
**UNIVERSITI PUTRA MALAYSIA**

***DEVELOPMENT AND CHARACTERISTICS OF STACKABLE CASSAVA (Manihot esculanta Crantz) CHIPS***

***NUR `AINI BINTI ISMAIL***

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# DEVELOPMENT AND CHARACTERISTICS OF STACKABLE CASSAVA (*Manihot esculanta* Crantz) CHIPS

By

NUR `AINI BINTI ISMAIL

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science**

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree Master of Science

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**NUR `AINI BINTI ISMAIL**

**September 2015**

**Chairman: Noranizan Mohd Adzahan, PhD**
**Faculty: Food Science and Technology**

The shortcoming of cassava chips products in the market which are; uneven shape and cannot be stacked have hindered the process of fitting cassava chips into cylindrical containers. These conditions have caused reduction in the attractiveness of the final product. In this study, the effects of process variables which are; the thickness and numbers of cassava slice, on the final shape of fried cassava chips were determined in order to develop cassava chips with stackable properties and acceptable quality as close as those displayed by fabricated potato chips. Moreover, the strength of cassava chips were evaluated through simulation test to imitate transportation and handling. A bigger frying setup was used to determine whether it could produce cassava chips with the intended stackable properties. Frying condition for mass production of cassava chips for SME industries was also studied. The shape of sliced cassava is ellipse with 5.0 cm major diameter and 4.8 cm minor diameters. Four different thickness measurements were used including 1.0 mm, 1.5 mm, 1.75 mm and 2.0 mm. Commercial potato chips with 1.27 mm thickness were used as control sample. Then, the sliced cassava was fried in the deep fat fryer with the temperature of 170℃ until no bubbles could be observed on the oil surface. For each thickness studied, different numbers of slices (10, 20, 30 and 40 slices) were fried simultaneously which resulted in different shapes of the fried cassava chips produced and the stacking ability of the chips was also recorded. The results show that there are 6 shapes of fried chips produced after frying in which curvy shape was chosen by the panelists as the best shape as it delivered the same characteristics as the control. High ratio of the numbers of cassava slices to frying area resulted in less curvy shape of the fried cassava chips due to the limited space between the sliced cassava. Cassava chips with thickness of 2.0 mm have higher strength and absorb less oil during frying compared to other thickness. To conclude, cassava chips thickness and numbers of slice during frying affect the final shape of cassava chips. Thirty cassava slices with the thickness of 2.0 mm yield the highest number of curvy shape when fried using frying temperature of 170℃, 594 $cm^2$ of frying area and frying time of 120 seconds.

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Abstrak tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

**PEMBANGUNAN DAN CIRI-CIRI KEREPEK UBI KAYU (*Manihot esculanta* Crantz) YANG BOLEH DISUSUN BERTINDAN**

Oleh

**NUR `AINI BINTI ISMAIL**

**September 2015**

**Pengerusi: Noranizan Mohd Adzahan, PhD**
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Terdapat dua kelemahan produk kerepek ubi kayu di pasaran iaitu; bentuk yang tidak sekata dan tidak boleh disusun dengan cantik telah menghalang proses pengisian kerepek ubi kayu ke dalam balang silinder. Keadaan ini menyebabkan kurangnya daya tarikan terhadap produk. Dalam kajian ini, kesan proses pembolehubah iaitu ketebalan dan bilangan keping kerepek ubi kayu terhadap bentuknya setelah digoreng telah dinilai untuk mendapatkan kerepek ubi kayu yang boleh di susun dengan sekata dan kualiti yang boleh diterima seperti yang terdapat dalam kerepek ubi kentang yang telah di fabrikasi. Selain itu, kekuatan kerepek ubi kayu juga telah di nilai melalui ujian simulasi untuk menyerupai situasi sebenar pengangkutan dan pengendalian. Sebuah kuali yang lebih besar telah digunakan untuk menentukan sama ada ia boleh menghasilkan bentuk kerepek ubi kayu yang di mahukan. Bentuk kepingan ubi kayu sebelum digoreng adalah bujur dengan major diameter 5.0 cm dan minor diameter ialah 4.8 cm. Empat ketebalan ubi kayu yang berbeza telah digunakan iaitu 1.0 mm, 1.5 mm, 1.75 mm dan 2.0 mm. Kerepek ubi kentang komersil dengan ketebalan 1.27 mm telah digunakan sebagai sampel kawalan. Ubi kayu yang telah dihiris di goreng di dalam kuali dengan suhu 170 ℃ sehingga masak iaitu tiada lagi buih dapat dilihat di permukaan minyak. Untuk setiap ketebalan ubi kayu, jumlah bilangan kepingan ubi kayu yang berbeza (10, 20, 30 dan 40 keping) telah goreng secara serentak dan ini telah menyebabkan terhasilnya bentuk yang berbeza dan kebolehan kerepek disusun secara bertingkat juga telah direkod. Hasil kajian menunjukkan bahawa terdapat 6 bentuk akhir kerepek ubi kayu telah terbentuk, di mana bentuk melengkung telah dipilih oleh ahli panel sebagai bentuk yang terbaik kerana ia mempunyai ciri yang sama dengan bentuk kerepek kawalan. Nisbah jumlah kepingan ubi kayu dengan kawasan menggoreng akan menyebabkan berlaku pengurangan dalam jumlah bentuk melengkung kerana terdapat ruang yang terhad antara ubi kayu di dalam kuali. Kerepek ubi kayu dengan ketebalan 2.0 mm lebih keras dan kurang menyerap minyak semasa di goreng berbanding ketebalan lain. Sebagai kesimpulan, ketebalan dan bilangan keping ubi kayu ketika proses pengorengan akan mempengaruhi bentuk akhir kerepek ubi kayu. 30 keping ubi kayu dengan ketebalan 2.0 mm akan menghasilkan bilangan bentuk melengkung yang paling tinngi apabila digoreng dengan suhu 170 ℃, kawasan pengorengan 594 $cm^2$ dan di goreng selama 120 saat.



