UNIVERSITI PUTRA MALAYSIA

PREPARATION OF FROZEN SWEET POTATO (*Ipomoea batatas*.) DOUGH BASE for TRADITIONAL MALAYSIAN FRIED CAKES

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PREPARATION OF FROZEN SWEET POTATO (*Ipomoea batatas*) DOUGH BASE for TRADITIONAL MALAYSIAN FRIED CAKES

By

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July 2008

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Sweet potato dough base is popular for making traditional fried cakes in Malaysia but there has been no specific quality standard as reference for the dough preparation. The independent variables to produce the dough, i.e. mashing time (11.36 – 138.64s) and wheat flour concentration (3.79 – 46.21%) were designed using the central composite design based on Response Surface Methodology (RSM). The dough and fried cakes produced were examined for quality on the basis of physical parameters and sensory attributes. Optimal conditions for making sweet potato dough for fried cakes production were determined, by Response Surface Methodology (RSM), to be 45s of mashing time at 150rpm and 25% of wheat flour concentration. The dough base was then produced using the optimum condition and stored for 6 months at -20±2^{o}C for quality changes observation at 1 month interval. Sweet potato paste was also included in the storage study for comparison. Unfrozen samples (dough and paste) were used as control in this study. Moisture content of frozen samples decreased

with increasing of storage time and caused dehydration in samples. The water holding capacity of the samples reduced reflected by drip loss produced in paste, also by increased in paste and dough adhesiveness after frozen storage. These suggested that structure damage occurred due to frozen and frozen storage. Thus, caused the firmness and elasticity (G') of dough and paste to increase. As the consequence, the Texture Profile Analysis (TPA) of fried cakes (firmness, cohesiveness, springiness and chewiness) were decreased. Micrographs obtained showed that all the structure of dough, paste and fried cakes collapsed, ruptured and were drier after 6 months of storage. Based on the Quantitative Descriptive Analysis (QDA), frozen dough and paste became harder to handle due to increase of adhesiveness. However, those negative changes in instrumental analysis did not influence the overall acceptability on the fried cakes. Fried cakes were still acceptable with overall acceptability score was 5.52, denotes as slightly acceptable. Freeze-thaw cycle study was conducted on sweet potato dough to investigate the stability of the dough against temperature fluctuation. Sweet potato dough and paste were exposed to 5 freeze-thaw cycles treatment for 5 weeks and the quality changes on the physical and sensory characteristics of samples were observed. Samples that stored for 5 weeks without undergoing freeze-thaw cycles were used as control. The freeze-thaw cycles resulted in severe damages to sweet potato dough and paste structure as the changes in moisture, drip loss, firmness, adhesiveness, storage modulus (G') and complex viscosity (μ*) were significant ($P<0.05$). Due to dough changes, fried cakes became firmer with increasing in number of freeze-thaw cycles. The dough, paste and fried cakes structure became

drier and many holes were developed after been exposed to 5 freeze-thaw cycles as shown in micrographs. Adhesiveness and handling ability from QDA assessment was the most affected physical characteristics. Even though freeze-thaw cycles caused severe damaged to dough structure, the fried cakes made from the dough were slightly acceptable.

Keywords: Sweet potato dough, traditional fried cakes, frozen storage, freeze-thaw cycle, physical changes, sensory evaluation

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENYEDIAAN DOH SEJUKBEKU BERASASKAN KELEDEK (*Ipomoea batatas*) untuk KUIH GORENG TRADISIONAL MALAYSIA

Oleh

HUSNI HAYATI BT. MOHD. RAFDI

Julai 2008

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Doh ubi keledek sangat popular sebagai asas doh bagi pembuatan kuih goreng tradisional di Malaysia tetapi tiada sebarang piawai kualiti untuk dijadikan rujukan bagi pembuatan doh tersebut. Nilai jangkaan spesifik bagi pembolehubah tidak bersandar untuk menghasilkan doh tersebut; i.e masa lecekan (11.36 – 138.64s) dan amaun tepung gandum (3.79 – 46.21%) telah diperolehi menggunakan rekaan komposit titik tengah daripada perisian *Response Surface Methodology* (RSM). Doh dan kuih goreng yang dihasilkan dianalisa kualitinya berdasarkan sifat-sifat fizikal dan penilaian deria. Keadaan optimum untuk membuat doh keledek bagi penghasilan kuih goreng akhirnya diperolehi, menggunakan RSM, ialah 45s bagi masa lecekan pada 150ppm dan 25% bagi amaun tepung gandum. Doh keledek kemudiannya dihasilkan menggunakan masa lecekan dan formulasi yang optimum yang kemudiannya disimpan selama 6 bulan pada 20±2^{o}C dan pemerhatian ke atas perubahan kualiti doh dijalankan pada setiap 1 bulan.

