EFFECTS OF PRE TREATMENTS ON TAPIOCA CHIPS

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ABSTRACT

EFFECTS OF PRE TREATMENTS ON TAPIOCA CHIPS

The aims of this study were to determine the effects of pre treatments on the tapioca chips’ quality, to improve the tapioca chips quality and to know the sensory acceptance towards the tapioca chips produced. Sensory evaluation (Ranking test) was conducted to determine the most preferred sample from 3 sessions and 40 semi-trained panels were subjected to this test. There were 5 samples in each session and in each sessions, the overall acceptance sample’s pre treatment condition were chosen out to be fitted into the next pre treatment session. The data were analyzed statically using SPSS Version 11.0 program. For comparison, the results obtained were analyzed using one-way analysis variance with the application of Tukey test (P≤0.05). Steaming was started as the first pre treatment to produce tapioca chips. From the sensory acceptance result, tapioca chips’ produced after steaming for 2.5 min and fried at 170°C, 100 sec are most preferred sample. Then this steaming condition was fitted in to the next pre treatment session. The following session were steaming and leaching out the tapioca slices’ reducing sugar in water. The sensory acceptance result indicated that the panel preferred the tapioca chips which have been steamed for 2.5 min, leached out tapioca slices’ reducing sugar in 70°C water for 3 min and fried at 170°C, 100 sec. The last session were steaming, leaching out reducing sugar and drying. In this session, the best tapioca chips produced were treated with steaming for 2.5 min, steeping in water at 70°C, 3 min; drying at 50°C, 10 min and frying at 170°C, 100 sec. There has been a significant difference with confidence degree at level of (P<0.05) in the sensory test for the fried tapioca slices after steaming, steaming and leaching out reducing sugar; and steaming, leaching out reducing sugar and drying pretreatment. This sample was then being compared with the local commercial potato chips in terms of its sensory acceptance, texture, oil uptake and moisture content. In term of the sensory acceptance, there was no significant differences (P>0.05) between the tapioca chips produced with the commercial potato chips. There has been a positive outcome as the panel highly accepted the tapioca chips produced when compared with these potato chips. However, the physicochemical analysis’s result, shown that there was a significant difference (P<0.05) in terms of the texture and the oil uptake of the tapioca chips produced with the potato chips in the market. This showed that the tapioca chips that were produced were similar to commercial potato chips in term of its sensory acceptance has successfully produced but need to improve its texture.
ABSTRAK

**KESAN PRA RAWATAN KE ATAS CIP UBI KAYU**

Projek penyelidikan ini bertujuan untuk mengetahui kesan daripada rawatan terhadap cip ubi kayu yang dihasilkan selain daripada cubaan untuk menghasilkan cip ubi kayu yang seakan dengan cip ubi kentang dimana produk baru ini dapat menggantikan cip ubi kentang yang ada di dalam pasaran. Dalam projek penyelidikan ini, pengkajian terhadap tahap penerimaan pengguna terhadap cip ubi kayu juga dijalankan. Justeru itu, satu proses penghasilan cip ubi kayu yang terbaik telah dibangunkan. Ujian pemeringkatan (Ranking test) telah dilakukan untuk memilih sampel yang paling digemari daripada 3 sesi dan 40 separa terlatih panel telah digunakan. Dalam setiap sesi terdapat 5 sampel dan hanya satu sampel dipilih keluar untuk dimuatkan ke dalam sesi pemprosesan seterusnya. Pemilihan berdasarkan penerimaan keseluruhan oleh panel. Untuk perbandingan, keputusan yang diperoleh dianalisis menggunakan ujian 'One-way ANOVA' dan ujian 'Turkey' yang ada pada perisian SPSS versi 11.0.

