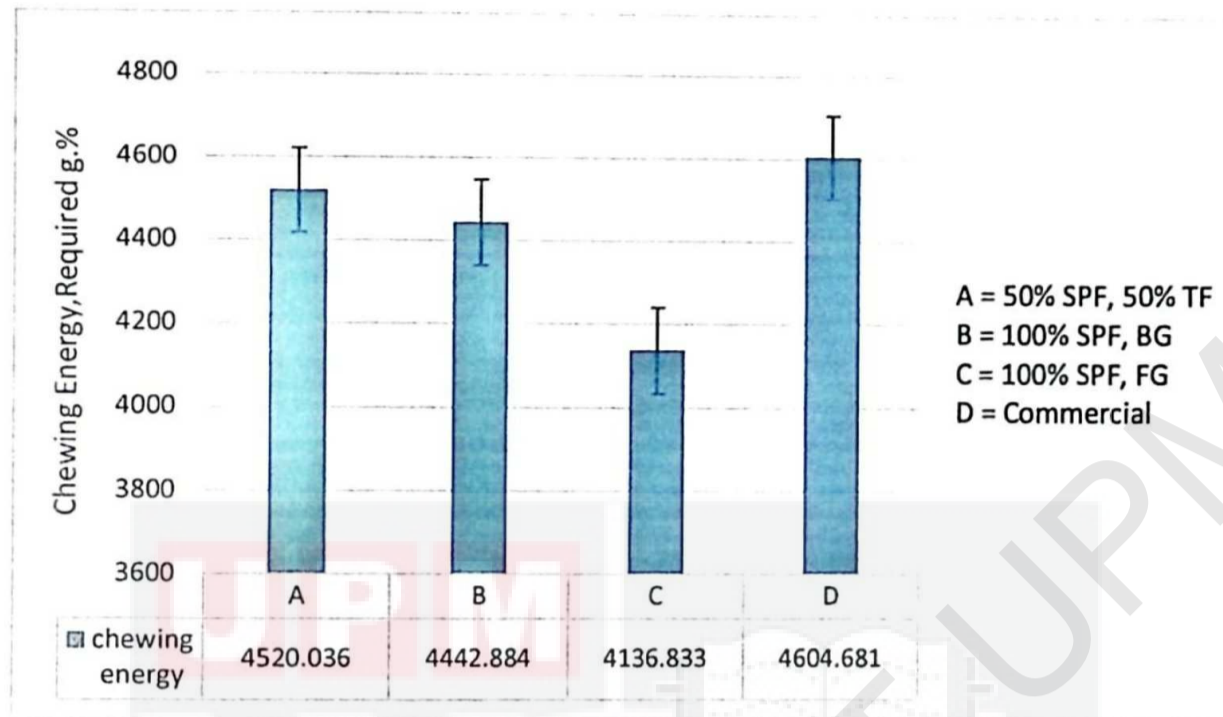


Figure 5: Chewing energy of the samples

Sample D has the highest chewing energy required (4604.681 ± 39.08382 g.%). Sample D is a commercialized boba where commonly made up from tapioca starch. According to International Starch Trading, the amylose content in tapioca flour is 17% which slightly less than sweet potato which is 18%. The higher the amylose content, the greater the energy required to chew it. Amylose structurally is a linear polymer and because of this linearity, they are more ready and extensive for hydrogen bonding, hence, more energy needed to break the bond (Hegenbart, 1996). However, this result slightly differ to the theory may due to the extra ingredients being added in the boba which affects it.

4.3 Water Holding Capacity

Water holding capacity (WHC) refers to the ability of the sweet potato flour to hold inherent or added moisture through several application forces such as heating and centrifugal. Figure 6 represents an increase of water holding capacity for sample A, B and C. The water holding capacity poses highest value for sample C with value of 0.9 g water/ g dry matter.

Mu. et. al., (2017) stated that the water holding capacity of viscous food products effected by the moisture content. The higher the moisture content, the higher the water holding capacity. According to AOAC (1990), the average moisture content of sweet potato is $81.8 \pm 0.2\%$ (w.b.) which can be considered as high moisture content. Therefore, the results are in agreement with the studies as sample C which formulation of 100 % SPF with added of fish gelatin has the highest water holding capacity due to the higher moisture content.

