



**UNIVERSITI PUTRA MALAYSIA**

***DEVELOPMENT AND OXIDATIVE STABILITY OF PISTACHIO  
(Pistacia vera L.) SPREAD***

**AHMAD SHAKERARDEKANI**

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**By**

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**DOCTOR OF PHILOSOPHY  
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**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
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**October 2012**

## DEDICATION

*This thesis is dedicated to my father who is always giving me his unlimited support  
and to my mother who is always praying for my well being.*

**I present this thesis to**

**My beloved mother and father, my wife and my sons**

**for their love, patience and understanding**



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment  
of the requirement for the degree of Doctor of Philosophy

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**Chairman: Associate Professor Roselina Karim, PhD**

**Faculty: Food Science and Technology**

Pistachio nut (*Pistacia vera* L.) is one of the popular tree nuts in the world. Due to its high nutritional value, pistachio is an increasingly important nut consumed either in the form of raw, roasted or salted. The main objective of this study was to value-add pistachio nut (Ohadi variety) by conversion into an acceptable and shelf-stable pistachio spread. Specifically, this study was conducted to investigate the effect of processing conditions of pistachio kernels (roasting and milling) on the quality of pistachio paste, to develop pistachio spread as a new product, and to determine the physicochemical properties and oxidative stability of pistachio spread. In the first part of the study, results obtained showed that increases in roasting temperature and time caused a decrease in the color attributes of both whole kernels and ground kernels except for the 'a' value of ground kernels. The hardness (N) and color attributes (L value, b value and yellowness index) of whole kernels and the 'a' value

of ground kernels could be used to monitor the roasting quality of whole kernels. The recommended range of roasting temperature and time of whole kernels for the production of pistachio paste were 130-140°C and 30-40 min, respectively. The colloidal stability of pistachio paste samples was found to be influenced by particle size and the most stable pistachio paste was obtained when the mill gap size was 20 µm. All pistachio pastes under study depicted the pseudo-plastic and thixotropic behaviors. The Herschel-Bulkley model was the most appropriate model to describe the flow behavior of pistachio paste. The storage modulus ( $G'$ ) values of pistachio paste were higher than the loss modulus ( $G''$ ) values for all frequencies studied. The second part of this study concentrated on the development of pistachio spread from the pistachio paste. The spread was prepared using pistachio paste as the main component, icing sugar, soy protein isolate and red palm oil at different ratios. A total of 17 formulations were prepared. From the study, two formulations were selected based on their sensory properties, work of shear, color attributes, oil stability, flow behavior and dynamic oscillatory property. The two formulations were Formulation 12 which contained 50.0% pistachio paste, 30.0% icing sugar, and 20.0% red palm oil, and Formulation 16 which comprised of 58.3% pistachio paste, 25.0% icing sugar and 16.7% red palm oil. Following this, appropriate terminologies for describing the sensory characteristics of these pistachio spreads were developed using quantitative descriptive analysis (QDA). Thirty-two potential panelists were screened and only twelve panelists were selected for training and finally only eight of them were found to be qualified for the evaluation of pistachio spread. Twenty attributes in terms of appearance, aroma, flavor, texture and aftertaste of pistachio spread were identified and developed by the trained panelists. Results from sensory evaluation showed that no significant ( $P < 0.05$ ) difference was observed in all the

sensory attributes between the selected pistachio spread formulations except for sweetness. In the third part of this study, further improvement of the pistachio spread, especially with respect to prevent oil separation, was made by the addition of monoglycerides (Dimodan HP-M). Results showed that the addition of 0.75 and 1.5% of monoglycerides led to the reduction in oil separation during storage probably due to creation of a strong network between fat, protein and other component by the emulsifier. The addition of monoglycerides also influenced the rheological characteristics such as the flow behavior ( $K$ ,  $n$ ,  $A$ ,  $\tau_0$  and  $R$ ), dynamic oscillatory values ( $G'$ ,  $G''$  and  $\tan \delta$ ) and color of the spread. The most suitable formulation based on the observed physicochemical, physical and rheological studies was the one that contained 58.3% pistachio paste, 25.0% icing sugar, 15.2% red palm oil and 1.5% monoglycerides. Based on the results obtained on the effect of accelerated storage at 60°C, it can be concluded that the shelf life of pistachio spread was 320 days at  $20 \pm 2^\circ\text{C}$ .