Proses penghasilan cip ubi kayu dimulakan dengan kaedah stim. Berdasarkan keputusan, cip ubi kayu yang paling digemari adalah dihasilkan selepas kepingan ubi kayu distim selama 2.5 min dan digoreng pada 170°C selama 100 saat. Ses i seterusnya ialah stim dan penceluran. Keputusan penerimaan sensori menunjukkan bahawa panel paling menyukai sampel yang telah melalui rawatan stim selama 2.5 min, penceluran pada 70°C selama 3 min dan digoreng pada 170°C selama 100 saat. Ses i terakhir ialah kaedah stim, penceluran dan pengeringan. Dalam sesi ini, sampel cip ubi kayu yang paling digemari akan diperolehi dan berdasarkan keputusan, cip ubi kayu yang terbaik adalah dihasilkan selepas rawatan stim selama 2.5 min, dicelur pada 70°C selama 3 min, digoreng pada 50°C selama 10 min dan digoreng pada 170°C selama 100 s. Terdapat perbezaan signifikan bagi ujian sensori pada darjah keyakinan (P<0.05) pada cip ubi kayu yang telah melalui proses stim, penceluran dan pengeringan. Dikajikan. Sampel ini kemudian dibandingkan dengan cip ubi kentang yang ada dalam pasaran tempatan dari segi penerimaan sensori, tekstur, pengambilan minyak dan kandungan air. Berdasarkan ujian sensori, didapati tiada perbezaan (P>0.05) yang signifikan antara cip ubi kayu yang dihasilkan dengan cip ubi kentang yang ada dalam pasaran. Produk ini mendapat sambutan yang menggalakkan dimana panel amat menyukai cip ubi kayu yang dihasilkan apabila ia dibandingkan dengan cip ubi kentang yang ada di dalam pasaran. Walaubagaimanapun, daripada keputusan ujian fizikokimia, terdapat perbezaan yang signifikan (P<0.05) dari segi tekstur dan pengambilan minyak cip ubi kayu dan ubi kentang yang ada di pasaran. Maka, cip ubi kayu yang seakan dengan cip ubi kentang yang ada dalam pasaran telah berjaya dihasilkan tetapi tekstursnya perlu diperbaikkan.
# CONTENTS

<table>
<thead>
<tr>
<th>TITLE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>EXAMINERS' VERIFICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>CONTENTS</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>x</td>
</tr>
<tr>
<td>LIST OF SYMBOLS</td>
<td>xi</td>
</tr>
<tr>
<td>CHAPTER 1: INTRODUCTION</td>
<td>xiii</td>
</tr>
<tr>
<td>CHAPTER 2: LITERATURE REVIEW</td>
<td>1</td>
</tr>
</tbody>
</table>

## 2.1 Tapioca
- 2.1.1 Nutrient content | 6 |
- 2.1.2 World production of tapioca | 10 |
- 2.1.3 World trade of tapioca | 12 |
- 2.1.4 Tapioca Production in Malaysia | 17 |

## 2.2 Application of tapioca in Malaysia
- 2.2.1 Food Industries | 18 |
- 2.2.2 Non food industries | 21 |

## 2.3 Snacks
- 2.3.1 Chips/crisps market in Malaysia | 22 |

## 2.4 Pre treatments
- 2.4.1 Blanching | 25 |
  - 2.4.1.1 Influence of blanching on tuber tissue | 26 |
- 2.4.2 Drying | 29 |
  - 2.4.2.1 Influence of drying on tuber tissue | 30 |