Besides, Pinnavaia and Pizzirani (1998) stated that the water holding capacity also can be relate to the gelatinization of the starch. International Starch Trading of Denmark said that sweet potato has higher amount of starch compared to tapioca. Therefore, contain higher amount of starch indicates higher amount of amylose and amylopectin content. According to Liu (2005), starch gelatinization process started when the starch granules where exposed to heat in the presence of water that cause the molecular order collapse within the starch producing irreversible changes. When the temperature of a suspension of starch granules in excess of water increases to the gelatinization temperature, the starch granule will lose its birefringence and crystallinity,

with concurrent swelling. This change is irreversible and called as gelatinization. The total gelatinization usually occurs over a temperature range (10-15 °C).

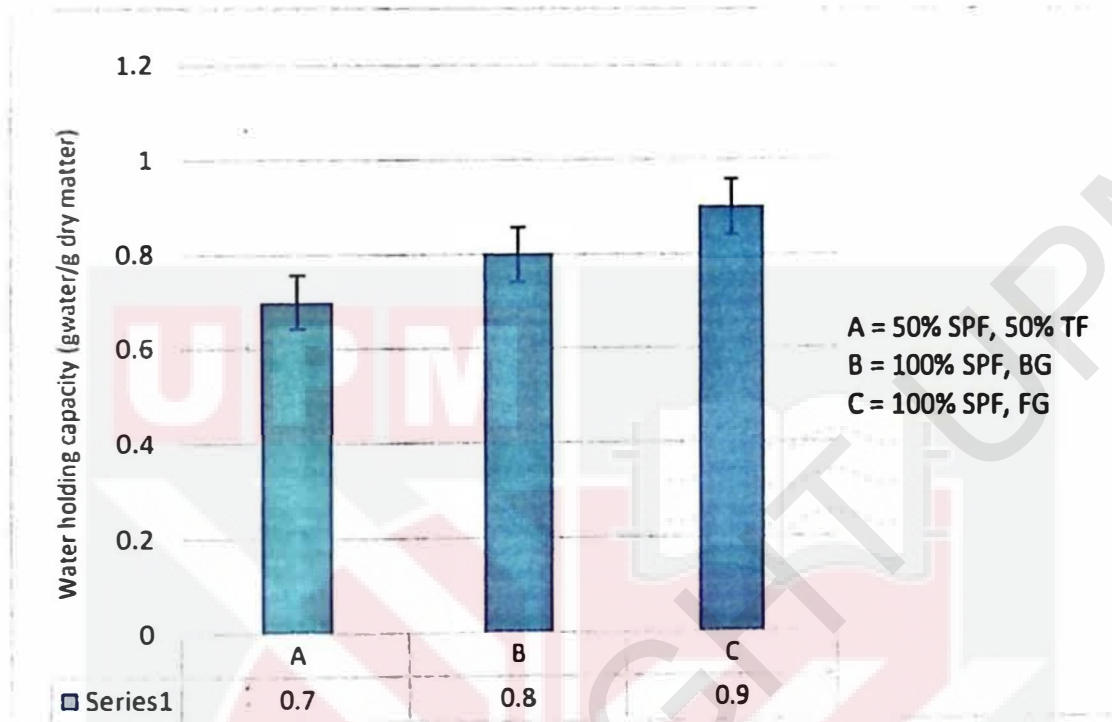


Figure 6: Water holding capacity of the samples

4.4 Sensory Analysis

Sensory analysis is utilizing human senses to evaluate the acceptability of new invented food products. Pie charts below show the result of sensory evaluation obtained from 50 untrained panelists from an early adulthood generation which the most boba lover generation. There are 5 parameters that is asked which appearance, taste, chewiness, sample like the most and will they change current boba to the sample the like the most.

