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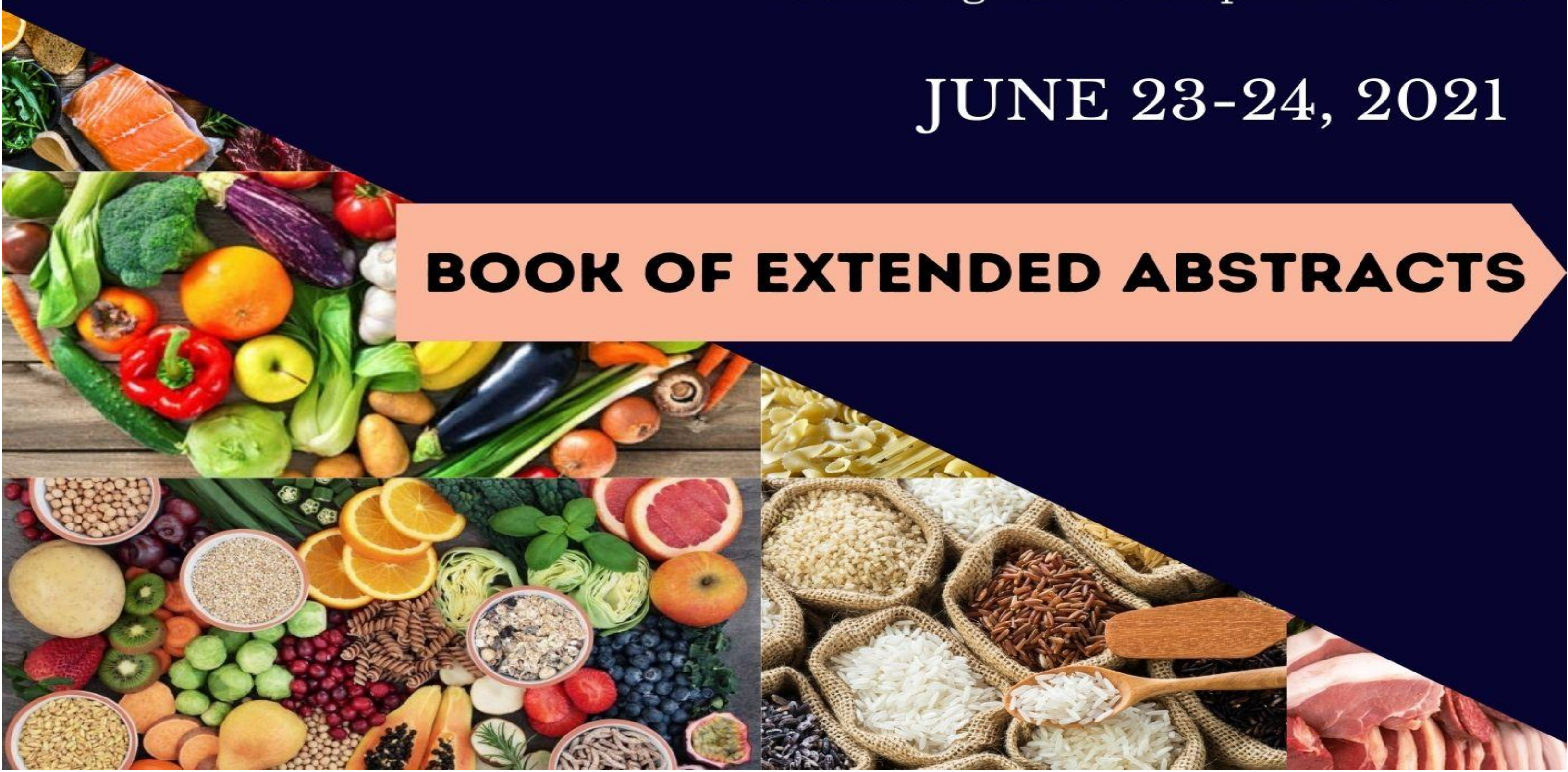
SoRIF 2021 PROCEEDINGS:

Inaugural Symposium of Research and Innovation for Food

"Fundamental and Applied Research towards Technological Development of Food"

JUNE 23-24, 2021

BOOK OF EXTENDED ABSTRACTS



Inaugural Symposium of Research and Innovation for Food (SoRIF) 2021

"Fundamental and Applied Research towards Technological Development of Food"

JUNE 23-24, 2021

Editors:

Dr. Nurain Aziman

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Nur Syahirah Ismail

Organized by

Alliance of Research & Innovation for Food (ARIF)
Universiti Teknologi MARA,
Cawangan Negeri Sembilan, Kampus Kuala Pilah,
72000 Kuala Pilah, Negeri Sembilan, Malaysia.

Bachelor of Food Science and Technology Association (B-FoST)
Faculty of Applied Sciences, Universiti Teknologi MARA,
Cawangan Negeri Sembilan, Kampus Kuala Pilah,
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PREFACE

SoRIF 2021 was held virtually by using Google Meet on June 23-24, 2021. SoRIF 2021 was organized by Alliance of Research & Innovation for Food (ARIF), and Bachelor of Food Science and Technology Association (B-FoST), Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah partnered with Universitas Brawijaya, Indonesia, The University of Queensland, Australia, Queensland Government of Australia and University of Nottingham. The theme of this symposium is "Fundamental and Applied Research towards Technological Development of Food." This symposium allows all researchers and students to share their research findings in food science and technology.

The proceedings are a compilation of the extended abstracts from Bachelor of Science (Hons.) Food Science and Technology Final Year Project students, UiTM, Cawangan Negeri Sembilan, Kampus Kuala Pilah, to assist participants in choosing the presentations that best suits their interest.

The success of SoRIF 2021 was due to the collective efforts of a large number of individuals. Hence, we would like to acknowledge all program committee members who supported and organized SoRIF 2021. Each individual and institution were beneficial for the success of this conference. Therefore, we would like to thank the organizing committees for their work. Thanks also to the editors Dr. Nurain Aziman, Dr. Marina Zulkifli, Dr. Alice Shanthi Kasawi @ Krisnan, Siti Nur Dina Haji Mohd Ali, Dzeelfa Zainal Abidin, Arinah Atikah Kamarudin, Nur Safiah 'Aqilah Mohd Jamil, and Nur Syahirah Ismail for their excellent editorial service to this proceeding.

We hope this symposium will be wholly beneficial to all participants and other interested readers.

With our warmest regards,

The Organizing Committees
June 23-24, 2021
Universiti Teknologi MARA, Cawangan Negeri Sembilan,
Kampus Kuala Pilah, 72000 Kuala Pilah,
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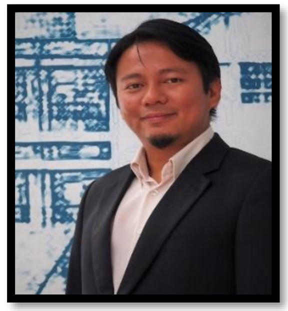
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Nur Syuhada Amira Hamizun

Book Format

Arinah Atikah Kamarudin

Nur Safiah 'Aqilah Mohd Jamil

Nur Syahirah Ismail

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Welcome Note from the
Deputy Rector of Academic Affairs
Universiti Teknologi MARA,
Cawangan Negeri Sembilan

Dr. Noorlis Ahmad

Assalamualaikum Warahmatullahi Wabarakatuh and Greetings.

In the Name of Allah, the Most Compassionate, the Most Merciful. May the peace, mercy, and blessings of Allah be upon you.

On behalf of the Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, I would like to welcome you to the *Inaugural* Symposium of Research and Innovation for Food (SoRIF) 2021 brought to you virtually. This event is organized by the Alliance of Research & Innovation for Food (ARIF) and the Bachelor of Food Science and Technology Association (B-FoST). Thus, I would like to congratulate both parties on successfully organizing this event. Besides, I would like to congratulate the working committee members of SoRIF 2021 for their commitment to making this symposium a success. It also gives me great pleasure to welcome all the eminent speakers; Dr. Natasha Hungerford from The University of Queensland, Australia, Dr. Wenny Bekti Sunarharum from Universitas Brawijaya, Indonesia, Dr. McKenzie Lim from the Queensland Health Forensic and Scientific Services (QHFSS), Australia, and Dr. Glab Yakubov from the University of Nottingham, United Kingdom as our keynote speakers.

It is my hope that this symposium will be a rich knowledge-sharing experience for all academia and students who have come together to share and discuss knowledge and information related to food science and technology. Therefore, without a doubt, I believe that this symposium is going to be beneficial to all participants. Good luck and thank you again to all participants who have come here virtually today to share their knowledge with us and support our effort. Again, let me thank and acknowledge the support team who have worked hard to make this symposium a truly successful one.

I would like to conclude my speech by wishing everyone a successful, safe, and fruitful symposium.

Thank you.

**Message from the
Head of the School of Industrial Technology,
Faculty of Applied Sciences,
Universiti Teknologi MARA,
Cawangan Negeri Sembilan,
Kampus Kuala Pilah**

Ts. Dr. Wan Syazehan Ruznan

Assalamualaikum Warahmatullahi Wabarakatuh and Greetings.

In the Name of Allah, the Most Gracious, the Most Merciful.

On behalf of the organizing committee and the School of Industrial Technology staff, Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, Kampus Kuala Pilah, it is a great pleasure to welcome you to our *Inaugural* Symposium of Research and Innovation for Food (SoRIF) 2021. First, I would like to congratulate the Alliance of Research & Innovation for Food (ARIF) and the Bachelor of Food Science and Technology Association (B-FoST) for organizing and making this event a reality despite the Covid-19 pandemic is still ravaging us.

This event involves the Bachelor of Science (Hons.) Food Science and Technology Final Year Project students presenting their final year projects. They are sharing their knowledge on research and innovation in food science and technology. The extended abstracts to their research and findings are compiled in this book. I hope and expect that this book will become a practical guide to future researchers as it can be a helpful guide for newer ideas to spring out as it compiles the abstract of their project. I am sure that this will benefit the upcoming final year project students and other participants as a guideline to share. We are fortunate to have the support of a great team of international speakers in this symposium; from Australia, Indonesia, the United Kingdom, and also local speakers from UiTM Kampus Kuala Pilah to share their thoughts and views on the trends and current practices related to the food industry.

Finally, I would like to thank all the participants for your support, and I hope this symposium will continue its success for a long time. In addition, I would like to thank the organization staff and the members of the program committees for their tireless effort in organizing this symposium.

Thank you.

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Appreciation Note from the Chairperson of the Organizing Committee for the *Inaugural* Symposium of Research and Innovation for Food (SoRIF) 2021

Dr. Siti Azima Abdul Muttalib

Assalamualaikum Warahmatullahi Wabarakatuh and Greetings.

In the Name of Allah, the Most Benevolent, the Most Merciful.

Welcome to the virtual *Inaugural* Symposium of Research and Innovation for Food (SoRIF) 2021. The theme for this conference is **"Fundamental and Applied Research towards Technological Development of Food."** The Alliance of Research & Innovation for Food (ARIF) and Bachelor of Food Science and Technology Association (B-FoST), Universiti Teknologi MARA (UiTM), Cawangan Negeri Sembilan, Kampus Kuala Pilah host this symposium. Our mission is to enhance the collaboration of food research, innovation, dissemination of knowledge, and commercialization for the national and international consortium of experts in various fields by providing forums to exchange new ideas. With this mission, we have organized the inaugural SoRIF 2021 virtually on the Webex platform from June 23 until June 24, 2021.

The 2-day symposium presents young researchers on June 23 and shares sessions from the renowned experts on June 24. SoRIF 2021 brought the international and local experts altogether: Dr. Natasha Hungerford from The University of Queensland, Australia; Dr. Wenny Bekti Sunarharum from Universitas Brawijaya, Indonesia; Dr. McKenzie Lim from the Queensland Health Forensic and Scientific Services (QHFSS), Australia; Dr. Gleb Yakubov from the University of Nottingham, United Kingdom; Dr. Eddie Tan Ti Tjih; Dr. Nurain Aziman; and Dr. Hisham Mohd Nooh from UiTM Kampus Kuala Pilah. We hope that our findings will enable this traditional knowledge to live on by incorporating them into food industry applications and health services.

As the symposium chairperson, I believe that the team's strength is an individual member, and the strength of each member is the team itself. Therefore, I would like to express my deepest gratitude to the organizing committee for all the hard work and effort to ensure SoRIF 2021. Last but not least, special gratitude to the advisory board for their continuous support and advice that are essentially needed for this symposium to succeed.

Thank you.

Scientific Programme

<u>Day 1 (June 23, 2021)</u>

Oral Presentation Session

<u>Day 2 (June 24, 2021)</u>

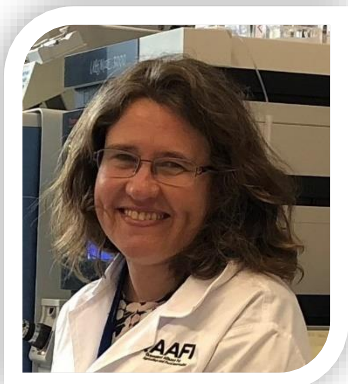
Sessions from Distinguished Speaker

Time	Keynote Speaker
9:00 am - 10:00 am	**Dr. Natasha Hungerford** Stingless Bees Produce Honey Rich in the Beneficial Disaccharide, Trehalulose
10:00 am – 11:00 am	**Dr. Wenny Bekti Sunarharum** Coffee Quality. Why Bother?
11:00 am – 11:30 am	**Dr. Eddie Tan Ti Tjih** Edible Bird's Nest, a Remarkable Salivary Product
11:30 am – 12:00 pm	**Dr. Nurain Aziman** Herbs – Natural Food Preservatives
2:00 pm – 3:00 pm	**Dr. McKenzie Lim** Food, What Matters – Quality or Quantity
3:00 pm – 4:00 pm	**Dr. Hisham Mohd Nooh** Production of Thermostable T1 Lipase Using Agro-Industrial Waste Medium Formulation
4:00 pm – 4:30 pm	**Dr. Gleb Yakubov** Functional Dietary Fibre in the Gastrointestinal Tract: From Physical Interactions and Biochemical Transformation to Health Benefits
4:30 pm – 5:00 pm	**Closing event** - Welcoming message by Symposium Chairperson - Opening message by Deputy Rector of Academic Affairs - Officiate closing ceremony by Rector - Best presenter award - Montage - Award session - Photo session

Keynote Speaker's Profiles and Presentation Summary

Dr. Natasha Hungerford

Research Fellow (1.0 FTE), Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Australia



Dr. Natasha Hungerford further her studies at The University of Queensland, Australia, and graduated in the year 1992 with a Bachelor of Science (BSc) (Hons) in Chemistry. She received an Awarded University Medal in the same year. She then pursued her Doctor of Philosophy (Ph.D.) in Chemistry at The University of Queensland, Australia. She graduated with her Ph.D. in 1997 and received the Dean's Commendation for Outstanding Ph.D. thesis in 1998. Furthermore, Dr. Natasha started her career in 1998 as a postdoctoral fellow at the University of Oxford and currently is working as a research fellow at The University of Queensland. She has also published 30 refereed journal articles in high-impact international journals with over 579 citations. In addition, her current collaboration includes Queensland Department of Agriculture and Fisheries Biosecurity Queensland, Queensland Health Forensic and Scientific Services, UQ School of Biological Sciences, Universiti Putra Malaysia (UPM), Australian Native Bee Association, Department of Agriculture and Fisheries Agri-Science Queensland, UQ School of Chemistry and Molecular Biosciences.