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I certify that a Thesis Examination Committee has met on 11 September 2015 to conduct the final examination of Nur `Aini binti Ismail on her thesis entitled "Development and Characteristics of Stackable Cassava (*Manihot esculanta* Crantz) Chips" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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The thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirement for the degree Master of Science. The members of the Supervisory Committee were as follows:

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## LIST OF ABBREVIATIONS

| | |
|---|---|
| cm | centimeter |
| $cm^2$ | centimeter square |
| g | gram |
| h | hour |
| Ha | hectare |
| kg | kilogram |
| km | kilometer |
| L | litre |
| lbs | Pound |
| mg | milligram |
| mL | milliliter |
| mm | milimeter |
| N | Force |
| RH | Relative Humidity |
| rpm | Round per Minute |
| s | second |
| SME | Small and Medium Entrepreneur |
| V | volt |
| W | watt |

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# CHAPTER 1

# INTRODUCTION

*Manihot esculanta* Crantz is the scientific name for cassava plant. There are various cassava names used worldwide for example, Manioc (French), Yuca (Spanish), Lucca (Italian), Mandioca (Brazil) and Ubi kayu (Malaysia) (Anom, 2012). There are increases of 44% in cassava harvesting area around the world since 1980 to 2011 (FAO, 2013). In Asia, Thailand is the leading producer of cassava since 2012 followed by Indonesian and other Asian countries. The area of cassava cultivation in Malaysia increase gradually from 2011 to 2013 and it shows that the request for cassava increased significantly due to high demand from entrepreneur. There are many types of food can be produced from cassava roots such as fufu, mingao, farina, sago wafers, gatot, gari and fried chips. The growths of sales of sweet and savoury snacks in Malaysia are increased as much as 3.8% from 2009 until 2013.

Few studies have been conducted to find the parameters that can be attributed to the quality of cassava chips. Salvador et al. (2009) relates sensory attribute of the potato chips with the crispy texture of chips. Olivier et al. (2002) measured the different thickness of slices cassava roots fried at 160℃ were affect the time for chips to be fried. As a result, there were different effects on the final quality of chips produced including colour, texture and oil uptake of the chips (Abong et al., 2011; Kita et al., 2007; Oliver et al., 2000; Romani et al., 2009; Vincent, 2004). This result can be related to the study from Vitrac et al. (2002), which has found that heat transfer process during frying contributed to the changes and development of final chips quality. According to Krokida et al. (2000), water loss and oil uptake in chips was a part of heat transfer process occured during frying. According to Chung (2010), cassava chips fried individually can be stacked nicely into cylindrical container.

Packaging is an important element in food industry. It does not only protect the food safety and appearance but it also can provide information about the product itself and at the same time can increase the commercial value of the products. If cassava chips can be developed to resemble fabricated chips, then it is likely can increase the commercial value of cassava chips. Besides that, Federal Agricultural and Marketing Authority Malaysia (FAMA) have requested to improve the quality of cassava chips in cylindrical container. Therefore, research in this sector is important which can help food industry since cassava products have a high and increasing demand especially during the festive seasons.

Cassava chips are usually prepared from sliced tubers and not fabricated such as those in the potato chips industry. Cassava chips in the current market are usually packed in plastic material. Although, there are cassava chips that have been packaged in cylindrical container, but it's does not have even shape, not stackable, fragile/breakable, burnt, uneven colour, less attractive and not attractive packaging. In the world, the most acceptable potato chips products from generation to generation are fabricated potato chips products for example Mister Potato™, Pringles®, Jacker, Lay's®, etc. Fabricated potato chips provides better chips colour, even size and shape, good packaging and stack nicely in canister. However the



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process of fabricating chips will increase cost for production of chips since it's involve several ingredient and processing step. In addition, when cassava has been fabricated, the taste and texture of the fried chips were changed to the point that it is not acceptable the consumers. Thus, the objectives of this study are;

i) To develop cassava chips with stackable properties and acceptable quality as close as those displayed by fabricated potato chips.
ii) To evaluate the strength of the developed cassava chips during transportation and handling.
iii) To determine whether a bigger frying setup could produce cassava chips with the intended stackable properties.

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