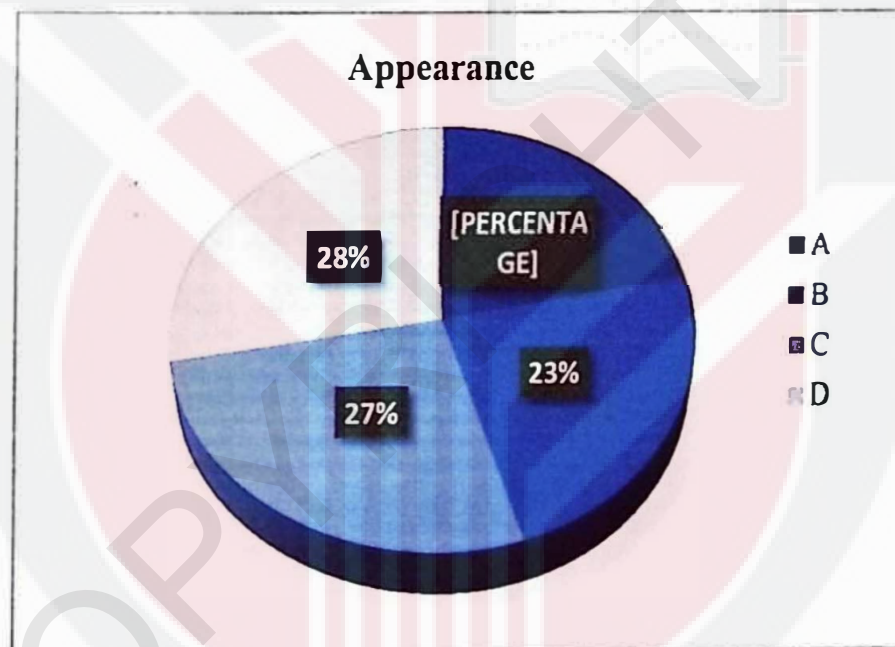


Figure 7: Sensory evaluation for appearance parameter

Figure 7 shows the result obtained for question based on appearance parameters. From the figure, sample D which are commercialize boba is slightly higher than sample C, combination of 100% SPF and fish gelatin while sample A, combination of sweet potato flour and tapioca flour is placed at the lowest rank. The result may due to the way of brown sugar being coated to the boba itself. Since sample D was bought from online

store, the raw boba received already been coated and dried well with brown sugar that being the reason of nice and attractive appearance.

Next, figure 8 shows the results of response based on taste of the samples. The taste of the boba influenced by the amount of brown sugar that is caramelized during cooking. Most of the panelist choose sample D may due to the high amount of brown sugar used while sample A, B and C are made with lower amount of brown sugar for healthy purpose. Therefore, sample D placed in the first rank of acceptance for taste evaluation compared to other samples.

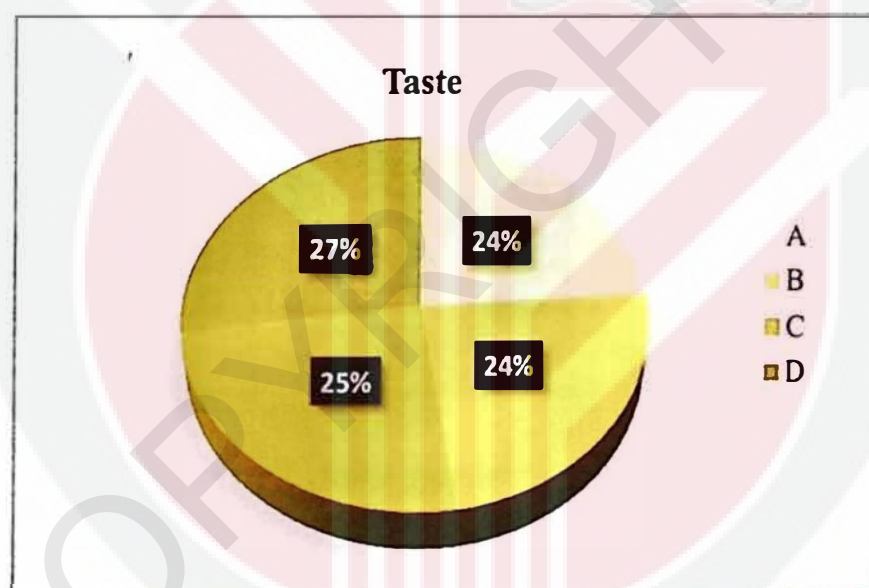


Figure 8: Sensory evaluation for taste parameter

Third question is on the chewiness of the samples. Chewiness is one of crucial question that need to be noted in making boba. From the correspondence result, based on Figure 9, most of them like sample C which combination of 100% SPF and fish gelatin. According to the result, since they always consuming sample D, they choose sample C as it less time need to chew the boba rather than other sample. This is because the presence of fish gelatin which lower gelling properties support the sweet potato flour

which naturally high gelling properties and viscosity. The less time to chew the boba indicates that the boba are easily to digest thus will be added advantage which children can consume sample C.

