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2. Saya ingin mengesahkan bahawa saya berpuas hati dengan pembetulan/ pindaan yang dilaksanakan oleh calon.

Sekian, terima kasih.

8/8/2020

(Tandatangan dan cop) (Tarikh)

PHYSICOCHEMICAL AND ANTIBACTERIAL CHARACTERISTICS OF CITRUS ESSENTIAL OIL NANOEMULSIONS

By

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A dissertation submitted in partial fulfillment of the requirements for the degree of
Bachelor of Technology (B.Tech) in the field of Food Technology
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July 2020

DECLARATION BY AUTHOR

This dissertation is composed of my original work and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

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TAHSINA MOYEEN

JULY 2020

ACKNOWLEDGEMENT

I would like to begin by expressing my gratitude to the one person who played a pivotal role in helping me develop this research and that is, Dr. Nor Shariffa Binti Yussof, my final year project supervisor. Her never ending patience in dealing with my poor time management skills, vast knowledge regarding lime essential oils and optimism for the future prospect of nanoemulsions in the food industry created the very foundations of this study. Not forgetting, all those consultation sessions which improved my understanding of the topic matter.

I would love to thank my parents and friends who never lost faith in my capabilities. Their moral support and encouragement got me through nerve wrecking anxiety and helped boost my confidence. I would be lying if I said, I completed my final year project without a hitch. Throughout the process of completing my research I have truly come to grips with the meaning of the term trial and error.

TAHSINA MOYEEN

JULY 2020

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LIST OF ABBREVIATIONS

Abbreviation	Caption
aka	another name for
BHI	Brain Heart Infusion
cm	centimeter
DLS	dynamic light scattering
EO	essential oil
etc	Et cetera
EU	European Union
FDA	Food and Drug Administration
GRAS	generally recognized as safe
HLB	hydrophilic/lipophilic balance
ie	in example
LCT	long chain triglycerides
MCT	medium chain triglycerides
MHA	Mueller-Hinton agar
MHB	Mueller-Hinton broth
MIC	minimum inhibitory concentration
mm	millimeter
mPa·S	millipascal-second
MS	Mass spectrometer
nm	nanometer
o/w	oil-in-water
PDI	polydispersity index

PSD	particle size distribution
rpm	revolutions per minute
w/o	water-in-oil
WHO	World Health Organization
UV-Vis	Ultraviolet-visible spectroscopy
v/v	volume/volume

KARAKTERISASI FIZIKOKIMIA DAN ANTIBAKTERI NANOEMULSI BERASAKAN MINYAK CITRUS

ABSTRAK

Usaha ahli teknologi makanan bagi menghasilkan pengawet semula jadi telah memberikan minyak pati perhatian yang baru bukan hanya sebagai bahan dalam produk penjagaan kulit, tetapi juga sebagai agen antimikrobial dan antioksidan yang kuat untuk dimasukkan dalam makanan. Penyelesaian terhadap halangan dalam penghasilan larutan berasaskan air yang mengandungi minyak pati lipofilik adalah teknologi nanoemulsi, yang dapat meningkatkan hidrofilisasi dan penyebaran minyak pati serta melindungi molekul minyak penting dalam fasa air. Nanoemulsi minyak pati adalah emulsi minyak dalam air (m/a) dengan nisbah formulasi masing-masing, terdiri daripada bahagian fasa air yang lebih besar berbanding fasa lipid. Dalam kajian ini, penyelidikan terdahulu yang membincangkan pencirian dan menyelidiki sifat fungsional nanoemulsi berasaskan minyak pati sitrus daripada buah-buahan dalam keluarga Rutaceae iaitu, limau kasturi (*Citrofortunella microcarpa*), limau purut (*Citrus hystrix*), limau lemon (*Citrus limon*) dan limau oren (*Citrus sinensis*) dibandingkan secara komprehensif untuk mengenal pasti parameter yang mengawal kestabilan fizikal dan aktiviti antibakteria. Nanoemulsi minyak pati dibezakan antara satu sama lain berdasarkan sifat fisiokimia mereka seperti, ukuran saiz partikel, taburan saiz partikel, indeks polidispersi, kekeruhan, kelikatan dan potensi zeta masing-masing. Aktiviti antibakteria minyak pati limau terhadap patogen bawaan makanan biasa seperti *Escherichia coli, Listeria monocytogenes, Salmonella Typhimurium* dan *Staphylococcus aureus* juga dibincangkan. Hasil kajian menunjukkan bahawa nanoemulsi minyak pati sitrus yang paling tidak stabil secara fizikal iaitu limau lemon mempamerkan sifat antibakteria terkuat diikuti

oleh limau kasturi, limau oren dan limau purut.

PHYSICOCHEMICAL AND ANTIBACTERIAL CHARACTERISTICS OF CITRUS ESSENTIAL OIL NANOEMULSIONS

ABSTRACT

The undertaking of food technologists to create natural preservatives has given essential oils a new limelight not only as a coveted ingredient of skincare products but also, as a strong antimicrobial and antioxidant agent to be incorporated in edible goods. A solution to the hurdle of creating a water based solution containing lipophilic essential oil is nanoemulsion technology, which can uniformly hydrophilize, disperse, and protect the essential oil molecules in the continuous aqueous phase. Essential oil nanoemulsions are oil in water (o/w) emulsions and the formulation ratio of each, consists of a greater portion of the continuous phase in comparison to the surfactant encapsulated dispersed lipid phase. In this study, previous researches which discussed the characteristics and investigated the functional properties of nanoemulsions made with citrus essential oils obtained from fruits of the Rutaceae family namely, calamansi lime (*Citrofortunella microcarpa*), kaffir lime (*Citrus hystrix*), lemon (*Citrus limon*) and orange (*Citrus sinensis*) were comprehensively compared to identify the parameters which controlled both the physical stability and antibacterial activity. The essential oil nanoemulsions were differentiated against one another on the basis of their physicochemical properties such as, particle size, particle size distribution, polydispersity index, turbidity, viscosity and zeta potential respectively. The credibility of their antibacterial strength against common food borne pathogens like *Escherichia coli, Listeria monocytogenes, Salmonella Typhimurium* and *Staphylococcus aureus* were also verified. Results showed that the least physically stable citrus essential oil nanoemulsion portrayed the strongest antibacterial properties

and the assimilated array began with lemon, followed closely by calamansi lime, then orange and lastly kaffir lime.