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DEVELOPMENT OF VIRGIN COCONUT OIL (VCO) BASED EMULSION PRODUCT AS DIETARY SUPPLEMENT

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DEVELOPMENT OF VIRGIN COCONUT OIL (VCO) BASED EMULSION PRODUCT AS DIETARY SUPPLEMENT

By

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DEVELOPMENT OF VIRGIN COCONUT OIL (VCO) BASED EMULSION PRODUCT AS DIETARY SUPPLEMENT

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Chair: Professor Tan Chin Ping, PhD

Faculty: Food Science and Technology

Recently, the demand of virgin coconut oil (VCO) among public continues to rise due to its superior flavour and also its potential health benefits. The present study reports on the development of a VCO-based emulsion product as a dietary supplement. This study is divided into four major parts, namely, the characterisation of commercial food supplement emulsions, the development of VCO-based emulsion formulations, storage stability studies using optimised VCO-based emulsion, and lastly a sensory assessment of an optimised VCO-based emulsion. In the product characterisation study, the physicochemical properties of the commercial emulsion products (C1, C2, C3, and C4) were investigated. C3 exhibited the smallest particle size at 3.25 µm. The pH for the emulsion samples ranged between 2.52 and 3.45 and were thus categorised as acidic. In a texture analysis, C2 was described as the most firm, it was very adhesive and cohesive, and it had high compressibility properties. From a rheological viewpoint, all the emulsion samples exhibited non-Newtonian behaviour, which presented as a shear-thinning property. In this context, the zeta potential of the commercial emulsion samples ranged between -23.17 mV and -52.77 mV. C2 exhibited the highest percentage of fat (18.44%) among all the emulsion samples. During the formulation development of full factorial studies, the influences of different levels of formulation variables, namely the gum arabic concentration (0.75-1.75%, w/v), the xanthan gum concentration (0.8-1.0%, w/v), the VCO concentration (10-20%, v/v), and the maltodextrin concentration (1-3%, w/v) on the pH, particle size, emulsion stability index (ESI), and rheological study of the VCO-based emulsion were studied. All the formulation parameters significantly ($p < 0.05$) affecting the responses. Two optimal formulations from two different sets of full factorial studies were reported to be 0.8% (w/v) xanthan gum, 1.0% (w/v) gum arabic, 7.5% (v/v) VCO (fixed), and 1% (w/v) maltodextrin (fixed); 0.8% (w/v) xanthan gum (fixed), 1.0% (w/v) gum arabic (fixed), 10% (v/v) VCO, and 2% (w/v) maltodextrin, respectively. Storage stability studies showed that the particle size distributions in the VCO emulsions remained stable throughout the three-month

storage period at 25 ℃ and at 50 ℃. Nevertheless, a phase separation did not occur in either of the VCO emulsion products throughout the storage-stability assessment period. No signs of microbial growth were detected in the emulsion products over the storage period. Furthermore, no significant ($p > 0.05$) changes in the free fatty acid contents of the emulsion products were observed during storage at 4 ℃ or 25 ℃ throughout the storage period. A sensory assessment among UPM students showed that for the flavouring preference, both 7.5% and 10% VCO emulsion products showed significant differences ($p < 0.05$) in terms of odour, taste, sweetness, and overall acceptability, and most of the panellists preferred mango flavouring. Among all the emulsion samples, the 7.5% VCO emulsion with mango flavouring yielded the best sensory score with all the sensory attributes scoring more than 5. For the public consumer sensory evaluation, the significant preference towards the VCO emulsion relative to VCO alone also supported the potential to market the VCO emulsion to increase VCO consumption among consumers.