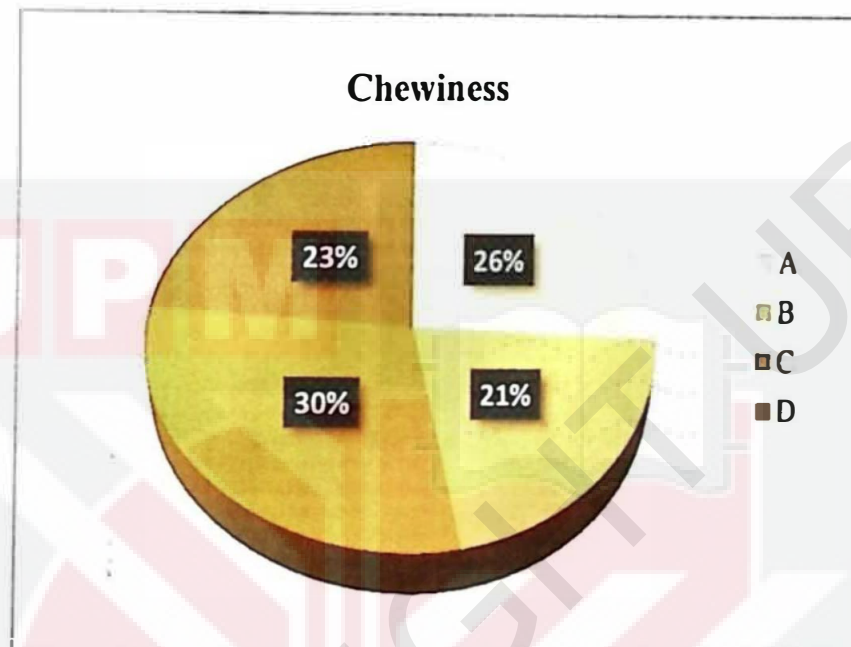


Figure 9: Sensory evaluation for chewiness parameter

Then, the correspondences are asked to choose one sample they like the most. Figure 10 illustrated the results of the correspondence. Sample C placed in the first rank as sample they like the most followed by sample D, A and B. The result between sample C and D slightly difference with 1% value as the correspondence may like the taste and appearance of the sample D but more choose to consider the chewiness parameter. Even though sample B is another modified formula where combination of 100% SPF and bovine gelatin, this sample is placed in the last rank. This result may due to the listed parameters before especially chewiness as the bovine gelatin has high melting point and higher imino acid content that caused the boba a bit chewy compared to sample C.

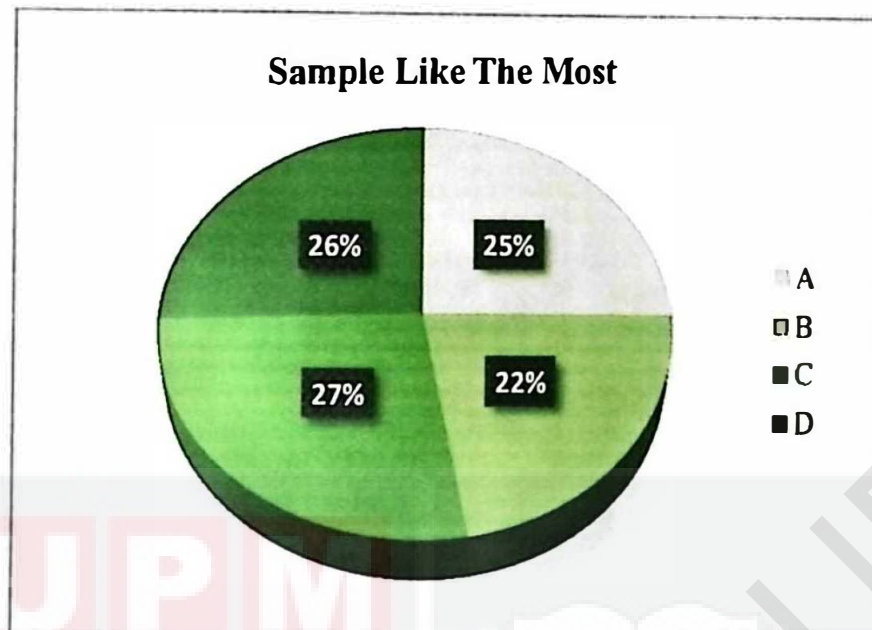


Figure 10: Sensory evaluation for sample like the most

From the sensory evaluation done, for the last question, the correspondences are asked, will they consider to change from current boba to the boba they choose like the most. From figure 11, 89 % of the correspondence choose to change to their chosen like the most boba where mostly sample C while 11 % choose to stay. Thus, from the result, the successful formulation of boba is the substitution of 100 % SPF and fish gelatin.