Presentation Summary

STINGLESS BEES PRODUCE HONEY RICH IN THE BENEFICIAL DISACCHARIDE, TREHALULOSE

Natasha L. Hungerford[1*], Jiali Zhang[1], Tobias J. Smith[2], Matheus Carpinelli de Jesus[4], Hans S. A. Yates[3], Sadia A. Chowdhury[3], James F. Carter[3], Dennis Webber[5], Isobella S. J. Stone[4,5], Joanne T. Blanchfield[4], Norhasnida Zawawi[1,6], Horst J. Schirra[7], Trong D. Tran[8], and Mary T. Fletcher[1]

[1]Queensland Alliance for Agriculture and Food Innovation (QAAFI), Health and Food Sciences Precinct, Coopers Plains, QLD 4108, Australia
[2]School of Biological Sciences, The University of Queensland, Brisbane, QLD 4072, Australia
[3]Forensic and Scientific Services, Queensland Health, Health and Food Sciences Precinct, Coopers Plains, QLD 4108, Australia
[4]School of Chemistry and Molecular Biosciences, The University of Queensland, Brisbane, QLD 4072, Australia.
[5]Biosecurity Queensland, Department of Agriculture and Fisheries, Brisbane, QLD 4108, Australia
[6]Department of Food Science, Faculty of Food Science and Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[7]Centre for Advanced Imaging, The University of Queensland, Brisbane, QLD 4072, Australia
[8]School of Science and Engineering, University of Sunshine Coast, Maroochydore, QLD, 4558, Australia
**Corresponding author: n.hungerford@uq.edu.au*

Stingless bee (Meliponini) honey produced by native bees in tropical/sub-tropical regions has long been valued for its health benefits and distinctive flavour. Previous analyses of Meliponine honeys reported maltose, (with lesser fructose and glucose), based only on co-elution with sugars by chromatography. We examined stingless bee honey from 5 species: *Tetragonula carbonaria* and *Tetragonula hockingsi* from Australia, *Geniotrigona thoracica* and *Heterotrigona itama* from Malaysia and *Tetragonisca angustula* from Brazil and found, instead of the disaccharide thought to be maltose, high levels of an unusual disaccharide, which by LC-MS/MS did not match any of our available disaccharides. This unusual disaccharide was isolated, and determined unambiguously by LC-MS/MS and NMR analyses, to be trehalulose, an isomer of sucrose. Further analysis of 36 honey samples from Australia and Malaysia by high performance ion chromatography, showed trehalulose ranging from 18 – 58 g per 100 g of honey, present together with fructose and glucose. Trehalulose has not been previously identified as a major food component. The presence of trehalulose with its known beneficial properties (low GI and acariogenic) supports the health value of stingless bee honey. Further work aims to identify the origin of this disaccharide and how to optimise its levels in stingless bee honey.

Keywords: Stingless bee, trehalulose, honey, LC-MS/MS

Dr. Wenny Bekti Sunarharum

Assistant Professor, Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Indonesia

Dr. Wenny Bekti Sunarharum is a lecturer since 2008 in Food Science Technology, Faculty of Agricultural Technology, University Brawijaya, Indonesia. Dr. Wenny graduated with her Ph.D. in Food Chemistry & Molecular Gastronomy (exl. wine) from The University of Queensland Australia in 2016 with the doctoral thesis title, The Compositional Basis of Coffee Flavour. Dr. Wenny has published about 26 articles from 2013, and some of the articles' titles are Exploration of chemical-physical characteristics and sugar of Garifta Mango (*Mangifera indica*) (2019), Sensory properties of yellow pea and macadamia honeys from conventional and flow hive extraction method (2020), and the current one is Physicochemical Characteristics and Consumer Acceptance of Bagged Indonesian Green Tea (*Camelia sinensis*) Formulated with Cinnamon Bark (*Cinnamomum burmannii*) and Lemon (*Citrus limon*) Peel (2020). Dr Wenny also has published four books which are Coffee Processing Technology in 2017, Sains Kopi Indonesia (Indonesian Coffee Science) in 2019, Food Chemistry in 2019, and Apple and Strawberry Products (Pastry and Pie) and The Packaging in 2020.

Presentation Summary

COFFEE QUALITY. WHY BOTHER?

Wenny Bekti Sunarharum[1,2]*, Johan Ramandias[2], and Ngesti Ekaning Asih[2]

[1]Brawijaya Senso-Gastronomy Centre, Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Jalan Veteran Malang, 65145, Indonesia
[2]Sensoflavo Sensory Collaborative Works, Malang, Indonesia

**Corresponding author: wbsunarharum@ub.ac.id*

The high economic value of coffee indicates the importance of this cash crop to the livelihood of people, especially in the producing countries, which are mostly the developing nations with low to middle income level. Major challenges encountered by coffee producing nations are in productivity and quality inconsistency. Therefore, besides improving productivity through a better coffee farming system, seeking for a new potential coffee species or varieties, and other measures, the improvement of coffee quality is important. Quality is one reason that drives people to drink coffee. The framework on improving coffee quality encompasses series of steps and management strategies involving available resources. The first key point is the understanding on coffee quality that can be achieved such as through educating and supporting coffee-related community. Another way is through innovation on the coffee processing steps from farm to cup.

Keywords: Coffee, quality, management

Dr. McKenzie Lim
Analytical Chemist, Health Support Services (HSQ), Queensland Health Forensic and Scientific Services (QHFSS), Special Services, Environmental Organic Contaminant Section, Brisbane, Australia

Dr. McKenzie Lim graduated in 1998 from The University of Queensland with a Bachelor of Science (BSc) (Hon) degree in Pure Chemistry and Polymer Science. He then took his Ph.D. at the Queensland University of Technology in 2000-2007 in Environmental Chemistry and with the thesis title Chemical and Physical Characterization of Aerosols from the Exhaust Emissions of Motor Vehicles. Dr. McKenzie Lim was working as a chemist at Australian Laboratory Services in June 2005 for 2 years 6 months. He then worked as researcher assistant and lab demonstrator at the Queensland University of Technology from May 1999 until December 2007, in a total of 8 years 8 months. Currently, Dr. McKenzie Lim works as an analytical chemist who works on environmental samples, food, and consumer products using Gas Chromatography Triple Mass Spectrometry instruments at Queensland Health Forensic and Scientific Services (QHFSS) from November 2007 until today.

Presentation Summary

FOOD, WHAT MATTERS - QUALITY OR QUANTITY?

McKenzie Lim

Queensland Health, 39 Kessels Road, Coopers Plains, QLD 4108, Australia

**Corresponding author: Mckenzie.Lim@health.qld.gov.au*

Food has been, for generations, bringing and nurturing people together regardless of differences in cultural heritage and ethnicity. On the other hand, there is ensuing global interest in the area of food science and technology continue to improve and develop the primary ingredients to give food its more palatable appearance, taste and flavour. To understand such processes behind it, there is a need for food technology and food science alike complement each other to achieve a common aim, which is the safe consumption of the food. A proportion of manufactured foods is examined and tested by Queensland Department of Health's food and organic laboratory in the effort to detect the presence of allergens, and to ensure that they are compliant with their manufacturing nutritional labels. Testing for agricultural chemicals are also obtained to further verify the safe consumption of the final products.

Keywords: Allergen, agricultural chemicals, food safety, quality

Dr. Gleb Yakubov
Assistant Professor, School of Biosciences, University of Nottingham, United Kingdom

Dr. Gleb Yakubov did his postgraduate research at the University of Mainz and Max Planck Institute for Polymer Research (Germany) and received his Ph.D. in Physical Chemistry. Prior to an academic position at the University of Nottingham, Gleb was a Senior Research Fellow in the School of Chemical Engineering at The University of Queensland (Australia), and before then he spent 8 years working in the industrial R&D roles in one of the UK-based global fast-moving consumer goods companies. His key expertise area is the application of colloidal, soft matter and polymer science principles to the problems in food research, digestive health and biomolecular technology. His technical expertise base is in complex carbohydrate analysis, rheology (flow), tribology (friction & wear), mechanics, and surface characterisation. Gleb leads the Soft Matter Biomaterials and Biointerfaces research team with instrumental capabilities spanning from macroscopic (rotational rheometry) to microscale (soft contact tribology) and nanoscale/molecular characterisation techniques (atomic force microscopy, quartz crystal microbalance with dissipation, ellipsometry, small-angle scattering incl. USANS/SANS/SAXS/DLS).

Presentation Summary

FUNCTIONAL DIETARY FIBRE IN THE GASTROINTESTINAL TRACT: FROM PHYSICAL INTERACTIONS AND BIOCHEMICAL TRANSFORMATIONS TO HEALTH BENEFITS

Gleb E. Yakubov

School of Biosciences, University of Nottingham, United Kingdom

**Corresponding author: Gleb.Yakubov@nottingham.ac.uk*

This talk considers the journey of dietary fibre along the gastrointestinal tract: from oral processing to colonic fermentation. Our primary focus is placed on uncovering how different physical interactions and biochemical transformations elicit specific physiological responses, leading to positive health outcomes and long-term wellbeing benefits. First, we consider a new definition of dietary fibre which provides physiology-based categorisation of fibre materials beyond the currently prevalent "soluble/insoluble" classification. This new outlook on the fibre properties and structure opens a new perspective on the mechanisms by which dietary fibre function in the gut. From the effect of fibre polysaccharides on gastric emptying, starch hydrolysis and lipid transformations in the small intestine, to the complex fermentation pathways of plant cell wall particles in the colon – we discover that such fundamental physical properties as hydration and structuring underpin physiological functionality of dietary fibre. The emerging evidence suggests that optimisation of fibre structure and functionality can lead to the improved glycaemic response, reduced risk of cardiovascular diseases and colon cancers, as well as it has a marked impact on systemic metabolism, from controlling the hepatic function to influencing the gut-brain axis. Ultimately, we overview principal avenues for a targeted design of dietary fibre materials to generate healthy foods with specific sets of physiological responses and desired health and wellbeing benefits.

Keywords: Fibre, gastrointestinal tract, interaction, transformation

Dr. Eddie Tan Ti Tjih
Senior Lecturer, Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, Malaysia

Dr. Eddie Tan received his Bachelor and Master Degrees from Universiti Teknologi Malaysia Skudai. He pursued his study and obtained a Ph.D. from The University of Queensland Australia in Year-2016. He is the first programme coordinator for Bachelor of Science & Technology in Universiti Teknologi MARA, Kampus Kuala Pilah, Negeri Sembilan; he is also the founder and coordinator of a Special Interest Group (SIG) - Alliance of Research & Innovation for Food (ARIF). In Year-2020, Malaysia Board of Technologist (MBOT) has appointed him as an accreditation panel. His research is focusing on the Nutritional and Safety Aspects of Food Processing. He has secured several research grants from the Ministry of Higher Education, university and industry. His research work has allowed him to publish fourteen Q1 and Q2 research papers with his current H-index of 9. His passion in teaching and research all this while has won him several recognitions and awards.

Presentation Summary

EDIBLE BIRD'S NEST, A REMARKABLE SALIVARY PRODUCT

Eddie T. T. Tan[1*] and T. H. Siew[2]

[1]Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia
[2]Nanyang Dreams International Trading Sdn. Bhd., No. 107A, Jalan Kenari 23, Bandar Puchong Jaya, 47170 Puchong, Selangor Darul Ehsan, Malaysia

**Corresponding author: eddietan@uitm.edu.my*

Edible Bird's Nest (EBN) is a salivary product, and it can only be produced by certain species of swiftlets in the Southeast Asia region. Even though the saliva product is not a popular delicacy among the non-Chinese community, its recent scientific nutraceutical discoveries have attracted much interest. There are many new findings reported on EBN in the recent ten (10) years; therefore, this discourse aims to address the latest peer-reviewed nutraceutical reports on the EBN. First, an advanced search in the Web of Science Core Collection with field tag keywords "Edible bird's nest" was performed. The search resulted in 129 articles for the year 2010 to 2020. Thus, the total number of yearly publications increased drastically from 1 article in the year-2010 to 23 articles in the year-2020. This indicates increasing interest in the research for EBN. Subsequently, the articles that met the EBN nutraceutical investigations criteria were reviewed. The data shows that various EBN nutraceutical properties were reported, such as antiviral effects, cholesterol metabolism enhancement, immunoregulation, learning and memory improvement, antioxidant capacity, anti-aging and wound healing, neurodegenerative disease improvement, and

chondroprotective ability. Even though the reported evidence was mostly non-clinical, the nutraceutical animal-based studies do provide a strong signpost for the EBN to become a potential valuable nutraceutical product. To conclude, the newly discovered nutraceutical findings of EBN suggested that EBN may offer much more than just another protein source.

Keywords: Edible bird's nest, nutraceutical, swiftlet

Dr. Nurain Aziman
Senior Lecturer, Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, Malaysia

Dr. Nurain Aziman obtained her first-class Bachelor of Science (BSc) (Hons) (Science and Food Technology) from Universiti Teknologi MARA Shah Alam, Selangor in 2009. She then pursued her Ph.D. at the same university under the fast-track Ph.D. program and received her Ph.D. in 2017. She is currently serving as a senior lecturer at Universiti Teknologi MARA, Kampus Kuala Pilah, Negeri Sembilan. Prior to this position, she was a postdoctoral fellow at the Malaysia Institute of Transport (MITRANS), Universiti Teknologi MARA Shah Alam, and Institute of Tropical Forestry and Forest Products (INTROP), Universiti Putra Malaysia, Serdang from 2017-2020. Her postdoctoral research with the title "Safe biodegradable packaging" has collaborated with Bangor University (UK), Eco Premium Packaging (M) Sdn. Bhd and PolyComposite Sdn. Bhd industries. Her research interests cover functional food, food antioxidants, and food microbiology. She has published 13 research articles from 2012 with her current H-index of 8.

Presentation Summary

Herbs - Natural Food Preservatives

Nurain Aziman

Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia

**Corresponding author: ainaziman@uitm.edu.my*

Food preservation is a primary concern of the food industry due to the high demand for better quality. Many food preservation methods have been practiced to prevent deterioration and spoilage of food products, and extend their shelf-life. However, the use of synthetic food preservatives to maintain the quality of food products has become commonplace, therefore consumer concerns about their safety are prompting the food industry to seek out natural alternatives. There are no

doubt plants provide good alternatives. Herbs which are generally consumed directly or are used in various local recipes to enhance the flavour of the foods have been reported to have a wide range of biological activities due to their phenolic compounds. The utilization of herbs as natural preservatives in food products and food packaging film to prolong shelf-life and to improve safety, thus maintaining the quality of the product has become our focus.

Keywords: Herbs, natural preservatives, shelf-life

Dr. Hisham Mohd Nooh
Senior Lecturer, Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, Malaysia

Dr. Hisham Mohd Nooh was born on 4th February 1984 at Raub, Pahang. Currently, he is a senior lecturer at Universiti Teknologi MARA, Kampus Kuala Pilah, Negeri Sembilan. He graduated with a Master of Science, Major in Microbial Biotechnology in February 2012 at Universiti Putra Malaysia with 1st Class. He graduated with a Ph.D., Major in Industrial Biotechnology with 1st Class in November 2018. Dr. Hisham Mohd Nooh has skills in Laboratory Hazardous Chemical Management (MS ISO 9001:2008), Laboratory Management - Procurement, Calibration, Service and Documentation, Research & Development Natural Bio-Product, Identification of Bacteria Using Molecular Technique, NCBI Basic Local Alignment Search Tool (BLAST), SDSC Biology Workbench, Statistical Analysis, Optimization Process - Response Surface Methodology & Artificial Neural Network (Neural Power) Cloning & Expression Using Bacteria And Yeast Host., Bioreactor Operation & Enzyme Production, Soap & Detergent Formulation, Rotary Evaporator, Freeze Dryer & Spray Dryer Operation And Maintenance, Computer Maintenance, Build And Upgrade.