## 2.5 Deep fat frying
- 2.5.1 Quality of Deep-fat fried food | 33 |
<table>
<thead>
<tr>
<th>TABLE'S NO</th>
<th>Description</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Tapioca varieties in Malaysia</td>
<td>8</td>
</tr>
<tr>
<td>2.2</td>
<td>The main constituents per 100 g edible portion in the tuber plant</td>
<td>11</td>
</tr>
<tr>
<td>2.3</td>
<td>Nutrient value of cassava</td>
<td>11</td>
</tr>
<tr>
<td>2.4</td>
<td>Cassava production in the world</td>
<td>12</td>
</tr>
<tr>
<td>2.5</td>
<td>Cassava production, area, and yield in the world, the continents and various countries in Asia in 2003</td>
<td>13</td>
</tr>
<tr>
<td>2.6</td>
<td>Production, supply and domestic utilization of cassava in seven major cassava producing countries in Asia in 2001.</td>
<td>14</td>
</tr>
<tr>
<td>2.7</td>
<td>World trade of cassava</td>
<td>18</td>
</tr>
<tr>
<td>2.8</td>
<td>Hectareage and Production of Cash Crops by Types in Malaysia 2002</td>
<td>19</td>
</tr>
<tr>
<td>2.9</td>
<td>Hectareage of Tapioca tuber in Malaysia in Year 2002</td>
<td>20</td>
</tr>
<tr>
<td>2.10</td>
<td>Vegetables, roots and tuber's imports in Malaysia</td>
<td>21</td>
</tr>
<tr>
<td>2.11</td>
<td>Hectareage of cash crops in Sabah in year 2003</td>
<td>21</td>
</tr>
<tr>
<td>2.12</td>
<td>Consumption of snacks: 1998/2003</td>
<td>27</td>
</tr>
<tr>
<td>4.1</td>
<td>Sensory acceptance for tapioca chips produced in session 2</td>
<td>54</td>
</tr>
<tr>
<td>4.2</td>
<td>Sensory acceptance for tapioca chips produced in session 2</td>
<td>60</td>
</tr>
<tr>
<td>4.3</td>
<td>Color changes and browning index of fried tapioca chips</td>
<td>67</td>
</tr>
</tbody>
</table>
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE'S NO</th>
<th>DESCRIPTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Tapioca's variety in Malaysia (MARDI, 2005)</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Transverse section of <em>Mentika</em></td>
<td>10</td>
</tr>
<tr>
<td>2.3</td>
<td>Pathways of processing fresh roots or green top into a multitude of products for human or animal consumption or for industrial purposes</td>
<td>15</td>
</tr>
<tr>
<td>2.4</td>
<td>Cassava roots processing into value added food and non foods products</td>
<td>16</td>
</tr>
<tr>
<td>2.5</td>
<td>Retail sales of chips/crisps value from 1999-2005</td>
<td>27</td>
</tr>
<tr>
<td>2.6</td>
<td>Retail sales of chips/crisps volumes from 1999-2005</td>
<td>27</td>
</tr>
<tr>
<td>3.1</td>
<td>Experimental design for tapioca chips production</td>
<td>40</td>
</tr>
<tr>
<td>4.1</td>
<td>Tapioca chips' (a) Area under compression curve; (b) moisture content and (c) Oil uptake after underwent steaming pretreatment</td>
<td>50</td>
</tr>
<tr>
<td>4.2</td>
<td>Tapioca chips' color parameter after underwent steaming</td>
<td>52</td>
</tr>
<tr>
<td>4.3</td>
<td>Tapioca chips after steaming and frying</td>
<td>52</td>
</tr>
<tr>
<td>4.4</td>
<td>Tapioca chips' (a) Area under compression curve; (b) moisture content and (c) Oil uptake after underwent steaming and leaching out tapioca slices' reducing sugar</td>
<td>55</td>
</tr>
<tr>
<td>4.5</td>
<td>Tapioca chips after steaming, leaching out tapioca slices' reducing sugar and frying</td>
<td>57</td>
</tr>
<tr>
<td>4.6</td>
<td>Tapioca chips' color parameter after underwent steaming + leaching out reducing sugar in (a) 70°C water (b) 90°C water + frying</td>
<td>59</td>
</tr>
<tr>
<td>4.7</td>
<td>Tapioca chips' (a) Area under compression curve; (b) moisture content and (c) Oil uptake after underwent steaming, leaching out tapioca slices' reducing sugar and drying</td>
<td>61</td>
</tr>
</tbody>
</table>
4.8 Tapioca chips' color parameter after underwent steaming + leaching out reducing sugar in 70°C water for 3 min + drying (a) 50°C and (b) 60°C + frying