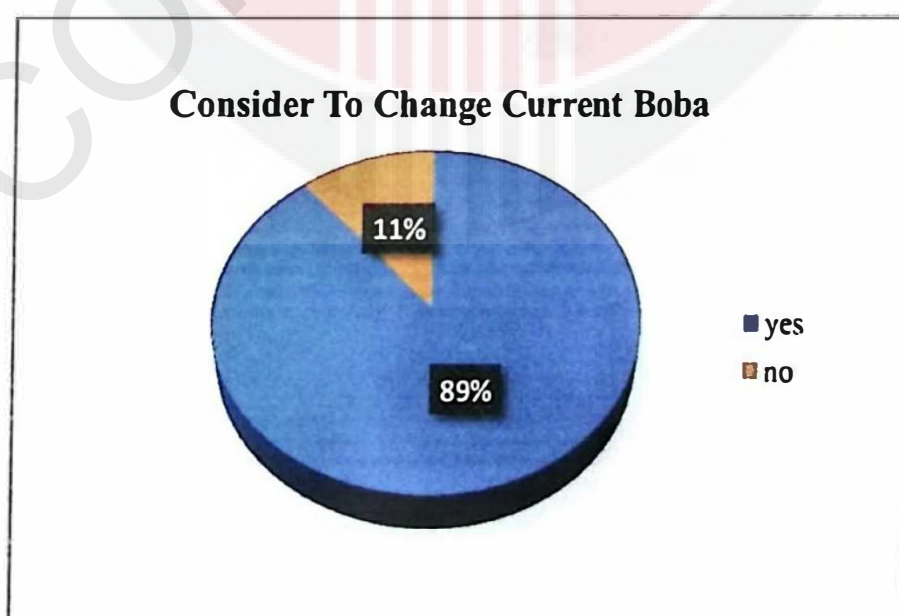
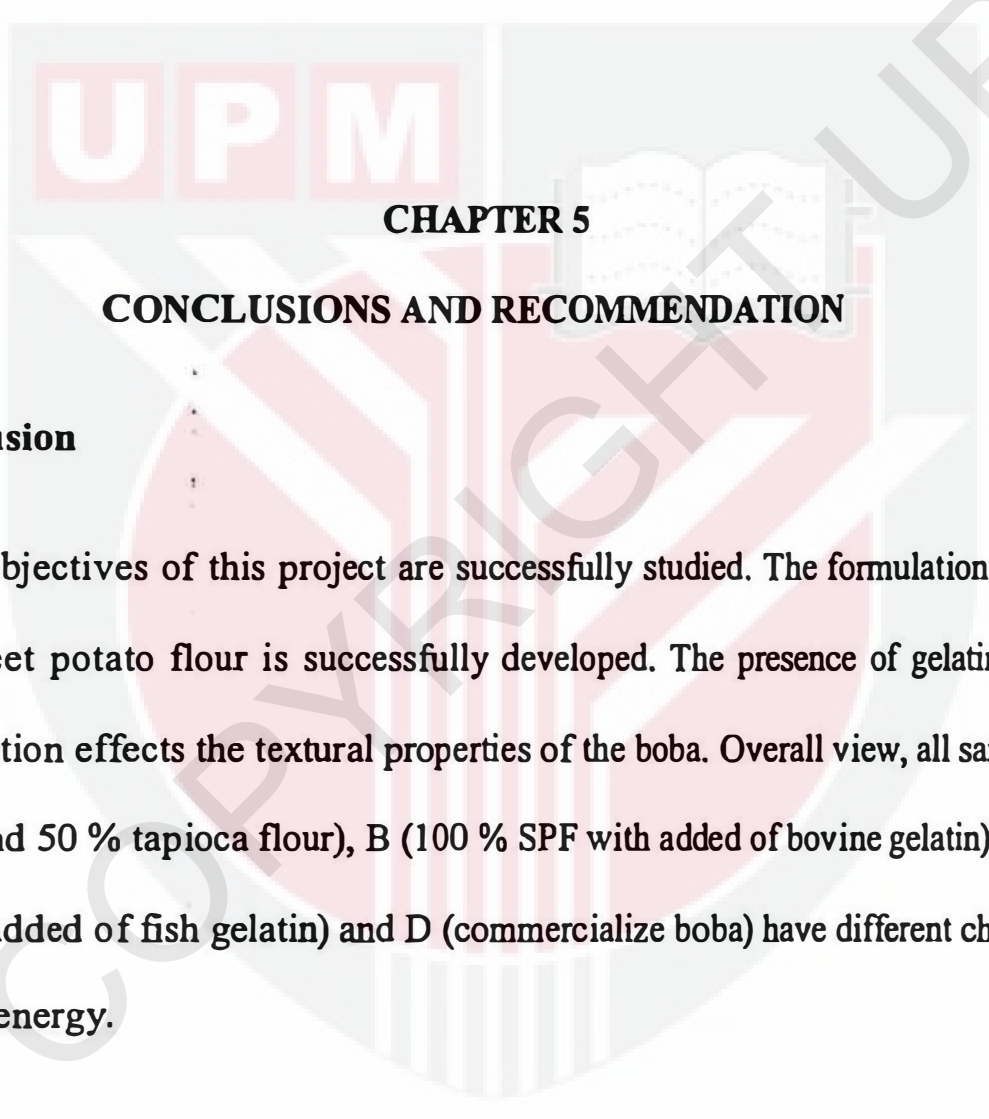