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

PEMBANGUNAN PRODUK EMULSI BERASASKAN MINYAK KELAPA DARA SEBAGAI MAKANAN TAMBAHAN

Oleh

KHOR YIH PHING

Disember 2014

Pengerusi: Profesor Tan Chin Ping, PhD

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Baru-baru ini, permintaan atas minyak kelapa dara di kalangan pengguna awam semakin meningkat disebabkan oleh rasanya yang unggul dan banyak memberi manfaat kepada kesihatan. Kajian ini melaporkan pembangunan produk emulsi berasaskan minyak kelapa dara sebagai makanan tambahan . Kajian ini dibahagikan kepada empat bahagian utama: kajian pencirian ke atas produk makanan tambahan emulsi komersial, pengoptimuman formulasi emulsi minyak kelapa dara, kajian penyimpanan ke atas produk optimum dan akhirnya penilaian deria ke atas produk emulsi berasaskan minyak kelapa dara optimum. Dalam kajian pencirian produk komersial, sifat-sifat fiziko-kimia produk emulsi komersial (C1, C2, C3, dan C4) telah dinilai. C3 mempunyai saiz partikel yang terkecil iaitu 3.25 µm. pH sampel emulsi didapati berada dalam lingkungan 2.52 ke 3.45 dan dikategorikan sebagai berasid. Daripada analisis tekstur, C2 boleh digambarkan dengan memperoleh sifat pejal, sangat melekat dan bersepadu, dan mempunyai sifat kebolehmampatan yang tinggi. Dari segi analisis reologi, semua sampel emulsi didapati mempunyai sifat bukan-Newtonian. Dalam konteks ini, potensi zeta sampel emulsi komersial berada dalam lingkungan -23.17 mV dan -52.77 mV. C2 mempunyai peratus lemak yang terbanyak (18.44%) antara semua sampel emulsi. Dalam pembangunan formulasi emulsi minyak kelapa dara, pengaruh pelbagai tahap pembolehubah formulasi, seperti kepekatan gam Arab (0.75-1.75%, w/v), kepekatan gam xanthan (0.8-1.0%, w/v), kepekatan minyak kelapa dara (10-20%, v/v) dan kepekatan maltodekstrin (1-3%, w/v) terhadap pH, saiz partikel, index kestabilan emulsi, dan kajian reologi telah dikaji ke atas semua sampel emulsi berasaskan minyak kelapa dara. Semua parameter formulasi menunjukkan kesan yang ketara ($p < 0.05$) ke atas semua respons. Dua formulasi optimum yang diperoleh daripada dua set kajian faktor penuh adalah 0.8% (w/v) gam xanthan, 1.0% (w/v) gam Arab, 7.5% (v/v) minyak kelapa dara (ditetapkan), dan 1% (w/v) maltodekstrin (ditetapkan); 0.8% (w/v) gam xanthan (ditetapkan), 1.0% gam arab (ditetapkan), 10% (v/v) minyak kelapa dara, dan 2% (w/v) maltodekstrin. Emulsi minyak kelapa dara menunjukkan taburan saiz partikel

yang kekal dalam kajian kestabilan penyimpanan produk optimum selama tiga bulan di suhu 25 ℃ dan 50 ℃. Fasa pemisahan juga tidak berlaku antara semua emulsi minyak kelapa dara sepanjang kajian kestabilan penyimpanan. Tiada kesan pertumbuhan mikrob sepanjang kajian penyimpanan dalam masa tiga bulan. Selain itu, emulsi minyak kelapa dara tidak menunjukkan perubahan yang bererti ($p > 0.05$) dalam kandungan asid lemak bebas walaupun disimpan dalam suhu 4 ℃ ataupun 25 ℃ sepanjang jangka masa penyimpanan. Dari segi keutamaan rasa, kajian penilaian deria antara pelajar UPM menunjukkan bahawa kedua-dua emulsi minyak kelapa dara optimum (7.5 dan 10% minyak kelapa dara) mempamerkan perbezaan yang ketara ($p < 0.05$) dari segi bau, rasa, kemanisan, dan penerimaan keseluruhan. Kebanyakan ahli panel lebih suka emulsi minyak kelapa dara yang berperisa mangga. Antara semua sampel emulsi, emulsi dengan 7.5% minyak kelapa dara berperisa mangga mendapat skor penilaian deria terbaik, dengan semua skor sifat penilaian deria lebih daripada 5. Orang awam juga didapati lebih suka emulsi berasaskan minyak kelapa dara berbanding dengan minyak kelapa dara dalam penilaian deria umum. Ini menunjukkan potensi emulsi minyak kelapa dara untuk dipasarkan dengan tujuan meningkatkan pemakanan minyak kelapa dara antara pengguna terutamanya kanak-kanak.