4.9 Tapioca chips after steaming, leaching out tapioca slices' reducing sugar, drying and frying

4.10 Tapioca chips' texture measurement after pretreatment

4.11 Oil uptake versus frying time for tapioca chips fried at 170°C after pretreatment

4.12 Color changes after different pretreatment and fried at 170°C for 100 sec

4.13 Browning Index for tapioca chips produced after different pretreatment and fried at 170°C for 100 sec

4.14 Tapioca chips' color fried at 170°C for 100 sec after different pretreatment

4.15 Differences between the tapioca chips produced with local commercial potato chips (a) texture, (b) oil uptake and (a) moisture content
# LIST OF SYMBOLS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>°C</td>
<td>Degree Celcius</td>
</tr>
<tr>
<td>%</td>
<td>Percentage</td>
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<tr>
<td>cm</td>
<td>centimeter</td>
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<tr>
<td>mm</td>
<td>millimeter</td>
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<td>Kg</td>
<td>kilogram</td>
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<td>Kcal</td>
<td>kilo calorie</td>
</tr>
<tr>
<td>mg</td>
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</tr>
<tr>
<td>N</td>
<td>Newton</td>
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<tr>
<td>μm</td>
<td>micrometer</td>
</tr>
<tr>
<td>g</td>
<td>gram</td>
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<td>ml</td>
<td>milliliter</td>
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<tr>
<td>MSG</td>
<td>Monosodium glutamate</td>
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<td>NACI</td>
<td>Sodium chloride</td>
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<tr>
<td>&amp;</td>
<td>and</td>
</tr>
<tr>
<td>MT</td>
<td>Million tones</td>
</tr>
<tr>
<td>He</td>
<td>Hectare</td>
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<tr>
<td>MARDI</td>
<td>Malaysia Agriculture Research and Development Institute</td>
</tr>
<tr>
<td>ARC</td>
<td>Agriculture Research Center</td>
</tr>
<tr>
<td>min</td>
<td>minute</td>
</tr>
<tr>
<td>sec</td>
<td>second</td>
</tr>
<tr>
<td>Nmm</td>
<td>Newton milliliter</td>
</tr>
<tr>
<td>HCN</td>
<td>cyanogenic glucoside</td>
</tr>
</tbody>
</table>
# LIST OF APPENDIX

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Sensory Acceptance Form (Ranking Test)</td>
<td>81</td>
</tr>
<tr>
<td>B</td>
<td>Sensory acceptance’s one way variance analysis’ (ANOVA one way) result for steaming pretreatment</td>
<td>82</td>
</tr>
<tr>
<td>C</td>
<td>Sensory acceptance’s one way variance analysis’ (ANOVA one way) result for steaming (2.5 min) and leaching out tapioca slices’ reducing sugar</td>
<td>84</td>
</tr>
<tr>
<td>D</td>
<td>Sensory acceptance’s one way variance analysis’ (ANOVA one way) result for steaming (2.5 min), leaching out tapioca slices’ reducing sugar (70°C, 3 min) and drying</td>
<td>86</td>
</tr>
<tr>
<td>E</td>
<td>Sensory acceptance’s one way variance analysis’ (ANOVA one way) result for comparison between tapioca chips produced with commercial potato chips</td>
<td>88</td>
</tr>
<tr>
<td>F</td>
<td>Correlation analysis for steaming pretreatment</td>
<td>90</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

With much changes in the eating habits of the population coupled with industrial food processing and marketing needs have directed research attention toward products based on cassava in Malaysia. Cassava (*Manihot esculenta Crantz*) or better known as tapioca in Malaysia is probably the most important food crop in tropical and sub-tropical regions. It ranks forth after rice, wheat and corn as source of complex food energy (FAO, 2002). In year 2002, the total value of production of cassava planted in Malaysia was RM18,484.6 million from 2,440.74 ha production area (Department of Agriculture Malaysia, 2002). This shown that tapioca is one of the cash crop in Malaysia. According to Flach & Rumawas (1996), cassava has the second highest energy content after sugar cane. In Asia, over 40% of the cassava produced is for direct human consumption, with much of the remainder exported as chips and pellet (FAO, 1999).

There are many ways of preparing tapioca for consumption such as steaming (tart), frying (chip), boiling, roasted or turn into intermediate products such as flour, garri (in Africa), and starch. Cassava is a cheap source of calories and often supplements insufficient rice supplies. According to FAO (1999), the major tapioca consumers are concentrated in India and Indonesia. There are two types of cassava recognized ‘bitter’ and ‘sweet’ (Stephens, 1994). The classification of tapioca is according to the cyanogenic glucoside content. Referring to O’Hair (1995), the sweet cultivar can produce as little as
20mg of HCN per kg of fresh roots, while bitter ones may produce more than 50 times as much.