Figure 11: Sensory evaluation on considering to change current boba



CHAPTER 5

CONCLUSIONS AND RECOMMENDATION

5.1 Conclusion

The objectives of this project are successfully studied. The formulation of boba by using sweet potato flour is successfully developed. The presence of gelatin in this boba formulation affects the textural properties of the boba. Overall view, all samples A (50 % SPF and 50 % tapioca flour), B (100 % SPF with added of bovine gelatin), C (100 % SPF with added of fish gelatin) and D (commercialize boba) have different chewiness and chewing energy.

Moreover, the effects of using gelatins in the boba formulation affects the chewiness and chewing energy. Sample B and sample C which are using bovine and fish gelatin respectively show difference result compared to sample A and sample D. The result show that sample C which consist of formulation between sweet potato flour with added of fish gelatin has lower chewing energy with value of $(4136.833 \pm 39.08382 \text{ g.\%})$ compared to other samples. Therefore, it is found to be suitable to all level of generation.

Furthermore, this study found that sweet potato flour has high water holding capacity. Having high water holding capacity is suitable to be applied in producing food product that need to maintain the moisture and viscous content. Thus, it is suitable to use in developing boba as the boba need to be moisture and viscous all the time to ensure the appearance, chewiness and the taste can be preserved.

Last but not least, the pH of sweet potato boba lies in low acidic condition which can be one of benefits in storage as bacteria that can spoil food is not able to grow in acidic condition, hence this formulated boba can be last in a long period. Sweet potato also has moderate value of glycemic index (GI) which is 54 that lies in medium GI compare to tapioca that has value of 85 which falls into high GI values. With medium GI, formulation of boba utilizing from sweet potato flour able to provide a lot of benefits to all generation.

5.2 Recommendation

Boba is a new phenomenon which is popular to adulthood children nowadays. Formulating boba from sweet potato flour is one of creative and innovative approach in food research and development. Therefore, there are a few recommendations can be done to refine this research study.

Firstly, vary the time needed to cook the boba to study the effect of the gelatin towards boba. This can be done by setting up a fixed time needed to cook the boba. By changing the variable of time, the appearance, taste, chewiness and chewing energy of boba can be affected by the presence of gelatin.

Next, it is important to know the storage condition and packaging system of this boba. Good storage condition can help to extend the shelf life and prohibit the growth of microorganism while having a good packaging system help to ensure the boba is well preserved and produced nice quality and texture especially the chewiness of the boba.

Lastly, there are more parameters that can be investigated in this new formulation of boba which lack in research study. Study on the swelling properties, effect of gelatinization temperature on the boba, and effects of adding sugar in cooking the boba can be done also to compare with commercialize boba. This further study can help to produce a healthy and safe boba that can be consumed to all generation.

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APPENDICES

Sensory Test Evaluation Form of Boba

Gender : _____

Age : _____

A. Please write the score of the rating for choices based on the appearance, texture, taste, chewiness, aroma/smell and overall acceptability.

Rating Scale	Like Extremely	Like Moderately	Like Slightly	Neither Like or Dislike	Dislike Slightly	Dislike Moderately	Dislike Extremely
Score	9	8	7	6	5	4	3

Rating Scale	Appearance and Texture	Taste	Chewiness	Aroma/Smell
Sample A				
Sample B				
Sample C				
Sample D				

B. Which sample you like the most?

A B C D

C. Will you consider to change the common boba you always consume to your choice in B?

Yes No