Presentation Summary

Production of Thermostable T1 Lipase Using Agro-Industrial Waste Medium Formulation

Hisham Mohd Nooh [1,2,6*], Malihe Masomian[3,6], Abu Bakar Salleh[2,5,6], Rosfarizan Mohamad[4,7], Mohd Shukuri Mohamad Ali[5,6], and Raja Noor Zaliha Raja Abd. Rahman[2,3,6]

[1]Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia
[2]Laboratory of Molecular Biomedicine, Institute of Bioscience, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[3]Department of Microbiology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia

[4]*Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[5]*Department of Biochemistry, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[6]*Enzyme and Microbial Technology Research Centre, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[7]*Institute of Tropical Forestry and Forest Products, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*

**Corresponding author: hishamnooh@uitm.edu.my*

Large-scale production of T1 lipase using conventional culture media is costly. To reduce the cost of production, an alternative growth medium using local resources has been developed. In this study, the growth of recombinant Escherichia coli and expression of T1 lipase were tested using different agro-industrial wastes as carbon and nitrogen sources by conventional method. Subsequently, by using central composite rotatable design (CCRD), a set of 30 experiments was generated to evaluate the effect of different parameters, including the amount of molasses (as carbon source), fish waste (as nitrogen source), NaCl, and inducer concentration on production of T1 lipase. Response surface methodology (RSM) analysis indicated that all factors had significant effects on T1 lipase production. This statistical analysis was utilised to develop a quadratic model to correlate various important variables for the growth of the recombinant strain and regulation of gene expression to the response (T1 lipase activity). Moreover, the optimum conditions obtained can be applied to scale up the process and minimise the cost of enzyme production.

Keywords: T1 lipase, agro-industrial waste, molasses, fish waste

A REVIEW ON EXTRACTION COUPLED WITH ANALYTICAL TECHNIQUES USED IN MEDICINAL PLANTS: TORCH GINGER (*Etlingera elatior*)

Adibah Aqilah Norddin[1] and Boon Yih Tien[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: boonyihtien@uitm.edu.my*

Abstract: The presence of active compounds in medicinal plants provides physiological effects and acts as a pharmacological agent in preventing and treating diseases since the last decade. This has resulted in an increase of interest in the medicinal plant due to the high demands of the current pharmaceuticals and nutraceuticals industry. However, the extraction parameters will negatively affect the extraction yield due to the degradation of the thermosensitive compounds. Therefore, it is very crucial to develop an effective and selective method for the extraction, separation and isolation of those bioactive compounds, especially from unexplored plants. Torch ginger is an unexplored medicinal plant that serves benefits on human health including medicament for cardiovascular diseases and cancer. This review intends to provide a comprehensive insight into the variety of extraction methods coupled with analytical techniques on torch ginger with a view to identify novel active compounds for global health benefits. This review will discuss the main parameters involved such as time, temperature, solvent, and sample pre-treatment. It is found that conventional extraction techniques are being replaced by non-conventional techniques to reduce energy and solvent consumption, increase efficiency and selectivity, and meet environmental regulations. The chromatography technique prevails in others due to its separation efficiency. However, the lab-intensive and time-consuming extraction, separation and isolation process has been the bottleneck for the bioactive compounds in pharmaceutical development. Further investigation is needed to improve the extraction, separation and isolation technique to maximize yields and reduce degradation associated with environmental concern and costs.

Keywords: Medicinal plant, conventional extraction method, non-conventional extraction method, analytical technique

1. Introduction

A poisonous and toxic plant was only discovered in prehistoric times after it was consumed and side effects such as stomach discomfort, vomiting, or other toxin responses were seen. Medicinal plant is defined as the variety of plants that provide medicinal properties to consumers (Jamshidi-Kia et al., 2018). The medicinal properties can be extracted from various parts of the plant such as leaf, root, skin, flowers and fruit.

The active compounds in the medicinal plants are extracted using extraction techniques whereas, the plants are processed before being subjected to any suitable extraction techniques. In the extraction process, it is advisable for the extraction techniques used to be devoid of degradation of the active compounds in plant samples. Analytical technique is conversely known as the process

that is used to analyse and determine the presence of compounds in the extracted yield after the extraction process (Marguí & Grieken, 2013).

Torch ginger or its scientific name *Etlingera elatior* is one of the ginger family known as Zingiberacea and natively found in Indonesia and Malaysia (Pitopang et al., 2019). Torch ginger contains medicinal properties and is considered one of the medicinal plants. The essential oil from torch ginger has the properties of therapeutic agents in treating sore throats, sea and travel sickness. It also relieves rheumatic pains and cramps (Choon & Ding, 2016). Therefore, this review aims to study the correlation of the extraction techniques with the presence of the analytical techniques with torch ginger as one of the medicinal plants.

2. Discussion

2.1. Extraction technique coupled with analytical techniques in torch ginger

Depending on the country or continent, torch ginger has been used for a variety of purposes. Torch ginger is used as a decoration in some countries, but it is also used as a condiment in Asian and Middle Eastern cuisines to enhance the aroma of their dishes. Apart from its fragrant perfume, torch ginger also has health benefits for humans, as previously indicated. To gain the benefits from the torch ginger, the extraction of the torch ginger essential oil is required along with the analytical techniques to analyse the compounds in the extracted yield.

Torch ginger has been the subject of numerous studies. Few researchers conducted extraction of torch ginger using conventional extraction techniques and obtained the yield of the torch ginger extract. However not many conducted the extraction process along with the analytical technique. For example, Khor et al. (2017) and Rachkeeree et al. (2018) conducted extraction of torch ginger using the same hydro distillation techniques and were able to yield torch ginger extract without involving any analytical techniques. The authors were able to detect the presence of phytochemical, phenolic content, flavonoid content and antioxidant activity but were unable to determine the mass of the compounds in the torch ginger extract. On the other hand, Fathin et al. (2017) conducted torch ginger extraction along with an analytical process and were able to conclude the compounds in the torch ginger were suitable for industrial use.

In addition, there are very few researchers that utilized the use of non-conventional extraction techniques due to the difficulty in handling the extraction process. Very few researchers incorporated these extraction techniques in their research moreover, extraction techniques coupled with analytical techniques. As such, Sungthong and Srichaikul (2018) and Nor et al. (2020) conducted extraction using ultrasound-assisted with ethanol and water as the solvent, respectively were able to determine the presence of phenolic, flavonoid content and antioxidant activity. However, Marzlan et al. (2020) found presence of chemical compounds in the torch ginger extract after putting the torch ginger extract through the gas chromatography analytical process.

The extraction process conducted without involving any analytical techniques were only able to determine the presence of compounds in the extract. Analytical techniques incorporated in the research with torch ginger as the sample would be able to determine the individualization and determination of the mass of chemical compounds in the extract, regardless of the extraction techniques used. However, as discussed in the advantages and the disadvantages of the extraction techniques, non-conventional extraction technique offers more improvements when compared to conventional extraction techniques. From the extraction and analytical techniques conducted by the researchers, they were able to determine the presence of beneficial compounds in the torch ginger extract and utilize its medicinal properties in the future.

3. Conclusion

In this review, conventional extraction techniques are well-known among the researchers despite the few drawbacks. However, there are researchers that have been developing the non-conventional extraction techniques to counteract the drawbacks of the conventional extraction techniques. The use of analytical techniques in a research is also crucial to identify and analyse the presence of the compounds in the sample specifically in analysing the plant extract.

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EDIBLE BIRD'S NEST (EBN) SAMPLE PREPARATION FOR RESEARCH STUDIES

Ainin Nadhirah Abd Manan[1], Wenny Bekti Sunarharum[2], Siti Azima Abdul Muttalib[1,3], Nadya Hajar[1,3], and Eddie Ti Tjh Tan[1,3*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Brawijaya Senso-Gastronomy Centre, Department of Agricultural Product Technology, Faculty of Agricultural Technology, Universitas Brawijaya, Jalan Veteran Malang, East Java, 65145, Indonesia*
[3]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author*: *eddietan@uitm.edu.my*

Abstract: Edible Bird's Nests (EBN) research works have seen a growing trend. Most of the EBN related studies involved solubilisation and solid-liquid separation before further analysis. However, there was a lack of examination on the solubilisation and separation techniques for EBN. Hence, this paper reported the examination of the EBN solubilisation methods and comparison of the solid-liquid separation techniques that were carried out previously. The collected data were based on the electronic literature search of Web of Science (WOS) and ScienceDirect. The literature search in the databases indicated the majority of the EBN processing related studies show the use of enzymatic solubilisation. It is a preferred solubilisation method and likely more effective than the use of non-enzymatic solubilisation. It is interesting to find that the data presentation for EBN solubility between enzymatic and non-enzymatic solubilisation was distinct. The solubility studies of enzymatic solubilisation were usually reported in the form of degree of hydrolysis (DH) while the non-enzymatic solubilisation reported the protein solubility. Besides that, it was found that the use of filter paper (Whatman No.1 and No.4) was the most frequently used solid-liquid separation method in EBN studies. In conclusion, enzyme solubilisation and filter paper filtration have emerged as preferable solubilisation and solid-liquid separation methods for EBN related research.

Keywords: Edible bird's nest, non-enzymatic solubilisation, enzymatic solubilisation, protein, separation

1. Introduction

Since the 16th century, Edible Bird's Nests (EBN) has been considered an important health supplement in traditional medicine to the Chinese. People consume EBN to enhance the immune system, promote metabolism, reduce skin complexion, and for rejuvenation (Looi & Omar, 2016). The distribution of EBN can be in several breeds of swiftlets which are *Aerodramus*, *Collocalia*, and *Hydrochous* (Dai, Cao, Wang, Chen, & Jiang, 2020; Looi & Omar, 2016).

White-nest swiftlets (*Aerodramus fuciphagus*) and black-nest swiftlets (*Aerodramus maximus*) are harvested for commercial purposes because these nests are able to produce saliva secretion contain mucin-like glycoproteins with high protein content (Looi & Omar, 2016). The cup-shaped nest produced by the swiftlet was made after the hardening of the high-protein glutinous secretion (Chua & Zukefli, 2016; Saengkrajang, Matan, & Matan, 2013). These hardened nests are harvested and cleaned into consumable EBN. Recently, there is a trend of increasing research in EBN studies.

Before carrying out the research studies, the EBN samples require solubilisation before proceeding to EBN-related analyses.

The cleaning process of EBN is crucial because the salivation of *Aerodramus swiftlet* species comprises about 5% to 10% of feathers and dirt (Ling, Chang, Babji, & Lim, 2020; Noor, Babji, & Lim, 2018; Nurfatin et al., 2016). Thereafter, solubilisation and solid-liquid separation will need to be completed before starting the EBN related research. Since there was also a lack of intensive review on the methods of solubilisation EBN and separation techniques for solubilised EBN. This study aims to summarise the different solubilisation techniques for EBN and review several methods of solid-liquid separation for EBN.

2. Discussion

2.1. Enzymatic solubilisation

Enzymatic solubilisation is an inventive method that used proteolytic enzymes to break down the protein network of EBN. In the end, protein solubilisation in EBN was measured using Degree Hydrolysis (DH). DH value can be influenced by several variables including concentration, pH, time, and temperature. According to the previous studies, there are a few enzymes that have been used to solubilise EBN such as Alcalase, Pancreatin, Protamex, and Papain (Amin, Mubeen, Ahmad, Aziz, & Arif, 2019; Amiza, Oon, & Norizah, 2019; Khushairay, Ayub, & Babji, 2014; Nurfatin et al., 2016).

However, the Alcalase enzyme has been reported by many research reports due to its broad specificity and has often been utilised to modify functional properties of EBN protein (Amiza et al., 2019; Khushairay et al., 2014; Nurfatin et al., 2016). The optimum pH reported was commonly 8, while the duration of solubilisation was usually within 60 to 180 minutes with the temperature between 60 to 90°C (Muhammad, Babji, & Ayub, 2015; Nurfatin et al., 2016; Ramachandran, Babji, & Sani, 2018). Meanwhile, DH reported in the literature was ranged from 82.7 to 84% (Khushairay et al., 2014; Nurfatin et al., 2016; Ramachandran et al., 2018). The value of DH increases with time due to Alcalse able enzyme to operate on the protein more thoroughly (Nurfatin et al., 2016; Zulkifli et al., 2019).

Moreover, most of the studies applied 60°C because temperatures above that have the potential for enzyme denaturation which affects enzyme activity and EBN protein solubilisation (Amiza et al., 2019). Overall, Alcalase is a widely used enzymatic solubilisation method for EBN, most probably due to its higher DH for EBN samples.

2.2. Non-enzymatic solubilisation

Apart from enzyme solubilisation, the non-enzymatic solubilisation method was proved to successfully solubilise the EBN, and the methods including water extraction, acid, and alkaline solubilisation methods. Previous studies claimed that the water extraction method is convenient since EBN contains mainly water-soluble protein and is widely used for protein extraction (Chua & Zukefli, 2016; Zukefli, Chua, & Rahmat, 2017).

Therefore, this method is widely used for EBN protein solubilisation. Water extraction methods reported were used in the temperature between 80 to 100°C with solubilisation time between 1 to 4 hours (Daud et al., 2019; Wong et al., 2018; Zamri et al., 2020). Apart from that, acid and alkaline solubilisation were also managed to solubilise EBN by disintegrating the structure to release

protein. The works of literature show that acid and alkaline solubilisation methods were commonly carried out at temperature 80 to 110°C and 25 to 45°C, respectively with different solubilisation time (Chantakun, Nuthong, & Benjakul, 2020; Noor et al., 2018; Tong, Lee, Cheong, & Lim, 2020).

Generally, the water extraction method exhibits the highest protein solubility of EBN among non-enzymatic solubilisation as reported in the previous studies ranged from 65 to 90% (Fan et al., 2020; Wong et al., 2018; You et al., 2015). Meanwhile, the acid and alkaline solubilisation method was commonly used as a pre-treatment to solubilise EBN prior to subjected analysis.

2.3. Solid-liquid separation methods

Both enzymatic and non-enzymatic solubilisation was required to perform separation on EBN prior to specific analysis and usage. There are several methods that currently exist to separate EBN which are centrifugation, gravity filtration, and ultrafiltration process (Babji et al., 2018; Muhammad et al., 2015; Ramachandran et al., 2018)**.**

Most of the studies applied centrifugation prior to other separation methods which are gravity filtration and ultrafiltration. Gravity filtration was effectively employed in enzymatic solubilisation of EBN using filter papers Whatman No.1 and Whatman No.4. Meanwhile, ultrafiltration method is applicable to solubilisation methods including enzymatic and non-enzymatic through different molecular weight cut-off (MWCO) membranes.

However, the ultrafiltration method is not extensively documented in EBN investigations as this method is mainly used to determine the properties of each fraction isolated from solubilised EBN.

3. Conclusion

In conclusion, the finding from this literature examination shows that enzymatic solubilisation is the most preferable processing method in solubilising EBN. This finding is supported by the majority of previous studies that used enzymes especially Alcalase prior to analysis of EBN. The implementation of separation methods from the previous studies synthesis that gravity filtration using filter papers Whatman No.1 and Whatman No.4 is effective to segregate the solubilised EBN.

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EDIBLE NANOCOATING: THE EFFECT OF DIFFERENT CONCENTRATIONS OF METAL NANOPARTICLES INCORPORATED WITH POLYSACCHARIDE-BASED MATERIAL ON ANTIMICROBIAL AND ANTIFUNGAL ACTIVITY

Ainnur Syamira Kamarudin[1], Noor Asnida Asli[3,4], and Nadya Hajar[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[3]*NANO-SciTech Lab, Functional Materials and Nanotechnology Centre, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*
[4]*Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*

**Corresponding author*: *nadya1844@uitm.edu.my*

Abstract: Fruit spoilage is very common during the postharvest phase due to extrinsic factors and therefore it renders them unsuitable for human consumption. The microbial and fungal spoilage in fruits results in substantial financial losses throughout the entire supply chain. Applying nanotechnology on the fruit can reduce significant privation. This review elaborates on the antimicrobial and antifungal activity by applications of polysaccharide and metal nanoparticles on fruits. Metal nanoparticles of silver, zinc oxide and titanium dioxide demonstrate attractive antimicrobial and antifungal properties on different concentration nanoparticles such that 0.02% - 8% by weight of polysaccharide could potentially be used. Incorporating nanoparticles in various polysaccharides pullulan, hydroxypropyl methylcellulose (HMPC), carrageenan, chitosan, and pectin polymer matrix increase the efficiency against *Aspergillus niger*, *Bacillus subtilis*, *Colletotrichum gloeosporioides*, *Escherichia coli*, *Fusarium oxysporum*, *Staphylococcus aureus*, and *Saccharomyces cerevisiae*. All samples display consequential inhibitory effects with increasing metal nanoparticles concentration incorporated with polysaccharide materials. The results obtained possessed a better understanding of different concentrations of polysaccharides incorporated into Ag/ZnO/TiO_2 nanoparticles to inhibit fungal and microbial growth which could be used in fighting against postharvest disease and improve the shelf life of fruits. The aims of this research work were to determine and analyse the effects of different concentrations of metal nanoparticles incorporated with polysaccharides-based material on antimicrobial and antifungal activities.