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PENGEMBANGAN DAN KESTABILAN OKSIDATIF SAPUAN  
PISTACHIO (*Pistacia vera* L.)**

Oleh

**AHMAD SHAKERARDEKANI**

**October 2012**

**Pengerusi: Profesor Madya Roselina Karim, PhD**

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Kacang pistachio (*Pistacia vera* L.) merupakan salah satu daripada pokok kacang yang popular di dunia. Memandangkan nilai pemakanannya yang tinggi, pistachio merupakan tanaman kacang yang semakin penting yang dimakan samada secara mentah atau setelah dipanggang dan ditambah garam. Objektif utama kajian ini adalah untuk nilai tambah kacang pistachio (varieti Ohadi) dengan mengubahnya kepada sapuan pistachio yang diterima dan stabil pada penyimpanan. Khususnya, kajian ini telah dijalankan untuk mengkaji kesan keadaan pemprosesan kernel pistachio (pemangangan dan pengisaran) keatas kualiti pes pistachio, untuk membangunkan sapuan pistachio sebagai produk baharu, dan untuk menentukan ciri fisikokimia dan kestabilan pengoksidaan sapuan pistachio. Dalam bahagian pertama kajian ini, keputusan yang diperolehi menunjukkan bahawa kenaikan suhu dan masa pemangangan menyebabkan pengurangan dalam sifat-sifat warna kedua-dua kernel penuh dan kernel serbuk kecuali untuk nilai a bagi kernel serbuk. Kekerasan (N) dan



sifat-sifat warna (nilai L, b dan nilai indeks kuning) kernel penuh dan nilai kernel serbuk boleh digunakan untuk memantau kualiti pemanggangan kernel penuh. Julat yang disyorkan suhu pemanggangan dan masa kernel penuh untuk pengeluaran pes pistachio adalah masing-masing 130-140°C dan 30-40 min. Kestabilan koloid sampel pes pistachio dipengaruhi oleh saiz zarah dan pistachio pes yang paling stabil diperolehi apabila saiz jurang pengisar adalah 20µm. Semua pes yang dikaji menggambarkan pistachio bersifat pseudoplastik dan thiksotropik. Model Herschel-Bulkley adalah model yang paling sesuai untuk menerangkan sifat aliran pes pistachio. Nilai modulus penyimpanan (G') untuk pes pistachio adalah lebih tinggi daripada nilai kehilangan modulus (G'') bagi semua frekuensi yang dikaji. Bahagian kedua kajian ini tertumpu kepada pembangunan sapuan pistachio dari pes pistachio. Sapuan telah disediakan dengan menggunakan pes pistachio sebagai komponen utama, gula ising, protein soya isolat dan minyak sawit merah pada nisbah yang berbeza. Sebanyak 17 formulasi telah disediakan. Daripada kajian ini, dua formulasi telah dipilih berdasarkan sifat sensori, kerja-kerja ricih, indeks warna, kestabilan minyak, sifat aliran dan nilai ayunan dinamik. Kedua-dua formulasi tersebut adalah Formulasi 12 yang mengandungi 50.0% pes pistachio, 30.0% gula ising dan 20.0% minyak sawit merah, dan Formulasi 16 yang terdiri daripada 58.3% pes pistachio, 25.0% gula dan 16.7% minyak sawit merah. Dalam langkah seterusnya, istilah yang sesuai untuk menerangkan ciri-ciri deria sapuan pistachio menggunakan analisis kuantitatif deskriptif (QDA) telah dibangunkan. Tiga puluh dua ahli panel yang berpotensi telah disaring dan hanya dua belas ahli panel telah dipilih untuk latihan dan akhirnya hanya lapan daripada mereka didapati berkelayakan untuk penilaian sapuan pistachio. Dua puluh atribut (dari segi rupabentuk, aroma, rasa, tekstur, dan 'aftertaste') bagi sapuan pistachio telah dikenal pasti dan dibangunkan oleh panel