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I certify that a Thesis Examination Committee has met on 2014 to conduct the final examination of Khor Yih Phing on her thesis entitled "Development of Virgin Coconut Oil (VCO) Based Emulsion Product as Dietary Supplement" in accordance with 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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LIST OF EQUATION

LIST OF ABBREVIATIONS

A

ANOVA	analysis of variance
AOAC	Association of Official Analytical Chemists
AOCS	American Oil Chemists' Society
APCC	Asian and Pacific Coconut Community

C

C1	commercial emulsion product 1
C2	commercial emulsion product 2
C3	commercial emulsion product 3
C4	commercial emulsion product 4

D

δ	delta
DE	dextrose equivalent

E

E.C.	European Comission
ESI	emulsion stability index

F

FAO	Food and Agriculture Organization of the United Nations
FDA	U S Food and Drug Administration
FFA	free fatty acid

G

G’	storage modulus
G”	loss modulus
GRAS	generally recognised as safe

H

HDL	high density lipoprotein
HC	height of cream layer
HE	initial emulsion height
HIV	human immunodeficiency virus
HS	height of sedimentation phase

L

LCFA	long chain fatty acids
LDL	low density lipoprotein

M

MCFA	medium chain fatty acids
MCT	medium chain triglyceride

N

nd	not detected

O

o/w	oil-in-water

P

PCA	principle component analysis
PORIM	Palm Oil Research Institute of Malaysia

R

RBD	refined, bleached, and deodorized

T

tan δ	loss tangent

U

UPM	Universiti Putra Malaysia

V

η	viscosity
V1	emulsion formulation with 7.5% VCO
V2	emulsion formulation with 10% VCO
VCO	virgin coconut oil
VLDL	very low density lipoprotein

W

WHO	World Health Organization

CHAPTER 1

INTRODUCTION

The golden crop, also known as the tree of life, coconut contributes various valuable products to humans in both food and non-food capacities. Its meat and juice, as well as the milk and oil derived from it, are used in the food industry, whereas the husk, shell, leaves, and stem of the coconut are raw materials for non-food industries (Songkro et al., 2010). The world's major supplier of coconut oil and the world leader in coconut trade is the Philippines, which contributes approximately 57.1% of the total export trade (Villarino et al., 2007). The idea of producing virgin coconut oil (VCO) is inspired by the well-known virgin olive oil. Virgin oil has become a widely sought after commodity as such oils contain beneficial minor components and are well preserved (Chua et al., 2012). Similar to virgin olive oil, VCO holds promise as a functional food oil, gaining popularity and capturing public attention for the reasons above. Unsurprisingly, the VCO market is experiencing dramatic growth. The increasing demand for VCO is drawing the curiosity of small- and large-scale entrepreneurs, in part because its production also restores the once near-stale coconut industry. The availability of VCO is especially high in southeast Asia, including the Philippines, Thailand, Indonesia and Malaysia (Marina et al., 2009).

Unlike the coconut oil that is extracted *via* the conventional method, which involves heat treatment and is marketed as cooking oil, VCO is an oil that may be consumed directly. VCO is an oil which is obtained from the fresh and mature kernel of the coconut through a wet extraction method (Hamsi et al., 2014).The advantage of wet extraction process is to retain bioactive compounds in the VCO such as tocotrienols, polyphenols, and tocopherols, that possess antioxidant properties. The price of VCO is estimated to be approximately 10-20 times higher than that of other commodity oils, such as corn, palm, and sunflower oils (Rohman & Che Man, 2011). VCO is also categorised under the lauric acid group of plant oils (Guarte et al., 1996). It is believed that the consumption of solid fats rich in lauric acid leads to a more favourable serum lipid profile in healthy men and women (Liau et al., 2011). Besides, lauric acid has also been reported to possess antiviral, antibacterial, anticaries, antiplaque and antiprotozoal functions (Villarino et al., 2007).

Despite the therapeutic benefits conferred by VCO, most consumers do not directly consume VCO because of its oily taste and strong coconut aroma. The consumption rate among children is very low compared to adult consumers. Therefore, the introduction of a VCO-based emulsion product as a nutritional food supplement could serve to increase the consumption of VCO among school children. Generally, food producers tend to create economically viable products from the well-known ingredients (Dalgleish, 2006). The surge in demand for emulsion-based products has also engendered much interest in the development of a virgin coconut oil emulsion to meet consumer satisfaction.

The unique saturated fat structures present in VCO contribute a soft buttery texture to the formulated product. This novel product is strongly believed to be capable of sustaining Malaysia’s coconut industry and of increasing the income of our local VCO producers. The emergence of new coconut products, either in food or nutraceutical applications, will beyond a doubt open windows of opportunity to farmers by adding value to their products. The main objectives of this research study were:

1. to characterise the physicochemical properties of the commercial emulsion samples (Chapter 3);
2. to develop and optimise the VCO-based emulsion formulations (Chapter 4);
3. to evaluate the physicochemical stability of the optimised VCO-based emulsions during storage (Chapter 5); and
4. to determine the organoleptic acceptability of the optimised VCO-based emulsions (Chapter 6).

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