UNIVERSITI PUTRA MALAYSIA

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By

NOR MAZLANA BINTI MAIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfilment of the Requirement for the degree of Master of Science

January 2008

Dedicated to my beloved

Parents...

Husband…

For their loves and encouragements…

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

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Chairman : Professor Russly bin Abdul Rahman, PhD

Faculty : Engineering

Microwave oven has been used extensively as to provide conveniences to consumers in preparing foods. The major problem in microwave baking is the inability of the microwave oven to induce browning on the surface of foods. To alleviate this problem and aid the browning and crisping on the surface of a baked food item, a packaging materials called susceptor has been developed specifically to support the usage of microwave oven.

This study presents the design of susceptor packaging rigid box that is effective to bake flaky pastry dough (puff pastry) in microwave oven and performance evaluation of the product through microwave testing.

Paperboard, corrugated board B-flute and metallized polyethylene terephthalate (MPET) film were used to design susceptor packaging rigid box. Testing on performance of susceptor packaging rigid box was implemented in microwave baking with different design and lamination of packaging material with puff pastry inside. Only one design of susceptor packaging rigid box was chosen which was design eight with the use of semi

coating MPET film based on the desirable quality of the susceptor packaging rigid box and the puff pastry. Quality parameters of puff pastries such as temperature after baking, weight loss, colour changes at top and bottom surfaces, specific volume after baking and hardness were obtained as a result of the application on susceptor packaging rigid box through microwave testing. The sensory attributes of puff pastries such as appearance (colour), odour, taste, crispiness, texture (hardness) and overall acceptability were also examined using Hedonic Test acceptability of panelists on the puff pastries that were baked in susceptor packaging rigid box in microwave oven.

As baking time was increased, all the quality parameters increased. Microwave baked puff pastries without susceptor packaging rigid box had some quality defects such as lack of colour, became soggy, shrank and brittle when cold. However, the microwave baked puff pastries had the highest specific volume and temperature. It was possible to improve the quality of microwave baked puff pastries with the aid of susceptor packaging rigid box. The colour of puff pastries changed into desirable rich brown and gave crispiness value similar to the conventionally baked ones at the three power levels used. However, microwave baked puff pastries with susceptor packaging rigid box had a lower volume at all power used. The best conditions for baking puff pastries in microwave oven with susceptor packaging were 270s, 285s and 300s at 340W microwave power; 165s and 180s at 500W microwave power; and 105s and 120s at 790W microwave power. When susceptor packaging was applied for this condition, it reduced conventionally baking time about 75%-91%. Results of sensory evaluation showed that puff pastries baked in conventional oven were highly accepted by the panelists with mean scores of 7.67 (mean scale: 1-9). The results followed by puff pastries that were baked with susceptor packaging rigid box with the mean score value of 6.93. Microwave baked puff pastries had the lowest mean score in overall acceptability (4.47).

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

BAHAN PEMBUNGKUS 'SUSCEPTOR' BAGI PEMBAKARAN DOH PASTRI BERLAPIS DALAM KETUHAR GELOMBANG MIKRO

Oleh

NOR MAZLANA BINTI MAIN

Januari 2008

Pengerusi : Profesor Russly bin Abdul Rahman, PhD

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Ketuhar gelombang mikro telah digunakan secara meluas sebagai melengkapi keperluan kemudahan kepada pengguna dalam penyediaan makanan. Masalah utama dalam pembakaran dalam ketuhar gelombang mikro ialah ketidakmampuan ketuhar gelombang mikro untuk menghasilkan pemerangan di atas permukaan makanan. Untuk mengurangkan masalah ini dan membantu keperangan dan kerangupan di atas permukaan makanan yang di bakar, bahan pembungkus 'susceptor' telah dibangunkan khususnya untuk menggalakkan penggunaan ketuhar gelombang mikro.

Kajian ini mempersembahkan rekabentuk pembungkus 'susceptor' kotak tegar yang efektif untuk membakar pastri doh berlapis (pastri puf) dalam ketuhar gelombang mikro dan menilai prestasi produk melalui ujian ketuhar gelombang mikro.