There are many varieties of tapioca which is planted but not all are suitable to be processed or consumed. Tapioca which is normally being processed and eaten in Malaysia are 'Sri Pontian', 'Mentega', 'Medan' and 'Perintis'. Black Twig variety is not suitable to be eaten but only can be processed into starch (MARDI, 2005). Tapioca roots are prepared much like potato; peeled and boiled, baked or fried. Although the cyanogenic glucosides content in tapioca can be reduced to innocuous levels through cooking however it is not recommended to consume tapioca in raw form (Flach & Rumawas, 1996).

Tapioca is not a staple food in Malaysia except in times of emergency when rice is short. Starch from tapioca is used in both food and non-food industry (MSG, dextrin, textile and paper industries). The largest commercial uses of tapioca are the monosodium glutamate (MSG). There were also production of tapioca-based products such as alcohol and starch-based sweetener, example high fructose glucose syrup (HFGS) (Tan & Cock, 1979; Vuilleumier, 1993; Pontoh & Low, 1995). While for human consumption, only a very small portion was used. The usage of tapioca in human direct consumption in Malaysia is mainly for traditional snack food production (tuber or roots) and dishes makes from the leaves. Examples of these snacks are cake, tart, lopes, talam, pudding, and tapai which is a popular type of fermented tapioca.

According to Sajilata (2005), snack such as tapioca chip is a light meal eaten between regular meals. Snack is one of the most popular processed foods (Aminlari,
Ramezani, & Khalili, 2005). Snack food industry in Malaysia is growing due to the high demand from the consumers. Potato chip is a very popular salty snack for 150 years and it represents 33% of total sales of snack in the US Market (Garayo & Moreira, 2002). Vitrac et al. (2000), reported that there might be a suitable potato chip substitutes found among tropical roots, tubers and plantain. Therefore in order to open a new market, new uses of cassava are being sought.

Frying is one of the oldest and most popular cooking methods in existence. Large amounts of food are simultaneously dried and cooked by deep-fat-frying. Deep frying or immersion frying has defined as the immersion of food product in an edible fat heated above the boiling point of water (Hubbard & Farkas, 1999) and may therefore, be considered a dehydration process. These conditions lead to high heat transfer rates, rapid cooking, browning, textures and flavor development (Farkas, Singh & Rumsey, 1996). High heat transfer rates are largely responsible for the development of desired and undesired sensorial properties in fried foods. Frying can create a unique flavor, color and textures in processed foods that improve its palatability.

Nowadays the health awareness between the consumers had increased. They tend to look for healthier snack which are consist of lower fat content. Due to public health concern, there is a strong demand to reduce the oil content of fried foods (Moreira & Barrufet, 1999). Several studies have been done to create a new product that can suit the current trend of consumers and at the same time retaining the desirable texture and flavor (Garayo & Moreira, 2002) in fried food products to reduce the oil uptake such as using edible coating from cellulose derivatives in deep-fat frying carrot slices (Garcia et al., 2002; Akdeniz, Sahin & Sumnu, 2006) and protein based coating
which derives from plants or animal sources, collagen or milk protein in potato chips (Aminlari, Ramezani, & Khalili, 2005); improving texture, color and reduce oil uptake by blanching with hydrocolloid addition in fried potato strips (Rimac-Brmcic, 2004); NaCl soaking treatment in french-fried potatoes (Bunger, Moyano & Rioseco, 2003) and drying (Moyano & Pedreschi, 2006).

The hard texture of tapioca is the main technical problem while producing tapioca chips. Therefore it is logical to make the tapioca softer by treatments which loosen the intercellular pectic substances via cell liberation in order to produce chip which is crispy. According to Kita (2002) the texture of potato crisp is depends on the starch contents, non-starch polysaccharide, lignin and protein nitrogen of the potato tubers. Therefore is makes sense that the texture of tapioca chips is also connected to the dry matter content of the raw cassava tuber. Among non-starch polysaccharide that have the most impact on influencing the chips texture, is protopectins (Kita, 2002). Vitrac et al. (2002) have proven that color, texture and final oil uptake of cassava chips were primarily related to the frying conditions. According to Vitrac et al. (2000), the required characteristics of chips (final moisture content, browning and texture) are the result of both raw material properties (moisture, cyanide, starch, sugar, reducing sugar and crops age) and it processing.