Keywords: Nanoparticles, concentration, polysaccharide, antimicrobial, antifungal

1. Introduction

Fruit spoilage is mainly caused by three factors such as physical, enzymatic activity, and microbial growth. The common microorganisms that cause the spoilage of fruits are bacteria, yeast, and moulds which have deteriorated the fruit quality. As mentioned by Erkmen and Bozoglu (2016), a contact between spoiled and unspoiled fruits can also lead to microorganism contamination due to the poor environmental condition from harvesting to marketing. In consequence, microbial spoilage contributes to approximately 20% of fruits harvested and leads to major economic loss. Therefore, an alternative using a coating treatment is needed to prevent susceptible fruits from easily being spoiled. In this review, the coating consists of a combination of metal nanoparticles

(NPs) and polysaccharides as base materials. Nanoparticles which have ultrafine materials with lower than 100 nm dimensions (Shamim et al., 2019) by using Ag, ZnO and TiO_2 NPs. They are generally recognized as safe and no threat to humans, animals, or the environment thus commonly used in daily products and applied in the food packaging field, antifungal additive, and nutritional supplement. These metallic nanoparticles will improve the shelf life of fruits by incorporation with polysaccharides as a coating treatment on fruits. When the polysaccharides are incorporated into Ag, ZnO, TiO_2 NPs, they further substantiate the stability of metal/metal oxide nanoparticles.

2. Discussion

2.1. Background of study

Fruit spoilage has affected a supply chain from farmers to the consumers due to the deterioration of fruits caused by bacterial, fungal, and insect pests. The deterioration contributes to undesirable odour, appearance, texture, and taste to the fruits for human consumption which is unfavourable (Rawat, 2015; Yahaya & Mardiyya, 2019). Normally, in a storage period, most fruits discolour and give an unpleasant taste due to oxidation and polyphenolic compounds in the fruits. For example, fungus *Colletotrichum gloeosporioides* has caused Anthracnose disease which led to development of dark circular lesions on the fruits' skin (Sarkar, 2016).

2.2. Nanocoating

With coating treatment of metal nanoparticles (NPs) and based materials, the fruits can maintain their quality without any mould present on the skin compared to uncoated fruits. In this review, metal NPs used are silver (Ag), zinc oxide (ZnO) and titanium dioxide (TiO_2) incorporated with polysaccharides as based materials such as pullulan, cellulose, chitosan, pectin and carrageenan. Polysaccharides can be obtained from natural sources such that pullulan is yielded from fermented starch by the fungus Aureobasidium pullulans; cellulose from wood pulp and cotton; chitosan made from the deacetylation of crustacean and insect chitin; carrageenan mainly from the red seaweed; and pectin which can be extracted from citrus fruits' peels or various kind of fruits.

As highlighted in this paper, different concentrations of metal NPs are used due to the different toxicity and level permitted by USFDA such that Ag NPs are ranging from 0 to 0.01 g, ZnO NPs from 0 to 0.25 g and TiO_2 NPs from 0 to 0.09 g. Then, a few physicochemical analyses such as pH measurement, total soluble solids, titratable acidity, weight loss, peel and colour appearance, and fruits' firmness are evaluated from fruit coated samples. A coating treatment at high concentration of ZnO NPs exhibited an overall acceptance of all analyses compared to Ag NPs and TiO_2 NPs. Thus, this will attract the consumers' eyes and purchase the fruits without hesitation; hence coating treatment can be applied to maintain the quality of fruits.

2.3. Analysis of antifungal and antimicrobial properties

On the effect of antibacterial and antifungal activity on different concentrations of metal NPs incorporated with polysaccharides-based material, the high concentration of metal NPs inhibited the bacterial and fungal cell. This is because each metal NPs manage to induce the production of reactive oxygen species (ROS). The interaction between bacterial and fungal cell and coating materials has caused particles to penetrate the cell wall and cell membrane of microbial cells. The

antimicrobial mechanisms of ZnO NPs proved that the production of reactive oxygen species (ROS) and the release of the Zn^{2+} ion, which can enter the cell wall and react with the cytoplasmic substance, causes oxidative stress in fruits (Anugrah et al., 2020). Intracellular components leaked due to interactions between amino groups in chitosan and electronegative charges on the microbial cell surface (Lavinia et al., 2020). Then, oxygen free radicals which consist of H_2O_2, OH^- and O^{2-} target the outer membrane and damage the cell's DNA, destroy the electronic transport processes and bacterial oxidation that result in bacterial death (Nithya et al., 2015). However, the disruption of fungal cell walls is mainly due to the existence of ultraviolet (UV) light. According to Medici et al. (2019), the actual mechanism behind the antifungal effect of metal NPs is still unknown. It was only found that Ag NPs can damage the fungal cellular membrane and impair the normal budding process which is similar to how bacteria are affected by the metal NPs.

3. Conclusion

The best alternative on fruits' coating would be ZnO NPs bound with chitosan with concentrations ranging from 0.1 - 0.25 g. ZnO NPs exhibited a small weight loss, high inhibition of microbial and fungal growth, increase in fruits' firmness, reduced colour changes thus delaying the ripening and extending the fruits' shelf life. To prevent the fruits from losing their nutrients', coating treatment is needed to preserve the ripeness and juiciness of the fruits with significant sugar content. Incoming research, metal NPs of silver, zinc oxide, and titanium dioxide could be widely studied on the application of various fruits which are especially sold in every market as they are prone to microbial and fungal spoilage.

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THE EFFECTS OF MICROWAVE DRYING COMBINED WITH OTHER APPROACHES ON NUTS QUALITY ATTRIBUTES: A REVIEW

Azizah Izzati Mohd Sabani[1] and Naemaa Mohamad[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: naemaa953@uitm.edu.my*

Abstract: Demand on nuts has been rising globally in recent years due to their good source of protein, healthy fats and nutrients hence providing many benefits to the body's health. To provide a better quality of nuts during processing, transportation and storage, nuts must be dried accordingly to reduce the moisture content, avoid microbial contamination and to avoid post-harvest losses. A suitable method of drying needs to be used to ensure the drying process occurs effectively and give better quality nuts. In this review, microwave drying had been selected due to its benefits of consuming less energy, reducing drying time yet providing an enhanced high-quality product when combined with other approaches for instance microwave drying with surface temperature control, intermittent microwave drying, microwave with ultrasound pre-treatment and microwave assisted solvent extraction. However, the drying method is known for its negative effects on dried product quality such as rancidity. That is why, the effects of microwave drying combined with other approaches on nuts quality attributes such as the drying rate, physicochemical properties, total phenolic content, antioxidant activity and sensorial properties of dried nuts have been discussed. High microwave power will lead to faster drying rate hence reducing the drying time. However, it will lead to higher shrinkage, increment in the total colour change and higher rate of rancidification for the dried nuts. In addition, the total phenolic content and antioxidant activity of nuts treated with microwave drying will increase in parallel with the increase of microwave power. Further study needs to be done regarding the optimizing of microwave drying combined with other drying methods to give a better quality of nuts.

Keywords: Nuts, microwave drying, quality, drying rate, physicochemical properties

1. Introduction

Nuts are high in essential amino acids, vitamins, minerals and nutritional fibres and are preferred among individuals of all ages. Tree nuts are in high demand due to their well-known health advantages, and their global demand has risen in recent years (Cuadrado et al., 2020). However, nuts have a short shelf life owing to their high susceptibility to rancidity due to their high unsaturated fatty acids and moisture content (Walton et al., 2017). The objectives of this report were to discuss the overview of nuts and to review microwave drying mechanisms combined with other approaches and the effects of microwave and other approaches on nut quality attributes on physicochemical properties, total phenolic content, antioxidant activity and sensorial properties. Hence, this report's findings will be useful to food industries that produce dried nuts by providing information in terms of the microwave drying treatment that may be used to dry nuts.

2. Discussion

2.1. Nuts

Nuts contain vitamins, minerals, healthy fatty acid composition, with low levels of saturated fat and high levels of monounsaturated and polyunsaturated fatty acids as well as other bioactive components like polyphenols. Drying of nuts is important to minimize the moisture content and thus limit microbial growth, and appropriate drying methods must be employed to assure the drying process is done properly. Nuts must be dried as soon as possible after harvest to achieve a moisture content of less than 6% and a water activity of less than 0.70 at 25°C in order to maximize storage life while maintaining their original quality (Giordano et al., 2019).

2.2. Microwave drying mechanism

Microwaves are sources of energy that interact with materials to produce heat as a result of their interaction and only heat the materials that are needed. Microwave heating works by converting alternating electromagnetic field energy into thermal energy by impacting a material's polar molecules. Non-contact heating, volumetric heating, selective heating and accelerated heating are several benefits of microwave heating (Zhao et al., 2019).

2.3. Other combination approaches with microwave drying

Food drying efficiency can be significantly enhanced by combining several approaches as this combination can be more beneficial compared to capability of each method alone (Junqueira et al., 2016). Some approaches that are always being combined with microwave drying are temperature-controlled systems, intermittent microwave drying, microwave with ultrasound pre-treatment and microwave solvent extraction method.

2.4. The effects of microwave drying on drying rate of dried nuts

Some factors affecting drying rate are the initial moisture content and the composition of the raw material, and temperature used for the drying process. Nuts dried using higher microwave power dried faster. This is due to the increment in heat transfer and mass rate when the microwave power increases (Jahanbakhshi et al., 2020).

2.5. The effects of microwave drying on physicochemical properties of dried nuts

Moisture content of dried nuts decreases with the increasing drying time and longer duration of ultrasound pre-treatment helps to reduce the moisture content of dried nuts. However, microwave drying increases the fat content of dried nuts and leads to higher rancidity. Meanwhile, higher microwave power leads to a higher amount of shrinkage due to the higher mass transfer that ruins the cell structure of dried nuts (Jahanbakhshi et al., 2020). Colour is a significant criterion for quality assessment. Higher microwave power will make the colour of dried nuts worsen. In addition, ultrasonic-microwave drying shows lower total colour change compared to ultrasonic-convection drying due to uniform heating in the ultrasonic-microwave dryer (Abbaspour-Gilandeh et al., 2019).

2.6. The effects of microwave drying on total phenolic content, antioxidant activity and sensorial properties of dried nuts

Antioxidant activity and total phenolic content of dried cashews are at the highest when treated with the highest microwave power due to the liberation of phenolics by the solvents applied due to preheating treatment received (Carvalho et al., 2018). Nuts can be dried using microwave drying but with a shorter drying time to avoid the shell of the dried nuts darken. Nevertheless, the taste of the dried nuts can still be maintained.

3. Conclusion

Microwave drying combined with other approaches results in a higher drying rate, total phenolic content and antioxidant activity. Microwave drying alone, on the other hand, has been shown to enhance the fatty acid composition of dried nuts, therefore increasing the rate of rancidity. Additionally, due to high shrinkage and total colour change, this method does not produce better quality dried nuts in terms of texture and colour. Microwave drying will darken the shell of the nuts but the taste will still be maintained. As a result, more research is needed to improve microwave drying conditions by combining with other approaches to improve the quality of dried nuts.

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EFFECT OF CHITOSAN-BASED COATING ON POST-HARVEST QUALITY OF 'MATA KUCING' *(Euphoria malaiense)*

Fatimah Hanisah Ahmad Radzuan[1] and Boon Yih Tien[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2*]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: boonyihtien@uitm.edu.my*

Abstract: The coating method is one of the preservation techniques that has been widely used in preserving post-harvest fruits due to its effectiveness in maintaining the quality, increasing the shelf life, and reducing the wastage of the post-harvest fruits. The chitosan-based coating is one of the edible fruits preserving post-harvest coating as it is able to maintain the quality of fruits such as colour, texture, moisture, sugar content, as well as the flavour of the fruits. This review aims to give an overview of the different treatments of the chitosan-based coating method on 'mata kucing'. The processing and preservation of the 'mata kucing' are recommended to be carried out after their harvest using cinnamaldehyde-chitosan and 2% chitosan treated with glacial acetic acids. The pH should be adjusted from pH 5.0 to 5.5 to avoid precipitation and to provide a good coating solution. The chitosan-based coating is generally safe for human health however it is not recommended for those who are allergic to shellfish. Thus, future research is needed to ensure the safety of chitosan-based coating products especially for those who are allergic to shellfish.

Keywords: Preservation techniques, chitosan-based coating, post-harvest, mata kucing

1. Introduction

'Mata kucing' *(Euphoria malaiense)* is a tropical fruit from the subspecies of *Dimocarpus longan ssp. malesianus*. The harvesting, processing and transportation process may affect the shelf life and quality of the fruit. For example, the fruits can encounter water loss, texture damage, off-flavour, and browning effect before they reach the customer. Therefore, a preservation technique with an edible coating such as chitosan coating can help to preserve the fruits. The edible coating is not only safe to be consumed but also does not impart unrequired flavour, helps reduce moisture loss and to maintain the firmness of the fruits (Medeiros Teodosio et al., 2021). It also helps in extending the shelf life and maintaining the post-harvest quality of the fruits. The objectives of this study are to investigate the concentration and the best treatment method in preparing the chitosan-based coating solution and to evaluate the coating effect on the quality and shelf life of 'mata kucing'.

2. Discussion

2.1. Edible coating

The edible coating can be categorized into four groups which are polysaccharide, protein, lipid, and composite based edible chitosan coating (Dhaka & Upadhyay, 2018). Chitosan is one of the

common edible coatings that fall under the group of polysaccharides and has been generally recognized as safe (GRAS) by the United States Food and Drug Administration (USFDA). The wide application of the chitosan-based coating in the food industry is due to its antimicrobial, biodegradability, biocompatibility with human tissue, bio function and non-toxic properties. This coating is a good oxygen barrier that can help in lowering the respiration rate and controlling the ripeness of the fruit since it has a hydrogen bonding structure that is tightly packed.

2.2. Treatment of chitosan-based coating solution

Chitosan can be derived from the deacetylation, demineralization and deproteination of chitin from recycled shellfish such as crab and shrimp (Fasciglione et al., 2020). The chitosan powder is diluted with an organic acid such as acetic acid, lactic acid, and propionic acid to obtain an effective coating solution with 0.5% to 5% concentration. However, 2% of the chitosan-based coating is found to be the most effective in preserving the fruits (Eshetu et al., 2019; Suseno et al., 2014). The pH of the coating solution must be adjusted between pH 5.0 and 5.5 to avoid precipitation and to decrease the electrostatic repulsion between the particles. The chitosan coating can be further treated with zinc oxide nanoparticles and cinnamon essential oil to enhance the coating properties.