Papan kertas, papan gelugor flut-B dan filem polietilena tereptalat berlogam (MPET) digunakan untuk merekabentuk pembungkus 'susceptor' kotak tegar. Ujian prestasi dijalankan ke atas pembungkus 'susceptor' kotak tegar dalam ketuhar gelombang mikro

dengan gabungan bahan dan rekabentuk yang berbeza bersama pastri puf di dalamnya. Hanya satu sahaja rekabentuk pembungkus ‘susceptor’ yang dipilih iaitu rekabentuk ke lapan yang menggunakan filem sebahagian lapisan pelindung MPET bedasarkan kualiti yang diingini pada pembungkus ‘susceptor’ kotak tegar dan pastri puf. Parameter kualiti pastri puf seperti suhu selepas pembakaran, kehilangan kandungan air, perubahan warna pada permukaan atas dan bawah, isipadu spesifik selepas pembakaran dan kekerasan akan ditentukan sebagai keputusan bagi pengaplikasian pembungkus ‘susceptor’ kotak tegar melalui ujian ketuhar gelombang mikro. Ujian deria rasa ke atas aspek pastri puf seperti warna, bau, rasa, kerangupan, tekstur (kekerasan) dan penerimaan keseluruhan juga dijalankan menggunakan Ujian Hedonic sebagai keputusan ke atas penerimaan panel kepada puf yang dibakar dalam pembungkus ‘susceptor’ kotak tegar dalam ketuhar gelombang mikro.

Semua parameter kualiti meningkat dengan peningkatan masa pembakaran. Pembakaran pastri puf di dalam ketuhar gelombang mikro tanpa pembungkus ‘susceptor’ kotak tegar mempunyai kualiti kurang baik seperti tiada perubahan warna, menjadi lembab, kecut dan keras apabila sejuk. Namun begitu, pastri puf mempunyai kadar isipadu spesifik dan suhu yang tinggi. Pembungkus ‘susceptor’ kotak tegar boleh digunakan sebagai bantuan untuk memperbaiki kualiti pembakaran pastri puf melalui ketuhar gelombang mikro. Warna pastri puf bertukar kepada keperangan yang diingini serta memberikan nilai kerangupan yang seakan sama dengan pembakaran secara konvensional pada ketiga-tiga peringkat kuasa yang digunakan. Namun begitu, pastri puf tersebut mempunyai nilai isipadu yang rendah pada semua peringkat kuasa yang digunakan. Situasi yang paling baik untuk membakar pastri puf dalam ketuhar gelombang mikro ialah 270s, 285s dan 300s pada kuasa 340W; 165s dan 180s pada kuasa 500W; dan 105s dan 120s pada kuasa 790W. Apabila pembungkus ‘susceptor’ kotak tegar diaplikasikan dalam situasi ini, ia dapat mengurangkan masa pembakaran sebanyak 75%-91%. Keputusan daripada ujian rasa menunjukkan bahawa pastri puf yang dibakar secara konvensional mempunyai penerimaan keseluruhan yang tertinggi oleh ahli panel dengan purata skor 7.67 (skala purata: 1-9). Keputusan diikuti pula dengan pastri puf yang dibakar menggunakan pembungkus ‘susceptor’ kotak tegar dengan purata skor 6.93. Pembakaran pastri puf

melalui ketuhar gelombang mikro memberikan nilai terendah dalam penerimaan keseluruhan oleh ahli panel dengan purata skor 4.47.

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I certified that an examination committee has met on 11 January 2008 to conduct the final examination of Nor Mazlana Binti Main on her Master of Science thesis entitled "Susceptor Packaging Material for Baking Flaky Pastry Dough in Microwave Oven" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulation 1981. The committee recommended that the candidate be awarded the relevant degree. The Committee Members for the candidate are as follows:

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

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LIST OF ABBREVIATIONS

AACC	American Association of Cereal Chemist
ANOVA	Analysis of variance
ASTM	American Society for Testing and Materials
MPET	Metallized polyethylene terephthalate
OD	Optical density
SAS	Statistical analysis software
TPA	Texture Profile Analysis

CHAPTER 1

INTRODUCTION

1.1 Overview

Packaging in today's society has become increasingly more sophisticated and technically sound. Improvements in plastic resin formulation and container of microwave fabrication techniques are occurring at a very rapid pace. The systematic assembly of the microwave package and food product is being done through simultaneous development of product and package to achieve common goals of efficiency and low cost (Gray & Harte, 1986; Maria, 1998). The use of packages which provide product protection as well as enhanced convenience is critical to the successful marketing of many products. Nowadays, greater number of people has higher level of education and higher income which makes them prefer packaged products that are more convenient to use. Therefore, packaging role in society is becoming increasingly important.