Many studies about cassava to be processed into food have been carried out (Edijala, Okoh, Anigoro, 1999; Kimaryo et al. 2000; Kostinek et al. 2005; Vitrac et al, 2002; Oboh & Akindahunsi, 2003). Grizotto & Menezes (2002), have highlighted the effect of using heat pretreatment (cooking) on crispness of cassava chips. However, none of these studies have reported the effect of pretreatments oil content and color of
cassava chips. Therefore the study was needed to be carried out to determine the effect of the pretreatment on the quality of tapioca chip as a snack. From this study, a tapioca chips processing can be developed to improve the quality of tapioca chips.

The specific objectives of the study were:

1. To determine the effect of steaming, leaching out the reducing sugar by steeping in water and drying on the organoleptic and physicochemical properties of tapioca chips.

2. To develop suitable tapioca chips process to produce crispier, lower oil uptake and better color’s tapioca chips.

3. To compare the physicochemical and organoleptic properties of tapioca chips produced with the potato chips in the market.
CHAPTER 2

LITERATURE REVIEW

2.1 Tapioca

Cassava or known as tapioca in Malaysia, falls within the species *Manihot esculenta Crantz* which belong to the family of *Euphorbiaeae*, is a perennial woody shrub with an edible root, which grows in tropical and subtropical areas of the world (Flach & Rumawas, 1996). Tapioca is a well known crop that is recognized by several names in different regions of the world. It is also known as yuca, *rumu* or *manioca* in Latin America, *manioc* in French-speaking Africa and Madagascar, cassava in English speaking Africa, Ceylon and Thailand, *mandioca* or *aipim* in Brazil, tapioca in India and Malaysia, *kamoting-kahoy* in Philippines, *bi ketela* or *kaspe* in Indonesia (FAO, 1998). Cassava is originated from Brazil and Paraguay. Today it has been given the status of cutigen with no wild forms of this species being known (O'Hair, 1995).

Sweet varieties of the crop such as *Manihot utilissima Pohl* have lower levels of cyanogenic glycosides while bitter tasting varieties exemplified by cultivars such as *Manihot palmate Muell* and *Manihot aipr Pohl* have higher level of cyanogenic glycosides content (Niba & Jackson, 1999). According to Stephens (1994), the bitterness of cassava is caused by cyanogenic glucoside content in the roots. During the unfavorable growth condition such as drought, these types of crops can still survive from the storage roots which formed during the first year of plantation and resume vegetative growth upon the
return of rain (Flach & Rumawas, 1996). The plant may assume the shape of a branching shrub or an unbranched small tree from 1-5m tall depending on the variety (MARDI, 2005).

In Malaysia, there are many tapioca's varieties and different tapioca varieties have different usage. These varieties of tapioca are differentiated by the morphology of the plants (leaves' shape; petioles' color; tuber's shape, skin color, corky periderms' color and color of the flesh) (Liaw, 1985). Usually the leaves' shape is oblanc and long oblanc while color of the tuber's flesh is either white, cream or yellow. The latest varieties of tapioca in Malaysia are 'Sri Pontian', 'Sri Kanji 1' and 'Sri Kanji 2', which are produced by Malaysia Agricultural Research & Development Institute (MARDI) for food and starch production (MARDI, 2005). Table 2.1 shown some of the varieties that are available in Malaysia. From the table we identify the tapioca varieties which are available in Malaysia. Each different variety has different usage according to its characteristics such as the starch content and cynogenic content.

