

UNIVERSITI PUTRA MALAYSIA

PHYSICOCHEMICAL, TEXTURAL AND ORGANOLEPTIC PROPERTIES OF REDUCED FAT CHEDDAR CHEESE

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This thesis is dedicated to my supervisor professor Mohd Yazid bin Abd. Manap and my parents who are always giving me their unlimited support



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

PHYSICOCHEMICAL, TEXTURAL AND ORGANOLEPTIC PROPERTIES OF REDUCED FAT CHEDDAR CHEESE

By

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Dairy products, particularly cheese products are the main source of saturated fats and cholesterol. It is well established that excessive consumption of fat increases the risk of ailments like obesity and cardiovascular diseases. Reduced and low fat cheese often exhibit poor sensory quality due to the reduction of fat which plays a critical role in flavor and texture.

The major objective of this research is to improve the textural and the organoleptic properties of the reduced fat cheddar cheese by the application of special adjunct starter cultures (*Lactobacillus helveticus, Lactobacillus casei, Streptococcus thermophilus*) and fat replacers namely xanthan gum and sodium caseinate. Initially different xanthan gum to sodium caseinate ratios (xanthan gum: 0, 0.015, 0.030, 0.045 (% w/w), Sodium caseinate: 0, 0.15, 0.30, 0.45 (% w/w)) were added as fat replacer to different fat levels of cheese milk (1.25, 2, 2.75, 3.5) (% w/w) in order to

investigate their ability to improve textural properties and yield of reduced fat cheddar cheese. Textural optimization was applied to obtain the best formulation to produce reduce fat cheddar cheese by using fat replacers. The results revealed that the type and concentration of fat replacers significantly (p < 0.05) affected the textural and composition of reduced fat cheddar cheeses. The multiple optimization results of the current study showed that using the high level of xanthan gum (0.045% w/w) in absence of sodium caseinate (0.000% w/w) in half-fat cheeses (2.000% w/w milk fat content) improved the texture and yield of cheddar cheeses with similar textural properties (TPA) of full fat ones and overall desirability of 90.065%. The best optimum formulation was chosen in order to develop the flavor by using single and mixed adjunct starter cultures (i.e. *Lactobacillus helveticus, Lactobacillus casei, Streptococcus thermophilus*).

Profiles of organic acid concentrations, free amino acids, volatile flavor compounds and consumer acceptability showed that the use of *Lactobacillus helveticus* (10^8) as an adjunct starter culture significantly (p < 0.05) improved the flavor score of reduced fat cheddar cheeses compared to use of *Lactobacillus casei* and *Streptococcus thermophilus* and full fat cheddar cheese as a control. Moreover, proteolytic rate of cheeses containing the adjunct starter culture were significantly greater than full fat cheddar cheese. The results obtained by the instruments in this study interestingly verified the descriptive sensory analysis results. Incorporation of xanthan gum with *Lactobacillus helveticus* allowed a considerable fat reduction with no detrimental effect on cheddar cheese overall quality and consumer acceptability. Although xanthan gum significantly affected the textural properties of reduced fat cheddar cheeses, the effect of sodium caseinate as a protein-based fat mimetic was imperceptible. Therefore, further extensive investigations are needed to clarify the effect of other fat mimetics and starter cultures on textural properties and flavor of reduced fat cheddar cheeses. This study recommends that a high quality reduced fat cheddar cheese can be obtained by using xanthan gum as carbohydrate-based fat mimetics and *Lactobacillus helveticus* as an adjunct starter culture.



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SIFAT FIZIKOKIMIA, TEKSTUR DAN ORGANOLEPTIK KEJU CHEDDAR RENDAH LEMAK

Oleh

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Produk tenusu, terutamanya keju merupakan sumber utama lemak tepu dan kolesterol. Pengambilan lemak yang berlebihan meningkatkan kadar risiko untuk menghidap penyakit seperti obesiti dan kardiovaskular. Keju rendah lemak selalunya menunjukkan kualiti sensori yang rendah disebabkan oleh pengurangan lemak yang berfungsi dalam penghasilan perasa dan tekstur.