Pes keledek turut dikaji sebagai perbandingan. Sampel (doh dan pes) yang tidak disejukbekukan telah dijadikan sampel kawalan dalam kajian ini. Penyimpanan sejukbeku selama 6 bulan telah menyebabkan pengeringan pada sampel disebabkan oleh penurunan kandungan lembapan. Kebolehan memegang air dalam sampel menurun berdasarkan penghasilan cecair dalam pes dan meningkatnya kadar kelekitan dalam doh dan pes selepas penyimpanan sejukbeku. Ini menunjukkan berlakunya kerosakan struktur dalam sampel yang disejukbekukan. Hasilnya, kekerasan dan kekenyalan (G') doh dan pes meningkat. Kesinambungan daripada itu, Analisis Profil Tekstur (TPA) kuih goreng (sifat kekerasan, keanjalan, kekenyalan dan kekunyahan) yang dihasilkan daripada doh sejukbeku menunjukkan penurunan. Gambar mikro mununjukkan struktur kesemua doh, pes dan kuih goreng menjadi rosak, musnah dan kering selepas 6 bulan penyimpanan. Berdasarkan Analisis Diskriptif Kuantitatif (QDA), doh dan pes sejukbeku semakin sukar dibentuk disebabkan oleh peningkatan sifat kelekitan. Bagaimanapun, kesemua perubahan negatif yang ditunjukkan oleh analisis menggunakan instrumen tidak mempengaruhi penerimaan keseluruhan kuih goreng. Kuih goreng masih diterima dengan nilai 5.52, iaitu penerimaan minimum. Kajian sejukbeku-cair telah dijalankan ke atas doh keledek untuk mengkaji kestabilan doh terhadap ketidakstabilan suhu. Doh dan pes telah didedahkan kepada 5 kitaran sejukbeku-cair selama 5 minggu dan perubahan kualiti terhadap sifat-sifat fizikal dan penilaian deria sampel telah dikaji. Sampel yang disimpan selama 5 minggu tanpa didedahkan kepada kitaran sejukbeku-cair dijadikan sebagai sampel kawalan. Kitaran sejukbeku telah menyebabkan kerosakan serius kepada

struktur doh dan pes memandangkan perubahan nilai kandungan lembapan, kehilangan cecair, sifat kekerasan, sifat kelekitan, sifat kekenyalan (G') dan sifat kelikatan kompleks (μ*) adalah jelas ($P<0.05$). Perubahan dalam doh mempengaruhi tekstur kuih goreng; iaitu kekerasan kuih goreng meningkat dengan peningkatan masa dan bilangan kitaran sejukbeku-cair. Kerosakan struktur dilihat jelas dibawah mikroskop, di mana struktur doh, pes dan kuih goreng menjadi lebih kering dan banyak ruang kosong terbentuk di antara struktur sampel selepas didedahkan kepada 5 kitaran sejukbeku-cair. Penilaian deria QDA menunjukkan bahawa sifat – sifat fizikal yang paling terjejas ialah sifat kelekitan dan sifat kebolehan membentuk doh. Walaupun kitaran sejukbeku-cair menyebabkan kerosakan serius kepada struktur doh, kuih goreng yang dihasilkan daripada doh tersebut masih lagi diterima dengan penerimaan minimum.

Kata kunci: Doh keledek, kuih goreng tradisional, penyimpanan sejukbeku, kitaran sejukbeku-cair, perubahan fizikal, penilaian deria

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I certify that an Examination Committee has met on 22 July 2008 to conduct the final examination of Husni Hayati binti Mohd. Rafdi on her Master of Science thesis entitled "Preparation of Frozen Sweet Potato (*Ipomoea batatas*) Dough Base for Traditional Malaysian Fried Cakes" in accordance with Universiti Putra Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The Committee recommends that the candidates be awarded the relevant degree. Members of the Examination Committee are as follows:

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Date: 16 October 2008

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

HUSNI HAYATI MOHD RAFDI

Date: 26 August 2008

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ABBREVIATIONS AND SYMBOLS

g	gram
mm	millimeter
cm	centimeter
µm	micrometer
ha	hectare
s	second
min	minute
hr	hour
rpm	round per minute
Pa	Pascal
N	Newton
kJ	kilo joule
Kg	Kilogram
G'	Storage modulus
G"	Loss modulus
η*	Complex viscosity
δ	Phase angle
FT	freeze-thaw
SEM	Scanning Electron Microscopy
TPA	Texture Profile Analysis
QDA	Quantitative Descriptive Analysis
RSM	Response Surface Methodology
PP	Polypropylene
FAO	Food Act Organisation
AOAC	American Organisation Association Chemist
IIR	International Institution of Refrigeration

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CHAPTER 1

INTRODUCTION

Sweet potato (*Ipomoea batatas*) is a dicotyledonous plant that is rich in fiber and carbohydrate. In Malaysia, sweet potato can be processed into tasty traditional fried cakes such as *kuih keria, cucur badak, kuih bom* and *cek mek molek*. The boiled and mashed sweet potatoes are used as the base for making these Malaysian fried cakes. The base is prepared by mixing the boiled and mashed sweet potato with wheat flour to form a dough. The dough is molded and either filled with or without fillings in the centre before they are fried (Hasidah and Khatijah, 1994).