*Mentega* also known as *Mentika* in Sabah is a yellow fresh variety of tapioca that is preferable for making cakes and snack such as kerepek, opak and keropok which are Malays traditional food (ARC, 2002). Adetan, Adekoya & Aluko, (2003), said that cassava has a fibrous root system. Some of these roots develop radically into root tubers forming 5-10 tubers per plant are the main economically useful parts of the cassava plant. The shape and the morphology of a cassava root (*Mentika*) are shown in Figure 2.1. The transverse section of the tuber Figure 2.2 shows that it consists of a central core called the pith and is surrounded by the starchy flesh.
<table>
<thead>
<tr>
<th>Variety</th>
<th>Leaves Shape</th>
<th>Petiole Color</th>
<th>Tuber Shape</th>
<th>Skin’s Color</th>
<th>Color of Corky Periderm</th>
<th>Flesh Color</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sri Kanji 1</td>
<td>Oblanc Cone</td>
<td>Green yellowish</td>
<td>Brown</td>
<td>Light brown</td>
<td>White</td>
<td>Suitable for eating</td>
<td></td>
</tr>
<tr>
<td>Sri Kanji 2</td>
<td>Oblanc Cylinder</td>
<td>Green yellowish</td>
<td>Dark brown</td>
<td>Light brown</td>
<td>White</td>
<td>Suitable for eating</td>
<td></td>
</tr>
<tr>
<td>Sri Pontian</td>
<td>Oblanc Red Cylinder</td>
<td>Brown reddish</td>
<td>Cream</td>
<td>White</td>
<td>White cream</td>
<td>Suitable for eating</td>
<td></td>
</tr>
<tr>
<td>Mentika</td>
<td>Oblanc Cylinder</td>
<td>Red upper yellow lower</td>
<td>Brown reddish</td>
<td>Yellowish brown</td>
<td>Yellow</td>
<td>Suitable for eating</td>
<td></td>
</tr>
<tr>
<td>Black Twig</td>
<td>Oblanc Cylinder</td>
<td>Pale yellow, red at stipule</td>
<td>Dark brown</td>
<td>Light brown</td>
<td>White</td>
<td>Commercial starch production</td>
<td></td>
</tr>
<tr>
<td>Green Twig</td>
<td>Long oblanc green Cylinder</td>
<td>Brown</td>
<td>Light brown</td>
<td>White</td>
<td>Commercial starch production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medan</td>
<td>Oblanc Very red Cylinder</td>
<td>Brown</td>
<td>Cream</td>
<td>Yellow</td>
<td>Suitable for eating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MM92</td>
<td>Oblanc Red Cylinder</td>
<td>Brown</td>
<td>Light brown</td>
<td>White</td>
<td>Suitable for eating and starch production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perintis</td>
<td>Oblanc Red Cylinder</td>
<td>Dark brown</td>
<td>Light brown</td>
<td>White</td>
<td>Commercial starch production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Tuaran</td>
<td>Oblanc Very red Cylinder</td>
<td>Brown</td>
<td>Pinkish</td>
<td>White</td>
<td>Suitable for eating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ubitelor</td>
<td>Oblanc Red Cone</td>
<td>Brown</td>
<td>Brown yellowish</td>
<td>Yellow</td>
<td>Suitable for eating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Udaran</td>
<td>Oblanc Dark red Cylinder</td>
<td>Brown</td>
<td>Pinkish</td>
<td>White</td>
<td>Suitable for eating</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(AARC, 2002)
Figure 2.1: Tapioca's variety in Malaysia

(Source: MAKDI, 2005)
REFERENCES


Department of Agriculture Malaysia, 2002


Euromonitor. 2006. at
 http://www.euromonitor.com.my


FAO, 2004. *Food Outlook No 2*
 fao.org/WAICENT/faoinfo/economic/giews/English/giewse.htm

FAOSTAT. 2004. Global Cassava Market
 http://www.apps.fao.org

 http://www.apps.fao./WAICENT/faoinfo/economic/giews/English/giewse.htm


http://www.puslittan.bogor.net


Ghani, S. 1999. Small-Scale Food Processing Enterprises in Malaysia. Food Technology Research Station MARDI. Malaysia


Liaw, H.L. 1985. Cassava Variety in Malaysia. Agricultural Research Centre


Vegetable and Cash Crop Statistic Malaysia. 2002. Department of Agriculture Malaysia