2.3. Application of chitosan-based coating on foods and post-harvest fruits

The chitosan-based coating can be applied to various types of food such as meat, poultry, cereals, vegetables, and others. The egg is one of the foods that is commonly coated with a chitosan-based coating. The coated egg has a stronger eggshell thus minimise the breakage of the eggshell. Next, lettuce also can be preserved with a chitosan-based coating by decreasing the weight loss and maintaining the colour. Mango, 'rambutan', strawberry, *Cavendish* banana, pummelo and navel orange are examples of fruits that have been studied using the chitosan-based coating. The chitosan-based coating can delay the ripening of bananas. Furthermore, the coating also helps in maintaining the total soluble solids, total sugars, and titratable acid contents found in the fruits. The antioxidant activity is also being maintained which gives an excellent colour and post-harvest quality to the fruits.

2.4. Effect of chitosan-based coating on 'mata kucing'

'Mata kucing' has soft skin that enables the chitosan-based coating to be absorbed into the flesh hence preserve the quality of the 'mata kucing'. The chitosan-based coating may have the potential to increase the total soluble solids content of 'mata kucing' (Shamshad et al., 2021). The chitosan-based coating also contributes to inhibiting colour declination and maintains the texture of 'mata kucing' as effective on pummelo (Nie et al., 2020). The chitosan-based coating did not impart any taste to the coated fruits and improve the sensory qualities for a longer time. Therefore, the taste, colour, odour, and consumer acceptability of the 'mata kucing' will be maintained. The antimicrobial and antioxidant activity of the 'mata kucing' also will be reduced when coated with a chitosan-based coating.

2.5. Challenges of chitosan as a coating on 'mata kucing'

'Mata kucing' continues its transpiration and respiration even after the harvesting process that makes the fruit tends to lose its quality and decrease its shelf life easily. 'Mata kucing' also continues to lose water content after harvesting since there is no water replacement from the plant. Since the fruit has thin flesh, it is easily exposed to the pathogen. It is important to ensure that the coating solution is adjusted to pH 5.0 to 5.5 to avoid precipitation which will reduce the effectiveness of the coating. In addition, the coating might have side effects on people who are allergic to seafood since it is derived from shellfish. Therefore, people who are allergic to seafood should be prevented from participating in the sensory evaluation.

3. Conclusion

In conclusion, the chitosan-based coating helps to maintain the quality and to extend the shelf life of the coated fruits. It is recommended to directly coat the flesh instead of the fruit skin of 'mata kucing' to make the coating process more effective. This can be further improved by using nanoparticle size based chitosan coating which can apply directly to the skin of the 'mata kucing'. Further research should be a focus on the application of the chitosan-based coating and its safety issue especially for those who are allergic to shellfish.

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LACTIC ACID BACTERIA AS A BIOPRESERVATIVE IN FERMENTED FOODS

Fatin Fatanah Ruslan[1] and Safiyyah Shahimi[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: safiyyahshahimi@uitm.edu.my*

Abstract: Public concerns regarding the safety of chemical preservatives in food have led to the use of natural preservatives. Naturally produced antimicrobial compounds tend to promote the substitution of conventional methods and lessen the rigidity of the use of chemical and physical preservatives. In this review, the effects of lactic acid bacteria (LAB) metabolites on the shelf life of fermented foods were investigated. Analysis of the LAB antimicrobial activity against pathogenic bacteria and the effect of LAB on physicochemical properties of the fermented foods were done. Based on the relevant articles, the shelf life of the fermented food was increased with the presence of LAB metabolites including lactic acid, acetic acid, sorbic acid, benzoic acid and bacteriocin. The LAB was found to be able to replace chemical preservatives as the shelf life of food samples was extended. Moreover, no negative effect was reported on the physicochemical properties of fermented food from the addition of LAB. It was shown to inhibit pathogenic bacteria *Listeria monocytogenes*, *Bacillus subtilis*, *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Micrococcus luteus* with the most dominant species of *Lactobacillus plantarum* found. Hence, these findings have demonstrated the LAB as an efficient biopreservative in fermented foods.

Keywords: Biopreservative, lactic acid bacteria, lactic acid, natural preservative, bacteriocin

1. Introduction

The food industry is focusing on using natural compounds that are considered safe alternatives and meet consumer preferences for healthier food. According to Mani-López et al. (2018), biopreservation is a food preservation technique that involves the use of antimicrobial substances to extend the shelf life of a product. Biopreservative may come from natural sources or formed in food fermentation. It should be safe and cheap, do not produce any adverse effects, stable, effective at low concentrations and permitted by regulatory agencies. However, only a few biopreservatives achieved or were close to these requirements. Fermented foods are known as food or beverages that are produced from control microbial growth and the components of the food are being converted through enzymatic action which is known as fermentation. The success and safety of the fermentation product are determined by the developed acidity, low pH value, and total sugar elimination (Dimidi et al., 2019). The main microorganism that is involved in the process of fermentation is lactic acid bacteria (LAB) which is predominant in fermented foods. These LAB will ferment carbohydrates into a combination of lactic acid, carbon dioxide, and acetic acid and/or ethanol (heterofermentation), or almost completely lactic acid (homofermentation). It also produces other metabolites such as lactic acid, hydrogen peroxides and diacetyl.

2. Discussion

2.1. Metabolites of LAB and its effect on shelf life of fermented foods

Ebah et al. (2019) analysed cabbage, carrots and tomatoes stored in a tight jar for fermentation for six days. The higher the concentration of LAB, the more lactic acid is produced as a result of LAB breaking down carbohydrates, lowering the pH of the fermented food. As a result, microbial development was suppressed, extending the vegetables' shelf life. Ageni et al. (2017) studied the shelf life of ogi and fufu by extracting the bacteriocin from *Lactobacillus acidophilus* that was isolated from yoghurt and nono. The amount of bacterial load was reduced when the bacteriocin was added into them and the shelf life of ogi and fufu had been extended for 15 and 5 days, respectively compared to 45 and 40 days without bacteriocin. Tumbarski et al. (2021) concluded that the addition of purified bacteriocin can increase the antifungal activity, hence, the shelf life of the yoghurt can be extended. Salleh et al. (2021) did a study on the production of sorbic acid and benzoic acid compounds from lactic acid bacteria. These acids can resist *S. typhimurium* ATCC 14028, *E. coli* ATCC 11795, *E. coli* O157, *S. aureus* ATCC 25923 and *V. cholera* which increase the shelf life of fermented durian flesh.

2.2. Effect of LAB on physicochemical properties of fermented foods

Ravindran and RadhaiSri (2020) did a study on the physicochemical probiotic oats milk drink fermented with microencapsulated *Lactobacillus plantarum*. The addition of *L. plantarum* caused the values of pH to differ significantly ($p < 0.05$) than the non-fermented oats milk. The viscosity in the fermented spice and strawberry flavoured probiotic oat milk increased significantly than the non-fermented sample ($p = 0.03$). Masia et al. (2020) investigated the effect of *Lactobacillus rhamnosus* on the physicochemical properties of fermented plant-based materials such as soy, oat, and coconut. The post-acidification trends of oat samples differed significantly from soy and coconut samples. Kumar et al. (2013) stated that fruit juices with probiotics are useful for developing health-beneficial goods, especially for individuals who are sensitive to dairy products.

2.3. Effect of antimicrobial activity of LAB against pathogenic bacteria

Nizori et al. (2019) did a study on the effect of LAB on the antimicrobial activity in fermented durian paste during four weeks of storage. The result revealed that supernatants from LAB strains inhibited the growth of *S. aureus* and *E. coli* ATCC 25923 strains to varying degrees. Demirbaş et al. (2017) reported that the function of sourdough in terms of the technology primarily depends on the metabolism of LAB that can be originated from flour and other ingredients. Only *L. paraplantarum* N-15 showed antibacterial activity against *S. typhimurium* RSSK 95091. A study by Hamid and Fuzi (2020) on the antimicrobial activity in tapai pulut (fermented glutinous rice) and tapai ubi (fermented cassava) against *Bacillus subtilis*, *E. coli*, *S. typhimurium* and *S. aureus* showed all isolates strongly inhibited all strains except *S. aureus.*

3. Conclusion

LAB was proven to be a biopreservative in fermented foods. Lactic acid and its metabolites, such as sorbic acid, acetic acid, benzoic acid, and bacteriocin, had a significant impact on the shelf life

of fermented food. Furthermore, LAB influenced the physicochemical properties of fermented foods such as pH, water activity, titratable acidity, and viscosity in a positive way. The growth of pathogenic bacteria such as *S. aureus*, *E. coli*., *B. subtilis*, *S. typhimurium* and *M. luteus* can be inhibited by the antimicrobial activity of LAB. Additional research is required to determine the standard approaches to confirm the isolated bacteria's role in increasing the shelf life and preservation efficiency towards selected food products.

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A REVIEW ON THE EFFECTS OF PROCESSING METHODS ON THE NUTRITIONAL COMPOSITION AND ANTINUTRITIONAL COMPONENTS OF QUINOA (*Chenopodium quinoa*) AND BUCKWHEAT (*Fagopyrum esculentum*)

Fatin Nadiah Saypol Anwar[1] and Marina Zulkifli[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*

**Corresponding author: marina547@uitm.edu.my*

Abstract: Quinoa originally from Andean region and buckwheat from China are two pseudocereals gradually making their way into the daily diet of humans due to its numerous health benefits. Both are packed with nutrients such as essential amino acids, proteins, fibre, vitamins and minerals. However, there is a limitation towards its use due to antinutrient components. Examples of antinutrients include phytate, saponin and tannin that affect the ability to absorb the nutrients. Thus, processing methods were executed in order to observe whether it gives positive or negative impacts towards the nutrients and antinutrients content. Processing methods reviewed include heat treatments (cooking, steaming, boiling, roasting, drying), germination and pressure. In this review, results showed that the roasting and germination process increases the content of nutrients while the process of pressure and microwave produces a lower loss of nutrients. For antinutrients, washing and boiling were the best processing technique to lower the antinutrient contents. It appears that the combination of heat and water would be the most effective way to increase the content of nutrients and lower the antinutrients in both seeds. Deeper research regarding these two pseudocereals is highly recommended, particularly in processing methods because it is proven to positively impact both nutrients and antinutrient components. For that reason, the application of quinoa and buckwheat seeds in the food industry can be expected to be industrialized over time, as they are believed to contain all the essential nutrients which can benefit one's health.

Keywords: Quinoa, buckwheat, processing methods, nutrients, antinutrients

1. Introduction

Quinoa (*Chenopodium quinoa*) is a type of seed known for its high nutritional quality comprised in its grains and leaves as stated by Martínez et al. (2015). Buckwheat *(Fagopyrum esculentum)* is also a type of seed known as pseudocereal as it generates starch seeds like cereals (Schoenlechner et al., 2008). Both of these seeds contain antinutrient components such as saponin, tannin and phytate. Filho et al. (2015) stated that if antinutrients are consumed in such large quantities, it can cause harmful effects to one's health. On the other hand, processing methods like boiling, soaking, germination and malting have been known to decrease the antinutrient components in quinoa and improve its nutrient content (Srujana, 2019). It was found that processing methods using heat application showed a great reduction. However, it has also significantly affected the protein structures which obstructs complete digestion of food proteins. Therefore, the different results on the effects of processing methods on these pseudocereals have strengthened the main objective of this article review being conducted to observe whether it gives positive or negative impacts to the nutrients and antinutrient components of both seeds.

2. Discussion

Quinoa has been considered as a superfood for its magnificent nutrient's properties due to the high-quality protein. The nutritional components of quinoa include carbohydrates, lipids, fiber, vitamins, minerals, gluten, isoflavones, betains and carotenoids (Gordillo-Bastidas et al., 2016). For composition of nutrients in buckwheat, it consists of a higher amount of minerals than quinoa. Macroelements like K, Mg, Ca, Na and microelements such as Zn, Fe and Mn are found in high quantities for buckwheat seed. However, both seeds are known to contain antinutrients components which include saponin, tannin and phytate. Saponin, which causes bitterness to the quinoa seed, has reduced its palatability as a source of food. A study done by Galwey (1993) stated that saponin is toxic once it reaches the bloodstream. It is known to affect digestibility of protein in humans and animals by precipitating with the protein component thus forming complexes (Samtiya et al., 2020). Phytic acid is capable of binding with bivalent minerals like calcium, iron, zinc, copper, even protein and enzymes (Matilla et al., 2018). Therefore, processing methods have been conducted in an attempt to lower these components of antinutrients.

Motta et al. (2019) mentioned that after quinoa has undergone processing methods, it has shown positive impacts such as improving the digestibility, bioavailability of nutrients, taste, flavour, texture and palability of these seeds. In this paper, quinoa seed undergoes proximate analysis, cooking and drying process while buckwheat seed undergoes heat treatments, germination and high hydrostatic pressure to see the effects of processing methods to the nutrients of both seeds. For proximate composition of quinoa, the parameters include analysis of moisture, crude protein, crude fat, crude fibre, total ash and carbohydrate. From the result observed, the process of boiling, steaming and roasting of quinoa has significantly decreased most of its nutritional contents except for analysis of moisture, total dietary fibre and carbohydrate. For the processing method of cooking (boiling and steaming) to the minerals of quinoa, steaming causes a much lower loss to the minerals as it uses lower temperature. For drying, a range of temperatures from 40°C, 50°C, 60°C, 70°C and 80°C were used. Medium temperature of 60°C-70°C would be the most optimum temperature to dry the quinoa seeds as high temperatures cause a reduction in the nutritional and mineral components.

Heat treatments for buckwheat include the process of microwaving, boiling, roasting and steaming. Microwave processing methods are encouraged to be used as less nutritional loss are observed rather than the boiling and roasting process. Steaming method has shown an increase in minerals of iron (Fe) for buckwheat seeds. Next, a germination method with different time periods from 0 h up to 72 h was observed. Analysis of crude fat, reducing sugars, crude protein, ash and carbohydrate were done. The amount of crude fat, reducing sugar, protein and carbohydrate were seen to be increasing over time (Zhang et al., 2015). However, it is notable that the longer the germination time, the higher the carbohydrate loss (Lee & Kim, 2008). For high hydrostatic pressure (HHP) method, Deng et al. (2015) in his study found that it has issued the highest increased amount of histidine and alanine but recorded the lowest composition of threonine, serine and glycine. The HHP process does not bring any positive impacts or increases the amount of chemical composition (starch, protein, lipid, ash, total flavonoids and total amino acid) of buckwheat seeds. It causes the lowest reduction of nutrients. As highlighted in this review paper, processing methods that can increase nutritional value are through the process of germination and

roasting. To produce a lower loss of nutrients, HHP, microwave, steaming and boiling methods are in accordance.

Lastly, on the effects of processing methods done on quinoa and buckwheat seeds, the highest reduction of antinutrients is from the boiling process. Deng et al. (2015) found that after boiling for 30 minutes, it causes the highest reduction (35.7% and 27.6%) for tannin and saponin. Process of microwaving causes a 27.5% and 20.1% reduction while HHP caused the smallest reductions (19.9 and 4.5 %, respectively) for tannin and saponin. Comparing the non-heat method, it is observed that washing, soaking and germination are in line with its effectiveness in decreasing antinutrients. Then, comparing all four heat treatments often used to make food, boiling tops as the most optimum method to reduce antinutrients components, followed by roasting, microwaving and HHP. Both quinoa and buckwheat seeds are forecasted to continually rise up due to a few aspects. No longer seen as a trend, there is a need towards consumption of organic food and gluten-free products in the daily lives of consumers along with the addition of various innovations in producing healthy food are one of the main causes as to why consumption of quinoa and buckwheat has seen a steady yet gradual increase.

3. Conclusion

Roasting and germination are the most effective methods in increasing the nutritional value of a seed while HHP and microwave processes are the best way to lower the nutrient loss during processing. For antinutrients, washing and boiling were the most effective processing methods in lowering the antinutrient contents. Overall, heat plays a major role in reducing the amount of antinutrients as well as increasing the amount of nutritional value. However, processing methods surrounding the effects towards antinutrients of these samples are very limited. Therefore, more studies need to be conducted in order to understand how these antinutrients can be minimized, especially using the application of heat and how the application of heat itself can increase the amount of nutrients for a maximum absorption to the human body.