Objektif utama penyelidikan ini adalah untuk meningkatkan kualiti tekstur dan ciriciri organoletik keju cheddar rendah lemak dengan mengaplikasikan kultur pemula hidup (*Lactobacillus helveticus, Lactobacillus casei, Streptococcus thermophilus*) dan pengganti lemak iaitu xanthan gam dan nitrium kaseinat. Kadar xanthan gam kepada nitrium kaseinat yang digunakan sebagai pengganti lemak adalah 0, 0.015, 0.030, 0.045 (% v/v) kepada 0, 0.15, 0.30, 0.45 (% v/v), ditambah ke dalam kadar lemak yang berbeza (1.25, 2, 2.75, 3.5) (%w/w) di dalam susu keju, bagi tujuan mengkaji kebolehan kedua-duanya dalam memperbaiki tekstur dan menpertingkatkan hasil keju cheddar rendah lemak. Optimasi tekstur digunakan bagi mendapatkan formulasi terbaik bagi mengasilkan keju cheddar rendah lemak. Kajian menunjukkan jenis dan kepekatan pengganti lemak memberi kesan signifikan terhadap tekstur dan komposisi keju cheddar rendah lemak. Beberapa hasil optimasi menunjukkan penggunaan xanthan gam pada kepekatan tinggi (0.045% v/v) tanpa kehadiran nitrium kaseinat (0.000% v/v) di dalam keju separa lemak (2.00% v/v komposisi lemak susu) berjaya memperbaiki tekstur dan hasil keju cheddar rendah lemak dengan menunjukkan nilai ciri-ciri tekstur (TPA) yang serupa dengan keju lemak penuh dan peratusan keinginan yang tinggi iaitu 90.065%. Formulasi optimum terbaik kemudiannya dipilih untuk penghasilan perasa menggunakan satu atau lebih kultur pemula hidup (*Lactobacillus helveticus, Lactobacillus casei, Streptococcus thermophilus*).

Kepekatan asid organi, asid amino bebas, kompaun perasa meruap dan penerimaan pengguna menunjukkan penggunaan *Lactobacillus helveticus* (10^8) sebagai kultur pemula memberikan signifikasi (p < 0.05) peningkatan skor perasa bagi keju cheddar rendah lemak berbanding penggunaan *Lactobacillus casei* dan *Streptococcus thermophilus* serta keju cheddar lemak penuh. Disamping itu, kadar proteolytic bagi keju yang mengandungi kultur pemula hidup adalah lebih tinggi berbanding keju cheddar lemak penuh. Keputusan yang di dapati melalui ujian instrumenatsi menyokong keputusan ujian sensori. Penggunaan xanthan gam dan *Lactobacillus helveticus* membolehkan pengurangan peratusan lemak tanpa memberi kesan negatif terhadap kualiti keseluruhan keju cheddar dan penerimaan pengguna. Walaupun xanthan gam memberi kesan signifikant terhadap ciri-ciri tekstur keju cheddar

terlindung. Oleh sebab itu, lebih banyak kajian perlu dijalankan untuk mengkaji kesan mimik lemak dan kultur pemula hidup terhadap ciri-ciri tekstur dan perasa keju cheddar rendah lemak. Kajian ini mencadangkan keju cheddar rendah lemak berkualiti tinggi boleh dihasilkan dengan penggunaan xanthan gam sebagai karbohidrat pengganti lemak dan *Lactobacillus helveticus* sebagai kultur pemula hidup.



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My sincere gratitude and respect to my beloved parents, my husband and my son for their countless love, support, patience and understanding during not only this project but also my entire life. I certify that a Thesis Examination Committee has met on 14 December 2011 to conduct the final examination of Leila Nateghi on her thesis entitled " Physicochemical, Textural And Organoleptic Properties Of Reduced Fat Cheddar Cheese" 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 doctor of philosophy.

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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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