terlatih. Keputusan dari penilaian deria menunjukkan bahawa tiada perbezaan yang signifikan ( $P < 0.05$ ) dicerap terhadap semua atribut deria pada formulasi sapuan pistachio yang dipilih kecuali kemanisan. Pada bahagian ketiga kajian ini, penambahbaikan sapuan pistachio, terutamanya untuk mencegah pemisahan minyak, telah dibuat dengan penambahan monogliserida (Dimodan HP-M). Hasil kajian menunjukkan bahawa penambahan 0.75 dan 1.5% monogliserida membawa kepada pengurangan dalam pemisahan minyak semasa penyimpanan kemungkinan disebabkan oleh kewujudan rangkaian yang kukuh di antara lemak, protein dan komponen lain oleh pengemulsi tersebut. Penambahan monogliserida juga mempengaruhi ciri-ciri reologi seperti sifat aliran ( $K$ ,  $n$ ,  $A$ ,  $\tau_0$ , dan  $R$ ), nilai-nilai ayunan dinamik ( $G'$ ,  $G''$  dan  $\delta \tan$ ) dan warna sapuan. Formulasi yang paling sesuai berdasarkan cerapan dari kajian fizikokimia, fizikal dan reologi adalah formulasi yang mengandungi 58.3% pistachio pes, 25.0% gula ising, 15.2% minyak sawit merah dan 1.5% monogliserida. Berdasarkan keputusan yang diperolehi dari kesan penyimpanan dipercepatkan pada 60°C, dapat disimpulkan bahawa tempoh simpanan sapuan pistachio ialah selama 320 hari pada suhu ambien.

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I certify that a Thesis Examination Committee has met on 30 October 2012 to conduct the final examination of Ahmad Shakerardekani on his thesis entitled “Development and Oxidative Stability of Pistachio (*Pistacia vera* L.) Spread” 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 degree of Doctor of Philosophy.

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

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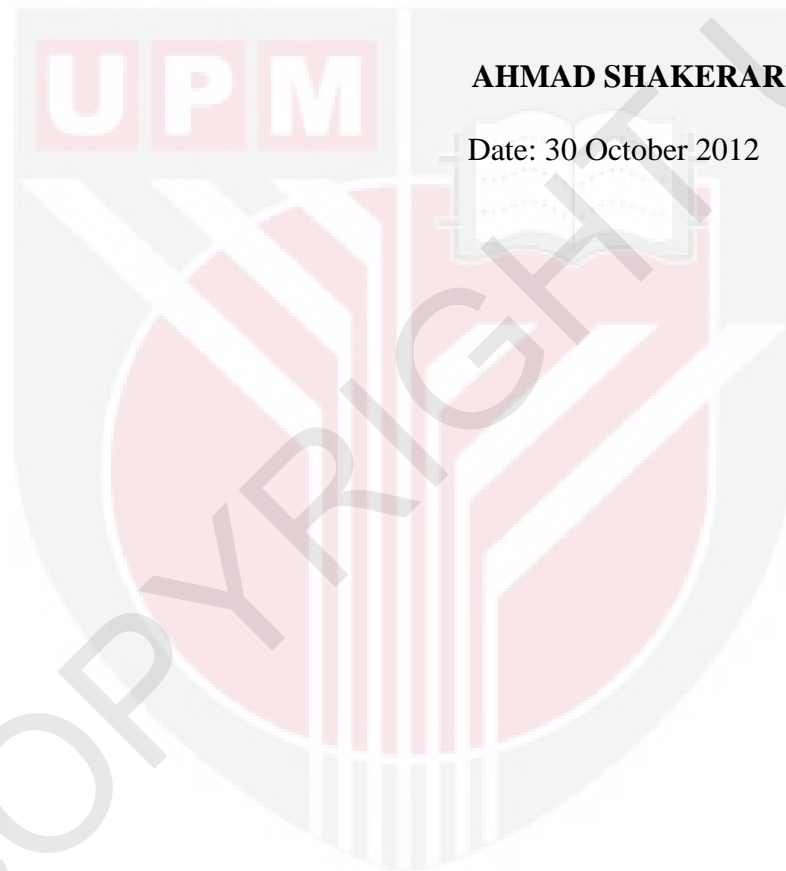
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## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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