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ANTIOXIDANT ACTIVITIES OF EDIBLE BIRD'S NEST (EBN)

Fatma Nabilah Muhammad Fakhran[1], Siti Azima Abdul Muttalib[1,2], and Eddie Ti Tjih Tan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan Malaysia*

**Corresponding author: eddietan@uitm.edu.my*

Abstract: Edible bird's nest (EBN) is well-known as an expensive animal product. This product is the saliva of swiftlets that has been proven to give many health benefits. Existing studies showed that saliva contains high antioxidant properties which contributed to the benefits. However, the antioxidant properties of EBN have not been reviewed. This paper aims to review the antioxidant properties of EBN through existing pieces of literature. With that, an in-depth search on Web of Science (WoS)b was carried out using the keywords "antioxidant", "edible bird's nest", "enzymatic hydrolysis" and "sialic acid". It was found that the most common method for antioxidant quantification of EBN was DPPH assay. DPPH assay antioxidant activity of the EBN treated by enzymatic hydrolysis is significantly higher than other sample preparation methods. The overall findings suggest that EBN antioxidant studies open up opportunities for research and development of EBN as a health food which is gaining attention from the community.

Keywords: Antioxidant, edible bird's nest, enzymatic hydrolysis, sialic acid

1. Introduction

Edible bird's nest (EBN) is the saliva of special swiftlets only found in Southeast Asia. It is solidified in the air to form their nests. The EBN is claimed to be beneficial as it improves β-cell function and insulin signalling for type II diabetes (Choy et al., 2021), improves neurological function for Parkinson's disease (Yew et al., 2018), anti-oxidative and anti-inflammatory (Zhang et al., 2015). Since EBN is high in antioxidants, many recent research works have started to focus on the antioxidant properties of EBN. Several sample preparation methods were used in preparing the EBN for antioxidant analysis such as salt extraction, alkaline extraction, heat treatment (Zamri, Mahadi, Abdullah, Syafiuddin, & Hadibarata, 2020) and enzymatic hydrolysis (Babji et al., 2018; Nurfatin et al., 2016).

Even though many research studies have reported the antioxidant activities of EBN, however, an overview of EBN antioxidant activities was not available. Therefore, this paper aims to examine the reported antioxidant properties of EBN.

2. Discussion

Generally, EBN in its existing form contains a complex protein structure. It needs to be degraded to enhance the antioxidant activity. This is because the total surface area increases after degradation hence will increase the exposure of bioactive compounds for antioxidant activities. The literature search shows four sample preparation methods were used for EBN antioxidant

studies, namely, salt extraction, alkaline extraction, heat treatment (Zamri et al., 2020), and enzymatic hydrolysis (Babji et al., 2018; Nurfatin et al., 2016).

Previous antioxidant reports for EBN were established based on several antioxidant assays such as DPPH, FRAP, ABTS, and TPC. The DPPH assay was used to quantify the primary antioxidant potentials available in EBN (Ling, Chang, Babji, & Lim, 2020a). The FRAP assay quantifies both primary and secondary antioxidant potentials available in EBN (Ling, Chang, Babji, & Lim, 2020b). While the ABTS involves both electron and hydrogen atoms from EBN antioxidants to stabilize the radicals (Ling et al., 2020b). The ABTS was used to determine the hydrophilic antioxidant compounds in the EBN (Gan, Chang, Nasir, Babji, & Lim, 2020; Ling et al., 2020a). TPC is involved indirectly in antioxidant methods of EBN. This method measures the amount of phenolic content and the free radical scavenging activity is assisted by the hydroxyl group of the antioxidant molecules (Aryal et al., 2019; Quek, Chin, Yusof, Law, & Tan, 2018).

Salt extracted EBN with 5% NaCl has provided high antioxidant activity. The values recorded for antioxidant activity using DPPH and FRAP were 58.29±3.30% and 1.81±0.24 AAE mM/g respectively. However, the phenolic content in this EBN was not detected (Zamri et al., 2020). The highest reported antioxidant activities of EBN were found in the EBN samples treated with alkaline extraction (0.5M NaOH), the EBN antioxidant activities quantified using DPPH, FRAP, and TPC were 58.10±11.61%, 5.13±0.02 AAE mM/g, and 0.08±0.01 GAE/g respectively (Zamri et al., 2020). In addition, the antioxidant activity of EBN steadily increased with the increase in temperature for the heat treatment method. The EBN treated at 100ºC depicted the highest antioxidant activity with a DPPH value of 51.76±1.08% and an FRAP value of 1.06±0.00 AAE mM/g (Zamri et al., 2020). The alcalase, papain, and papaya juice were also used for enzymatic hydrolysis of EBN. It was found that the antioxidant activity of EBN treated with papain for two hours has the highest antioxidant values with a DPPH scavenging value of 29.9±4.9% (Zulkifli et al., 2019).

EBN contains glycoprotein which holds the component responsible for its antioxidant activities known as sialic acid. Besides the sialic acid, the amino acids are also contributed for its antioxidant activities. A study reported the antioxidant activities of EBN after the drying method. It was found that sialic acid in the EBN decreased with the increment of drying temperature. The increase of drying temperature from 25ºC to 70ºC also reduced the ABTS radical-scavenging activity from 85.61±0.09 TEAC/g dry weight to 34.28±0.14 mg TEAC/g dry weight respectively (Gan, Ong, Chin, & Law, 2017). Different EBN hydrolysates have different antioxidant values. A study conducted using alcalase and papain resulted in different values of FRAP assay with the reducing power of 0.0175±0.002mg/ml and 0.0680±0.0004 mg/ml respectively (Muhammad, Babji, & Ayub, 2015).

3. Conclusion

In conclusion, it was found that the antioxidant activities of EBN were measured using many antioxidant quantification methods depending on the type of compound to be studied. EBN sample prepared by enzymatic hydrolysis yielded the highest antioxidant activities compared to other sample preparation methods.

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A REVIEW ON THE ANTHOCYANIN AND ANTIOXIDANT CAPACITIES OF *Clitoria ternatea* FLOWER

Khalimatul Saadiah Jamsari[1], Eddie Ti Tjih Tan[1,2], and Siti Azima Abdul Muttalib[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: sitiazima@uitm.edu.my*

Abstract: Butterfly pea flower has been used as food colourant for decades by Malaysians, purposely to add an aesthetical value to the food. Besides, the flower has been scientifically displaying several bioactivities properties. A multitude of works on the antioxidant capacity of butterfly pea has been presented in literature and the antioxidant capacities are correlated with the presence of polyphenolic compounds. Hence, this review aims to understand the correlation between anthocyanin, phenolic compounds and antioxidant activity of butterfly pea flowers. The finding from this review unveils that antioxidant capacity of butterfly pea are depending on the number of hydroxyl groups attached on the carbon 3' and 4' of ring B, the availability of main reactive sites for nucleophilic and electrophilic attacks, as well as the presence of electron donor on the chemical structure of the bioactive compounds. Furthermore, high antioxidants are obtained in the solvent extraction that has been added with acid. The protonation-deprotonation process of the anthocyanin at various pH is the main factor that contributed to the antioxidant activity. Thus, a comprehensive study on the antioxidant properties of butterfly pea flower as a natural antioxidant towards foods is recommended to widen the application of butterfly pea in the food industry.

Keywords: Antioxidant, anthocyanin, butterfly pea, natural colourants

1. Introduction

Butterfly pea (*Clitoria ternatea*) flower has been used as colouring in bakery products such as sourdough and cake. Anthocyanin pigment is found in butterfly pea and is responsible for the deep blue to purple colour of the flower (Campbell et al., 2019). The stable polyacylated anthocyanin at high temperature due to the complex structure that enables the use of this pigment in the food. Beside of imparting colour, butterfly pea also has antioxidant properties which help to decrease the lipid oxidation and prolong the shelf life of food product with safer ingredient. The antioxidant capacity of butterfly pea flower varied according to the type of solvent used, which is attributable by the different in polarity, solubility and structure of phytochemical (Jaafar et al., 2020). Furthermore, the total phenolic acids, flavonoids content and anthocyanin content present in butterfly pea flowers contributes to the antioxidant capacity. Therefore, high anthocyanin does not always provide high antioxidant power because the high antioxidant activity is primarily derived from other phytochemicals such as flavonoids (quercetin and rutin).

2. Discussion

2.1. Chemical structure of anthocyanin in butterfly pea

A vivid deep blue colour of butterfly pea flower which is known as “Double Blue” (*Clitoria ternatea* var. *pleniflora* Fantz) which has multiple petals and a wild-type butterfly pea (*Clitoria ternatea* var. *ternatea* L.) with single dark blue bilateral petals consists of anthocyanin. Anthocyanin present in the butterfly pea flower has the ability to change colour in different pH that ranges from deep blue to magenta (Muzi Marpaung et al., 2017; Adisakwattana et al., 2020). The basic structure of anthocyanin is glycosylated polyhydroxy and polymethoxy derivatives of 2-phenylbenzopyrylium cation or namely as flavylium cation which was mentioned by Cavalcanti et al. (2011). Delphinidin is the anthocyanidin found in butterfly pea alongside with other polyacylated and polyglycosylated delphinin, known as ternatin. The hydroxyl group attached to the B ring of the delphinidin structure is the main reason for the instability of delphinidin compared to malvidin with the methoxyl unit attached to the B-ring. However, the polyacylated and glucosylated form of delphinidin hinders the nucleophilic and electrophilic attacks on the delphidin structure, then stabilizes the colour (Alappat & Alappat, 2020). Figure 1 shows the chemical structure of dephinidin and ternatin.

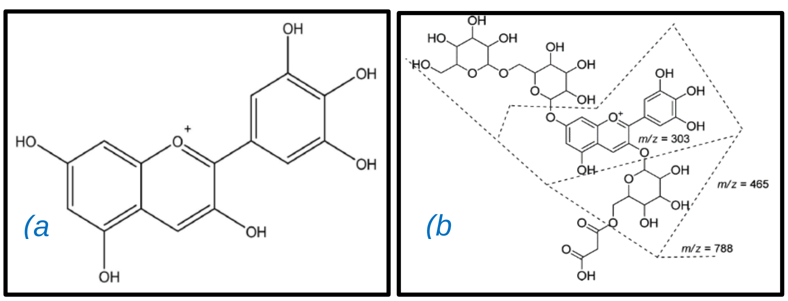

Figure 1. (a) Chemical structure of delphinidin and (b) Chemical structure of ternatin.
Source: Alappat and Alappat (2020); Nair et al. (2015).

2.2. Bioactive compound in butterfly pea in different extraction solvent

Phenolic acids, flavonoids and anthocyanin are detected in butterfly pea flowers and have a significant role in the colour stability and antioxidant activity of the butterfly pea flower extraction (Escher et al., 2020). Although, there are different amounts and types of phenolic compounds are yielded at the end of extraction procedure due to the different types of solvent used, time and temperature of extraction. The solvent used for extracting bioactive compounds has different effectiveness in different species of plant (Jaafar et al., 2020).

2.3. Antioxidant activity of butterfly pea

The antioxidant activity of anthocyanin is mostly determined by their chemical structure, which includes the number and position of hydroxyl groups, conjugated double bonds, as well as the presence of electron donors in the structural ring (Martín et al., 2017). Delphinidin from butterfly pea, which contributes to the main colourant molecules of anthocyanins, has a high antioxidant capacity. Aside from that, phenolic chemicals play a bigger role in antioxidant activity than the anthocyanin found in butterfly pea flowers (Havananda & Luengwilai, 2019). The ethanol and aqueous extraction can be improved by the addition of acid (Pengkumsri et al., 2019). In order to produce high antioxidant activity, the optimum pH 3 and high concentration of anthocyanin added must be followed (Kungsuwan et al., 2014).

3. Conclusion

In conclusion, phenolic compounds which consist of phenolic acids, flavonoids and anthocyanin contribute to high antioxidant capacities of butterfly pea flowers. Furthermore, the antioxidant capacities are correlated to the phenolic compounds present in the extraction. Thus, it's important to extract the butterfly pea flower at favourable condition (i.e. type solvent and temperature) with suitable solvent which will extract the desired compounds. Solvents may have different affinity towards the phytochemical which is highly dependent on their structure and polarity. Hence, acidified solvent can be used to yield more phenolic acids, flavonoids and anthocyanin which then produce stable colour and antioxidant capacities.

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REVIEW ON NUTRITIONAL CONTENT AND PHARMACOLOGICAL ACTIVITIES IN LEAVES OF BARRINGTONIA SPECIES (*Barringtonia acutangula* L. and *Barringtonia racemosa* L.)

Noor Nazzatul Syazana Mohammad Zamri[1] and Nur Aisyah Ismail[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research and Innovation for Food, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: aisyah@uitm.edu.my*

Abstract: *Barringtonia* species have enormous potential for complementary and medicinal uses, however, the uses of the species are underutilised and limited research. Each part of this species has their own functionality; however, this review only focused on the leaves as the leaves of the species can be consumed as *ulam*. It also contains high total phenolic content and exhibits antioxidant activity. It is aimed to provide a clearer explanation and information regarding these species. The review discussed two species which are *B. acutangula* and *B. racemosa* and made a comparison between the proximate analysis and the phytochemical content in the leaves of the plants. The approximate percent composition of moisture (70.52%), ash (0.96%), fibre (1.38%), protein (2.54%) and carbohydrate (25.71%) in *B. racemosa* while for *B. acutangula*, only carbohydrate (9.85%), protein (13.13%) and ash (7.7%) were analysed quantitatively. Phytochemicals present in these plants are collected from current studies and reported *B. racemosa* have higher content in total phenolic content (1585.20 mg/g) and total ascorbic acid (88.9 mg/g). Meanwhile, *B. acutangula* reported to have higher content in total flavonoid (109.52mg/g) and total tannin (105.52 mg/g). The review also comprised pharmacological activities in the *Barringtonia* species, particularly, antioxidant, antibacterial and antidiabetic activities, from current documented literatures to provide significant information on the nutritional benefits of *Barringtonia* species. This review proved the needs for future research and commercialisation on this species due to the abundance of sources and nutritional content especially in making it as future medicine for Malaysians.

Keywords: *Barringtonia racemosa, Barringtonia acutangula,* proximate analysis, phytochemicals, pharmacological activities

1. Introduction

In Malaysia, *ulam* is a popular traditional vegetable due to the unique aroma, flavors, a useful source of medical uses and has plenty of nutrition. *Barringtonia* is a genus of big tree that has flowers and comes from the Lecythidaceae family. There are three species of *Barringtonia* that are known for nutritional and ethno-biological uses, however, only *Barringtonia racemosa* and *Barringtonia acutangula* will be reviewed in this article. *B. racemosa* L. is known as *putat* in Malaysia and used as traditional medicine to cure snake bites and rat poisoning. Fruits, seeds and leaves of the *putat* plant can be consumed and have their own nutrition and benefits to the consumer's health. Triterpenoids, diterpenes, flavonoids, saponins and steroids have been found in *putat* plants (Nurul Mariam et al., 2008). According to current research, this species has been used

as natural antioxidants as it can scavenge free radicals and can inhibit tissue damage and degenerative diseases (Ali et al., 2007). *B. acutangula* can be consumed as *ulam* and traditionally used for many diseases such as diarrhea, inflammation, arthralgia, flatulence, and haemorrhoids as an anthelmintic. In India, *B. acutangula* is popular and usually used for medication especially in liver disorders, eye problems, splenic diseases and worm infestation. This plant has a lot of nutrients and benefits, and all the parts can be used including root, leaves, fruit, seed and bark. According to Sultana et al. (2019), compounds that have been isolated from the leaves of *B. acutangula* are acutangulic acid, saponins, acutagenol A, acutagenol B, barringtogenols B, C, and D, stigmasterol, βsitosterol, and β-amyrin. It was also reported to contain antioxidant, phenolic compounds and hepatoprotective activities in the leaves of the plant.