The preparation of the sweet potato dough is very tedious and time consuming. This is because it involved several processing stages such as peeling, boiling, mashing the sweet potato tuber, mixing it with flour and molding into desired shape prior to deep-frying. Therefore, the introduction of a new semi finished product such as frozen sweet potato dough will provide an alternative for consumers who do not have much time but wish to make fresh sweet potato cakes at anytime they want to. It is quick and easy to use dough as consumers need only to thaw the product before it can be moulded and then fried into the desired type of cake.

Although the sweet potato traditional cakes recipe is easily accessible, to date there is no published scientific information on the preparation of a desirable and an optimal quality of traditional fried sweet potato cakes. Besides, very limited reports are published on sweet potato, especially on frozen sweet potato products compared with other tubers like cassava. Therefore the optimization of sweet potato dough processing method is important for processing improvements in the industry.

Freezing keeps food safe by slowing the movement of molecules, causing microbes to enter a dormant stage. Freezing preserves food for extended periods because it prevents the growth of microorganisms that cause both food spoilage and foodborne illness (USDA, 2005), therefore lengthen the shelf life of a product. Developing the frozen semi finished sweet potato dough will provide diverse choice to consumers as Malaysian consumers are increasingly recognizing convenient food such as frozen processed food due to the increasingly busy and hectic lifestyles, and also widespread ownership of freezers and microwave ovens. Few internationally established brands that have entered the frozen bakery products subsector in the country offer Asian-style frozen bakery products, like Chinese pau (buns), roti prata/canai (a local crispy savoury pancake usually consumed with curry) and curry puffs (Euromonitor, 2005).

Although freezing extended the shelf life of most foods, it also affects the food quality. An understanding of the rheological behavior of food materials is important for new product development, equipment design, process improvement and food quality control (Rodriguez-Sandoval *et al.*, 2008). Not much work have been done on the quality of frozen sweet potato paste or dough but, abundant of information on the quality of frozen bread dough and potato are available. The quality of bread made from frozen dough is influenced by the dough formulation, process parameters (Rouille *et al.*, 2000), freezing rate, storage duration and thawing rate (Inoue and Bushuk, 1991; Neyreneuf and Delpuech, 1993; Lu and Grant, 1999). Dough was reported to suffer from loss of strength in frozen storage attributed to various factors such as ice recrystallization and the water redistribution (Berglund *et al.*, 1991; Bot and de Bruijne, 2003; Selomulyo and Zhou, 2007). These factors may either act independently or synergistically to damage, disrupt and resulted in a less continuous gluten network (Berglund *et al.*, 1991; Bot and de Bruijne, 2003; Lucas *et al.*, 2005) in a bread dough system.

In the case of mash potato products, Hopkins and Gormley (2000) reported that frozen stored mashed potato had higher compressive strength but lower shear and adhesiveness values compared to granules that were not frozen. Canet *et al.* (2005) indicating that, TPA and firmness parameters were lower in the frozen/thawed mashed samples than in the fresh samples. Therefore, the effect of frozen storage on sweet potato dough will be investigate in term of rheological, texture, sensory evaluation and microstructure changes for quality determination.

During frozen storage, the probability of temperature fluctuation to occur is high. Temperature fluctuation occurred normally due to temperature gradients from within the products during freezing and thawing, also during storage or transportation (Breton *et al.*, 2000). Such temperature fluctuations cause the available water to form ice crystals and gone through recrystallization. This creates a number of undesirable effects, including moisture migration, dehydration, syneresis, structural breakdown, and the formation of large ice crystals which impart a gritty mouthfeel to frozen foods (Kuntz, 1995). According to Lee *et al.* (2000), the drip loss obtained from three repeated freeze-thawed sweet potato starch gel was more than doubled. Bhattacharya *et al.* (2003) reported that repeated freeze-thaw cycles produced significant decrease in dough resistance, but increases the dough extensibility. Determining the appropriate temperatures and cycling procedure to ensure that a product truly is "freeze/thaw-stable" is a matter of making assumptions of the number and degree of thaw and refreezing cycles a product will undergo before it is consumed. Typically this is based on the conditions the product is likely to encounter after it leaves the manufacturer. Freeze-thaw cycle test is crucial to the food formulation to see if it met the shelf life and storage requirements (Kuntz, 1995).

Therefore, the objectives of this study are:

1. Optimize the mashing time and wheat flour concentration of sweet potato dough base using RSM.
2. Study the effect of frozen storage on the quality of sweet potato paste and dough base for traditional fried cakes preparation.
3. Study the effects of freeze-thaw cycles on the quality of sweet potato paste and dough base for traditional fried cakes preparation.