During late 1970 and well into 1980, using a microwave oven for cooking food at home was a dubious trend that was not taken very seriously by consumer. In 1990, microwaveable foods became the growing trend and the microwave technology was improved. However, consumers were quickly tired of products that did not heat uniformly and most products that were meant to crisp while cooking were coming out of

the microwave soggy (Barry, 2004). Nowadays, busy consumers are demanding higher quality products, easier to use packaging and faster, more efficient cooking methods which means more flexibility in the kitchen. In America for example, about 95% of homes have at least one microwave oven (Nishkaran, 2002). Microwaving food simply is not an option anymore but it is a necessity for them. Subsequently, microwave packaging is now going through a technological renaissance that must be competed with more conventional methods of cooking via stovetop, oven or toaster oven (Barry, 2004).

Today, cooking by using microwave is very common and it is widely adopted in developed countries. For an average consumer, the term 'microwave' generally means microwave oven which is used in many households for heating food and it is also generally used as convenient method for reheating rather than cooking. The advantages of using microwave oven are that it is fast and easy to use. It is highly suitable for busy life style as it can heat food faster than other conventional heating methods.

1.2 Research Background

Demands and requirements of market place are an accumulation of influences including demographics, lifestyle changes, social, cultural and technological development. People want packaged product which can offer convenience, quality, variety and excitement, safe and promote good health (Hughes, 1994). Over recent years, popularity of food items that can be stored in a refrigerator or freezer and then subsequently transferred to microwave oven to be cooked or reheated increased tremendously. Consumers also

preferred food products to be packaged in containers, which were suitable for both storage in refrigerators or freezers and for heating purpose, subjected to microwave radiation. Such products can be purchased as chilled or frozen items, stored at home and then eventually heated in a microwave oven. Alternatively, some of the products may have been purchased from vending machines, comprising a refrigerated unit and a microwave oven unit (Savage *et al.*, 2004). These demands reflected the growth of many products especially for microwave food product.

In recent years, applied research and process developments are seeking a new application of microwave technology. The pace of advancement and dynamic changes was taking place, as the food industry responds to demand from consumers for a wider selection of quality microwaveable food products, at reasonable cost. The response to this demand, in order to improve the package quality, was not an easy job to be achieved because of the unique mechanism associated with the microwave energy. Common microwave penetrable packaging materials, such as paperboard will heat and cook the food directly inside the package, but the problems raised in relation to the other food products, such as those that need crust, crisp and require a degree of browning in packaged products, which cannot be achieved by the simple usage of microwave heating (Savage *et al.*, 2004).

In response to these concerns, the manufacturer has to develop their packaged product to meet customer needs, and these packages must be balanced in terms of required function

especially to be used in microwave oven. Thus, a packaging material called susceptor was developed for food and packaging industries.

Susceptor is a very unique packaging material. Microwave susceptors are devices that provide electrical conductive layer, which can produce heat when expose to microwave energy. This material has an ability to absorb a portion of microwave energy and then convert it into heat, which can be used to make foodstuffs crisp and brown (Anastasia *et al.*, 1999). Susceptor may consist of a laminate composed of paper or board adhered to metallized polyester (Arthur, 1991). The temperature for food during microwave heating does not exceed the boiling point of water, 100°C (Harrison, 1988; Anastasia *et al.*, 1999). Therefore, by using susceptor, a continuous heating occurred until the maximum temperature (approximately 200°C) was reached, and then susceptor will behave like a conventional oven up to this time (Savage *et al.*, 2004).

Since foods are generally treated in packages during microwave heating and processing, most of the research in this area was devoted to the determination of migration of additives, or plasticizers from food grade packaging materials in microwave heating and processing into foodstuffs (Kruijf & Rijk, 1994; Abdul Malek, 1996; Mountfort *et al.*, 1996; Anastasia *et al.*, 1999). Packages for microwave heating and processing attracted a special attention in migration studies due to the high temperatures reached during cooking. Polyethylene terephthalate (PET) /polypropylene (PP) laminates with a barrier layer of ethylene-vinyl alcohol (EVOH), polyvinylidene chloride (PVdC), polyethylene