2. Discussion

2.1. Nutritional Content

Proximate analysis is needed to evaluate the nutritional content of the *B. racemosa* and *B. acutangula.* It includes moisture, ash, lipid, protein and carbohydrate contents. Proximate analysis of *B. racemosa* showed higher content in moisture, carbohydrate and ash and indicates best sources of energy and high mineral content while *B. acutangula* is higher in protein content. The approximate percent composition of moisture (70.52%), ash (0.96%), fibre (1.38%), protein (2.54%) and carbohydrate (25.71%) in *B. racemosa* while for *B. acutangula*, only carbohydrate (9.85%), protein (13.13%) and ash (7.7%) were analysed quantitatively (Nurul Syafizan & Rabeta, 2018; Vaidya & Shingadia, 2017; Kathirvel & Sujatha, 2012).

Phytochemicals are commonly known as secondary metabolites and have low molecular weight. It is produced by plants in a small amount by several chemical pathways. Recent studies reported that phytochemicals can give a lot of benefits to consumers, especially in human cells. The flavonoid content in *B. racemosa* leaves using methanol extraction is from 83.7 mg/g until 239.35 mg/g. Meanwhile, 13.21 mg/g to 109.52 mg/g of flavonoid contents were reported in *B. acutangula*. The phenolic compounds can be found in most of the plants and play as antioxidant agent as it has redox properties and a good electron donor (Johari & Khong, 2019). Based on the data collected, phenolic content in *B. racemosa* leaves is in range (146 mg/g-1585.20 mg/g) (Nurul Syafizan & Rabeta, 2018; Kong et al., 2012). Kathirvel and Sujatha (2012) used several types of solvent extraction to estimate the phenolic content, and methanol extraction produced the highest yield of the content which is 79.71 mg/g in *B. acutangula.* Several studies reported presence of ascorbic acid in leaves of *B. acutangula* in the range of 16.35 mg/g-79.69 mg/g while *B. racemosa* reported to have ascorbic acid in the range of 42.7 mg/g-88.9 mg/g. Tannins are the substances that have astringent properties that are commonly found in plants such as at leaves, woods and bark. Based on study, leaves of *B. acutangula* and *B. racemosa* contained tannin compounds. Kathirvel and Sujatha (2012) reported that tannin content in leaves *B. acutangula* from various solvents are 15.39 mg/g-105.52 mg/g. 105.52mg/g tannin in *B. acutangula* in methanol extraction is the highest value while *B. racemosa* contained 33.11 mg/g of tannin by Nurul Syafizan and Rabeta (2018). Tannin content in *B. racemosa* using aqueous solution is reported to have lower value compared to methanol which is 13.38 mg/g.

2.2. Pharmacological activities

Consumption of antioxidant foods is important because oxidants that are present in our body can give harmful effects to human bodies because the oxidant could attack lipid, DNA and protein that lead to critical diseases like cancer, diabetes etc. Leaves of *B. acutangula* are reported to have high antioxidant activity. Based on several studies, the antioxidant activity analysis by DPPH can be summarized in range of 3.83-38.16 µg/mL (Mohan & Anand, 2019; Faruk et al., 2016; Woraratphoka et al., 2012). While the *B. racemosa* leaves reported to have antioxidant and this have been proved by several studies that DPPH inhibition of *B. racemosa* in range of 78.42% - 85.34% (Nurul Syafizan & Rabeta, 2018; Sumazian et al., 2010).

Antidiabetic is an agent that can treat diabetes patients by controlling glucose in blood. Diabetes mellitus is a carbohydrate metabolism complication that is evaluated by the ability of producing insulin to control blood in glucose. The data showed that *B. racemosa* extract can reduce the blood glucose from 398.6 mg/kg to 45.5 mg/kg. This reaction agrees with the statement that *B. racemosa* has the ability to inhibit carbohydrate absorption due to diterpenoids, triterpenoids, pentacyclic and bartogenic acid (Umaru et al., 2018). *B. racemosa* is reported to have antidiabetic properties due to the presence of phenolic compounds. For *B. acutangula*, the antidiabetic activities of the leaves in aqueous extract shown at 500 mg/kg is the most effective as it can reduce the value of blood glucose to 96.24 mg/kg which is below than control sample value.

Both *Barringtonia* species are a good antimicrobial agent. Gonelimali et al. (2018) stated that phytochemicals in medicinal plants such as flavonoids, alkaloids, tannins, and terpenoids, can act as antimicrobial and antioxidant properties. *B. acutangula* could inhibit several types of microorganism and could be summarised as a good antimicrobial agent. Chandra Mo and Anand (2019) mentioned that phytochemicals extracted from the plants can produce effective drugs and less lethal in controlling microbial activities. A study conducted on *B. racemosa* leaves extracts, to evaluate microbial activity against *Mycobacterium smegmatis*. The microorganism can cause tuberculosis disease and affect human's health. Minimum inhibitory concentration was evaluated by analysing the lowest concentration of extracts which means no growth in the sample in *B. racemosa* extract (Mmushi et al., 2019).

3. Conclusion

In conclusion, this review revealed that there is abundance of nutritional content (moisture, protein, carbohydrate, ash, fibre, flavonoid, phenolic, ascorbic acid and tannin) and pharmacological activities (antioxidant, antidiabetic and antimicrobial) of *Barringtonia* species. *B. racemosa* has higher nutritional content in carbohydrate, ash, phenolic, flavonoid and ascorbic acid content while *B. acutangula* only higher in protein and tannin. In terms of pharmacological activities, *B. acutangula* showed higher potential in antioxidant and microbial agents while *B. racemosa* has higher potential in antidiabetic activity.

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A COMPARATIVE REVIEW: EFFECT OF THERMAL AND NON-THERMAL TREATMENT TOWARDS THE PHYSICOCHEMICAL CHARACTERISTICS OF STINGLESS BEE HONEY

Noor Syaza Aqilah Amran[1] and Mohd Hilmi Hassan[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hilmi@uitm.edu.my*

Abstract: Stingless bee or *Kelulut* honey is known to have a higher water content compared to other types of honey that may reach up to 28%. Malaysian Standard has stated that a good quality of *Kelulut* honey shall have a water content of not more than 17%. Hence, many approaches, including thermal and non-thermal treatment, have been done to reduce its moisture content. This is because high water content may lead to quality degradation of *Kelulut* honey. This review aims to compare the effect of both thermal and non-thermal treatment towards the physicochemical characteristics such as moisture content, viscosity, colour, total phenolic content, 5-hydroxymethylfurfural (HMF), diastase activity, and antioxidant activity (DPPH) of stingless bee honey. Numbers of studies reported that both treatments were able to reduce the moisture to a level recommended by the Malaysian Standard. The results also showed that other physicochemical characteristics of stingless bee honey were altered after both treatments, highlighting the changes of honey to become more viscous and darker colour, and increasing in phenolic content. On the other hand, the changes in diastase number and HMF are slightly different. As for thermal treatment, diastase number decreased and HMF increased with the temperature and contrariwise for the non-thermal treatment. To sum up, by implementing the right temperature and processing time, thermal treatment results in a better quality of dehydrated *Kelulut* honey.

Keywords: Stingless bee honey, thermal treatment, non-thermal treatment, physicochemical characteristics

1. Introduction

Honey can be defined as a sweet substance that is naturally produced by the honeybees either from the nectar of plants, from the secretion of living parts of plants, or the excretions of plant-sucking insects on the living parts of the plants. Two main species of bees uniquely produce honey, which are honey bees (*Apis* sp.) and stingless bees (*Meliponini* sp.). There are various species of stingless bees worldwide. The most commonly known species of stingless bee in Malaysia is *Heterotrigona itama*. Honey consists of a complex mixture of simple sugar and other constituents which includes enzymes, amino acids, organic acids, carotenoids, vitamins, minerals and aromatic substances (Da Silva et al., 2016). However, compared to other types of honey, *Kelulut* honey is considered a rare product as it has high moisture and acidity content and low sugar content (Braghini et al., 2019). This contributes to a storage problem faced by the meliponiculture which is rapid alcoholic fermentation that led to quality degradation of honey. Several treatments were conducted towards the *Kelulut* honey to reduce its moisture while preserving its quality. This treatment can be done

in several approaches, such as dehydration, thermosonication, and open and cabinet drying. There is also new research on implementing low temperature drying towards these heat-sensitive materials to ensure that the quality, nutrients, and other qualities will be preserved. Different treatment results in different effects, hence selecting the right treatments is important to preserve the quality of stingless bee honey.

2. Discussion

The quality of *Kelulut* honey can be determined through its physicochemical characteristics. The physicochemical characteristics of honey, in general, depends on four main factors including honeybee associated factors, geographical origin and environmental condition, floral origin, and factors associated with the honey itself. This paper is focused on one of the honey associated factors which are processing consisting of both thermal and non-thermal processing. Application of both thermal and non-thermal treatments towards the honey can alter its physicochemical characteristics such as the moisture content, viscosity, colour, TPC, HMF, diastase activity and antioxidant activity.

For moisture content, both treatments could reduce the moisture to a level recommended by the Malaysian standard. The factors that affect the removal of moisture in *kelulut* honey are the treatment period and either temperature or the power used (Yap et al., 2019). Hence, prolong thermal treatment led to drastic moisture reduction that may reach to as low as 0%. Reducing the moisture content be it thermally or non-thermally causing its viscosity to increase. The increment of viscosity value is not only related to the water content, but also colloidal matters and protein present in honey. Commonly, when honey is treated at a high temperature, denaturation of proteins tends to occur causing the increase of water uptake at the expense of free unbound water present in the honey matrix. Thus, decreasing the free unbound water and lead to an increase in the viscosity of honey. Therefore, it can be concluded that there is a positive relationship between moisture reduction and viscosity of honey.

The colour of *Kelulut* honey is commonly being determined in several ways including the determination of colour intensity by using mAU and by measuring the colour parameters. Thermally treated honey reported the increment of its colour intensity together with the temperature. This might occur because of the degradation of the volatile substance, caramelization of sugar present in the honey, and the production of brown melanoidins as a result of the Maillard reaction. Razali et al. (2019) in their study is determining the colour changes of *Kelulut* honey through the browning index (BI) and both kinds of honey undergone high-pressure processing and thermal treatment resulting in a lower browning index in comparison to the untreated honey. The study indicates that processing can reduced the browning in *Kelulut* honey. TPC in *Kelulut* bee honey can be affected by several factors, including the impact of industrial heat treatment. Previous studies show the effect of thermal and non-thermal treatment on the phenolic compound of *Kelulut* honey where the TPC of honey undergone both treatments are higher compared to the fresh honey. The increment was related to the thermal extraction of phenolic compounds during the dehydration process. Complimentary to the total phenolic content, honey's antioxidant properties are also related to the colour intensity. This is because phenolic content contributes as one of the sources of antioxidants in *Kelulut* bee honey. This can be seen through the results obtained as the observed antioxidant properties and TPC increased together with the colour. Thus, it can be summarized that the darker colour of honey indicates honey with a more significant antioxidant property. In contrast, a study reported that honey samples undergo both dehumidification and microwave treatment which can be considered as non-thermal, results in lower antioxidant capacity compared to the untreated stingless bee honey samples

HMF plays a crucial role in the industry that acts as a quality parameter for the freshness of the honey, indicating any possible exposure to either overheating or a prolonged storage time. Several studies reported that the increment of HMF in thermally treated honey. This is caused by the sugar present in *Kelulut* honey undergone dehydration under an acidic circumstance during thermal treatments. The effect of non-thermal treatment on the HMF content can be seen in the research conducted by Schvezov et al. (2020), pasteurized stingless bee honey results in a higher HMF value compared to dehumidified honey while no changes reported for refrigerated honey. The diastase activity can be described as the enzyme activity of 1g of honey that able to hydrolyse 0.01g of starch at 40 °C within 1 hour (Da Silva et al., 2016). Typically, this value will be reduced by the presence of heat and due to processing and storage time. However, Razali et al. (2019) recorded no significant difference among all samples and this might be associated with the possible recovery of diastase activity after the thermal treatment. The possible recovery of diastase activity could be related to the alteration in the structure of enzymes, therefore affecting their enzymatic activity. Other than that, the insufficient number of activated molecules that were exceeding the energy barrier of the transition state, causing less denaturation to occur, also contributing to these results.

3. Conclusion

Thermal treatments were reported to results in changes such as lowering the moisture content, increasing the viscosity, notable changes in terms of colour, increase in TPC and HMF value, increase in antioxidant activity and decrease in diastase activity. As for the non-thermal treatment, the results are contradictory from one research to another due to the diastase recovery. Although thermal treatments are reported to cause drastic moisture reduction, it can be seen that both treatments (thermal and non-thermal) have the ability to reduce the moisture and water content in stingless bee honey. The results gathered shows that non-thermal treatments work better in preserving the quality of stingless bees honey.

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THE EFFECTS OF HOT AIR-DRIED AND FREEZE-DRIED TREATMENTS ON SHIITAKE MUSHROOM (*Lentinula edodes*): A REVIEW

Nor Syafini Roslan[1] and Naemaa Mohamad[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: naemaa953@uitm.edu.my*

Abstract: The total world production of mushrooms were 11 million metric tons and 73.9% of the production was from Asian region as they are being consumed throughout the world for their specific aroma, texture and taste. During storage and transportation fresh shiitake mushrooms are prone to texture softening thus declining its quality as fresh shiitake have a high-metabolic rate after plucking and have high water content. Thus, two out of the various drying techniques which are hot air-drying (HAD) and freeze-drying (FD) that are being used as a preservation method for shiitake mushrooms were reviewed in this paper. HAD provided a simple drying mechanism to dry food products but the prolonged time and high drying temperature were the major drawbacks as it produced an extensive deterioration of final product structure. While, FD is able to produce a final dried product resembling the fresh product state but has a higher production cost compared to HAD. In this review, the comparison between HAD and FD on the qualities of shiitake mushrooms were discussed. Based on the literature, there is a lack of research being done that describes the qualities such as physicochemical properties, sensorial, nutritional and microbial safety of HAD and FD on shiitake mushrooms. Overall, HAD and FD have their own advantages and limitations, further research should be done to compare and optimize HAD and FD in order to produce good qualities of dried shiitake mushrooms.

Keywords: Shiitake mushrooms, freeze-dried mushrooms, hot air-dried mushrooms, qualities of dried mushrooms

1. Introduction

Freshly harvested mushrooms immediately start to deteriorate after harvesting (Tian et al., 2016). Thus, an appropriate preservation method needs to be applied to extend their shelf life. An optimal drying method is also crucial in order to improve the quality of the mushrooms as each drying method has its own advantages and limitations (Sehrawat et al., 2018; Tian et al., 2016).
Hot air drying and freeze drying methods have their own unique characteristics and drawbacks. Thus, the qualities of dried shiitake mushroom in terms of moisture content, colour, microstructure, volatile composition, sensory properties, nutritional component and microbial after undergoing HAD and FD were discussed.

2. Discussion

2.1. Overview and drying methods

Different methods of drying are associated with their own advantages and limitations. Hot air drying is the simplest and most popular drying method (Cui et al., 2018) but cause many unfavourable changes in plant products (Kurata et al., 2020) Freeze drying in general produces the highest quality of final produce as the dried product usually resembling the original food (Politowicz et al., 2018) but higher in cost.

2.2. Physicochemical properties

HAD products exhibit a lower moisture content compared to freeze-dried products. FD treatment gives the larger volume retention ratio and a fast rehydration rate but exhibits the dry matter lost value. HAD treatment will hugely contribute to the formation of dark colour in the final dried product. While, FD has a better overall colour of the final dried product which is closer to the original colour of fresh shiitake mushroom. Wang et al. (2019) also reported that the increasing of the temperature resulting the surface cellular structure to collapse as shiitake mushrooms that treated by HAD had a tight microstructure as the hyphae, and a less collapsed and more uniform microstructure image was found in the FD sample.

2.3. Sensorial properties

Hu et al. (2021) stated that FD samples show a lower rating for taste despite it can mimic the original taste of fresh mushroom while HAD sample gives more umami taste compared to FD as it has higher EUC (equivalent umami concentrations) (Harada-Padermo et al., 2020). Apart from that, both of the drying treatments provide a different aroma profile for the dried shiitake mushroom (Luo et al., 2021).

2.4. Nutritional properties

FD has a better drying method as it is able to preserve protein content and polysaccharide compared to HAD (Zhao et al., 2019a) and FD treatment can retain a higher vitamin D content compared to HAD treatment.

2.5. Microbiological safety

In terms of microbiological safety, HAD sample was contaminated with bacteria based on the total viable bacterial counts that significantly exceeded the total yeast and mould count even though the value was still permissible by WHO (Pewlong et al., 2019).

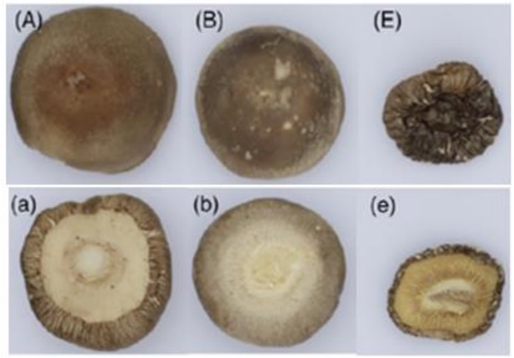

Figure 1. The appearance of shiitake mushroom.
Note: A, B and E means the caps of mushrooms in fresh state and the samples dried by freeze-drying and hot-air drying respectively, a, b and e corresponding to the inner pleats of fresh shiitake and those that undergo freeze-drying and hot-air drying respectively.
Source: Zhao et al. (2019).

3. Conclusion

The qualities of dried shiitake mushroom in terms of moisture content, colour, microstructure, volatile composition, sensory properties, nutritional component and microbial after undergo HAD and FD can be concluded based on the presentation of the scientific researches that have been conducted previously.

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THE PREVALENCE OF LACTIC ACID BACTERIA AS PROBIOTIC IN MALAYSIAN FERMENTED FOOD PRODUCTS: A REVIEW

Norsyafiqka Kamsan[1] and Nur Rabiatul Adawiah Mohammad Noor[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: rabiatuladawiah@uitm.edu.my*

Abstract: Ingestion of probiotics products have been associated with a variety of health advantages and are beneficial to the gut. The most common types of probiotics employed for their beneficial properties are lactic acid bacteria (LAB) which are typically found in fermented food. In Malaysian fermented foods, LAB is already being used especially in non-dairy fermented foods. However, these fermented food products are usually prepared on a small scale which might be exposed to microbial contamination. Numerous research has been conducted to isolate LAB from several varieties of Malaysian fermented food in order to find the ideal strain to use as starter culture. Hence, the review of LAB in Malaysian fermented food products was conducted to identify which fermented food products can be classified as probiotic. For this, studies published and indexed in Google scholar between 2016-2020 were manually searched and analysed. The study includes products from different food groups which are fish, seafood, legumes, vegetables and fruits. This review also highlights the parameter of probiotics screening and the benefits of probiotics in fermented food. Malaysian fermented food products were identified to be a good potential probiotics property with *Lactobacillus* spp. was found in most of the fermented products. *Lactobacillus* spp. can survive the human digestive tract and shows antimicrobial effects towards pathogenic bacteria. Hence, Malaysian fermented foods that are cheap and abundant may be a good alternative for foods with potential probiotics and thus can be considered as functional foods.

Keywords: Probiotic, lactic acid bacteria, fermented food

1. Introduction

Probiotics are living microorganisms, generally beneficial bacteria or yeasts, which can be provided in sufficient quantities to aid the host's health. The probiotic's enzymatic action will alter the constituents of food in a way that benefits the gastrointestinal system. Lactic acid bacteria (LAB), which are commonly found in fermented foods, particularly dairy products, are the most common forms of probiotics used by the food industry for their beneficial qualities (Peng et al., 2020).

LABs are among the most beneficial probiotics because they can enter via food to the host body, persist in the acidic environment of the stomach and then colonise the gut, where the bacteria may produce lactic acid and other necessary nutrients when converting carbohydrate. One of the advantages related to lactic acid produced by LABs is that it lowers the pH level in the host's gut which can hinder the pathogenic microorganism's growth and survival (Peng et al., 2020). Because of a greater knowledge of the role of these bacteria in protecting the host's health, there has been a significant increase in the production of probiotic bacteria-containing products.

However, two main issues related to fermented dairy products are lactose intolerance and the cholesterol content of milk. These are compelling reasons to study the role of non-dairy products in supporting probiotics. In many Asian fermented foods, LAB is already being used especially in non-dairy fermented products like vegetables, fish and meat (Muryany, Salwany, Ghazali, Hing, & Fadilah, 2017). These fermented foods have been devoured for thousands of years before any clear health benefits became truly understood. Numerous researches have been conducted to isolate LAB from several varieties of Malaysian traditional foods. Hence, the data from previous study on lactic acid bacteria in fermented food will be extracted and presented in this paper. Thus, helping other researchers or industry in commercial production of non-dairy probiotic products.

2. Discussion

2.1. Parameter of probiotic screening

Probiotics strains' health effects are mostly determined by their capacity in order to make it through the upper GT, colonise and proliferate in the host intestine. Probiotic bacteria's metabolic products or cell components also should not have or create any pathogenic, toxic, mutagenic or carcinogenic impacts on the host. There are several phases that can have an impact on the viability and survival of probiotic bacteria.

Firstly, bacteria must survive the acidic environment of the stomach. The pH of hydrochloric acid in the human stomach during digestion fluctuates from 1.5 to 4.5, depending on the eating intervals or the variety of the food. Hence, survival at pH 3 is critical since intake with food elevates the pH in the stomach to 3 or higher. Bile produced in the small intestine, is known to decrease bacterial viability by disrupting cell membranes. Hence, 0.3% of bile salts is considered essential and sufficient to screen for resistant strains (Muryany et al., 2017).

One of the more significant selection criteria for probiotics LAB is the ability to adhere to the intestinal mucosa because adhesion to the intestinal mucosa is thought to be a requirement for colonisation to have a positive effect on the host. Then lastly, the ability of an isolate to inhibit or prevent the development of bacterial pathogens. Probiotics must be able to interact directly with disease-causing microorganisms in order to boost the immune system and aid in disease prevention in the gut (Muryany et al., 2017). LAB generates peptides and bacteriocin with inhibitory characteristics that can stop pathogenic bacteria from growing.

2.2. Probiotic potential in Malaysian fermented food products

Malaysia produces a wide range of fermented food, including fish, vegetables, seafood, legumes, fruits, and many more. The study by Muryany et al. (2017) shows that only three pure isolates from fermented fish have probiotic characteristics and further study shows that the three isolates have good adhesion and colonisation on intestinal cells.

The study by Harnentis et al. (2020) demonstrates that LAB isolated from Tapai and Budu can withstand bile salt with a resistance of >30% and also have >84% hydrophobicity ability in the intestines. The study by Tengku Abdul Hamid and Fatin Amysya (2020) also has been done on fermented cassava together with Belacan and found that the majority of these isolates exhibiting broad spectrum inhibition of pathogenic bacteria.

The results from the Novarina, Dinoto, Julistiono, Handayani, and Saputra (2020) indicate that bacteria isolated from tempeh met the standard for probiotic candidate, which include the ability

to produce antimicrobial activity, and the ability to be exposed to simulated gastric juice, bile salt, and stimulated intestinal juice. Next, a study revealed that pickled 'maman', pickled mustard, pickled bitter bean and pickled carrot have a strong antagonistic activity of LAB isolates against the pathogenic strains.

Lasly, the recent study by Khalil, Abd Manap, Mustafa, Alhelli, and Shokryazdan (2018) investigated potential probiotic properties of seven *Lactobacillus* strains isolated from tempoyak. The findings revealed that all the strains were extremely resistant to the low pH 3.0, 0.3% percent bile salts and the in vitro model of gastrointestinal conditions which shows a good potential of probiotics.

2.3. Benefits of probiotics in fermented food products

Probiotics have been recommended as a treatment for numerous health conditions such as lactose intolerance, colon cancer, rheumatoid arthritis, Crohn's disease, food allergies and reducing the duration of acute infectious diarrhoea in babies and children. LAB-containing probiotics can also be utilised to enhance intestinal barrier function, therefore avoiding infection and inflammation (Evivie, Huo, Igene, & Bian, 2017).

Tempeh has been shown in the literature to be effective in treating diarrhoea in monogastric mammals. Tempeh's anti-diarrheal effects may be connected to its antibacterial characteristics. Moreover, several research investigating the anti-diabetic benefits of LAB have been published in past years.

Obesity has been linked to intestinal environmental variables in both humans and mice. It has been reported that the consumption of *L. gasseri* SBT2055 decreased body weight, BMI, abdominal adiposity and hip circumference.

3. Conclusion

Hence, it can be seen that from previous study there are some Malaysian fermented food products that have probiotic and *Lactobacillus spp* especially *Lactobacillus plantarum* is present in most Malaysian fermented food. Comprehensive study should be done to collect sufficient data on humans to provide information to Malaysian consumers so they will have better understanding towards our foods.

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SUPERFOOD IN MALAYSIA: THE BUTTERFLY PEA FLOWER (*Clitoria ternatea* L.)

Nur Atikah Mohamad Rizal[1] and Hisham Mohd Nooh[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hishamnooh@uitm.edu.my*

Abstract: Superfood is a term generally known as a type of food which provides many health benefits and well-being towards living things. It is a term closely related to functional food however the definition for superfood is indefinite as it is usually applied in advertising and marketing. Nevertheless, there are still many types of food that are related to the superfood term as they possess beneficial bioactive properties and high nutritional values. These foods are known throughout the world, but it is very hard to get here in Malaysia. Malaysia is a diverse country which comprises all sorts of food including edible flowers that possesses high nutritional values and bioactive properties. One of the famous known flowers is the butterfly pea flower or is called as *Bunga Telang* in Malaysia. Numerous researches have found that this flower consists of a high amount of bioactive properties and medicinal values but it is not regarded as a superfood. Hence, this review is to clearly identify the superfood term and to claim the butterfly pea flower as a type of superfood here in Malaysia. To accomplish this study, a review was carried out on topics relating to superfood and the butterfly pea flower. This study also includes the applications of the flower in food and the benefits it provides. Obtained findings on the general superfood properties were found to be synonymous with that of the flower which might consider the flower as a type of superfood.

Keywords: Superfood, butterfly pea flower, bioactive properties

1. Introduction

Superfoods are foods which can provide many health benefits towards mankind. The term superfood is closely related to functional foods but may differ in certain aspects. Functional foods are food that pertains to the health and wellness of a person where it helps improve the physical and mental wellbeing by reducing the risk of some diseases or even curing them fully while satisfying the hunger and also providing nutrients to the consumer (Tacer-Caba, 2019).

Even though the term for superfood is unclear, there are still research articles regarding some food characteristics relating to the superfood term. These foods are named for their high concentrations of vitamins, minerals, phytonutrients, and particularly antioxidants (Hegazi et al., 2021; Lakhani, 2011). In Malaysia, it is hard to find food that is deemed as superfood while this country consists of various local foods that have the potential to be one. Among the many sources that we have here in Malaysia includes edible flowers and one of them specifically is the butterfly pea flower (Mahmad et al., 2018).

2. Discussion

2.1. Superfood and its properties

Superfood is described to be a traditional or minimally processed functional food. Superfoods have the common trait of being confined in their culinary and therapeutic use, frequently in far-flung locales. A general definition on superfood is stated as a nutrient dense, antioxidant-rich, natural-food product that is minimally processed and bioavailable in numerous, potent nutritive constituents. A superfood's typical quality includes being immune system supportive and very nutritious, with remarkable concentrations of antioxidants, monounsaturated fats, dietary fibre, phytosterols, essential amino acids, vital trace minerals, vitamins and many more (Proestos, 2018). The main properties exhibited by common superfood is its antioxidant activity followed by other potential properties like antimicrobial activity, anti-cancer activity, antidiabetic activity and many more. Among the commonly known superfoods are goji berries, blueberry, pomegranate, kale, chia and quinoa (Shah et al., 2019; Proestos, 2018).

2.2. Bioactive properties of the butterfly pea flower

Butterfly pea flowers are reported to have various types of phytochemical properties and bioactive compounds that can be beneficial towards human health. Some bioactive compounds mentioned to be available in the butterfly pea flowers are the polyphenols family where anthocyanins are the main compounds. Other types of constituents present in this flower include the ranges of flavanols like kaempferol, quercetin and myricetin (Tacer-Caba, 2019).

The butterfly pea flower is known to have a high antioxidant potential against free radical scavenging activity as has been founded by several antioxidant detection methods such as DPPH radical scavenging activity, the ferric-reducing antioxidant power (FRAP), the reducing capacity of the Folin-Ciocalteu reagent as well as the ABTS activity.

Next, it is also found that the butterfly pea flower has an antidiabetic activity as it reduces the glycemic index of starchy food when incorporated with the extract of the flower. It was also found that consumption of the beverage with addition of sugar can help reduce the plasma glucose and insulin level (Chusak et al., 2018).

Other than that, the flower also shows anticancer potential. Several findings have noted that the extract of the butterfly pea flower shows a cytotoxicity effect against the Human peripheral B-lymphoblast DAUDI cancerous cell lines and a hormone-dependant breast cancer cell line. The constituents of the flower which was found to have been responsible for these anticancer activities are mainly ternatins, kaempferol and quercetin (Nanda, 2019).

Antimicrobial activity was also exhibited by the butterfly pea flower extracts for several types of microorganisms by measuring the inhibition zone diameter present. Some of the bacteria and fungi inhibited by this flower extract are *E. coli, S. aureus, B. subtillis, K. pneumonia, P. aeruginosa, Candida albicans, Rhizopus* and *Penicillium spp*. Other bioactive properties from the flower constituents includes anti-inflammatory activity, the anti-arthritic potential, antiparasitic effects, antiasthma and anti-aging effects (Jeyaraj et al., 2020; Nair et al., 2015).

2.3. Application of the butterfly pea flower in daily food consumption

There are various ways to apply the butterfly pea flower in daily consumption. According to a research, direct consumption of the flower does not give as much as when it is extracted and incorporated in foods. In Malaysia, there are several dishes being prepared using the butterfly pea flower and one of the famous dishes is the *nasi kerabu* where incorporation of the flower extract in the white rice can exhibit beneficial effects. Beverages of the flower is also a good way to obtain the health benefits. New applications of the flower in food are also being developed such as ice-creams and candies to attract better consumers and promote the health benefits of the flowers (Gaytos & Lumagbas, 2019; Mahmad et al., 2018).

3. Conclusion

The study has summarized that superfood is a type of food that can contribute high beneficial health factors towards humans as it possesses various bioactive properties. Among the superfoods and its characteristics, the butterfly pea flower has definite potential to be categorized as a superfood as its constituents and bioactive properties match the standard for a type of superfood. It also has many potential applications to be implemented in daily food intakes which will provide direct health benefits for consumers. Further studies are suggested to be carried out on the butterfly pea flower so that its potential can be applied widely in the food industry.

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CHEMICAL COMPOSITION AND POTENTIAL COMMERCIAL VALUES OF RAMBUTAN (*Nephelium lappaceum* L.) SEED: A REVIEW

Nur Hanani Mohd Nizar[1] and Nurul Azlin Tokiman[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: nurulazlin@uitm.edu.my*

Abstract: Rambutan (*Nephelium lappaceum* L.) seed, which contributes up to 20% of its total fruit weight always being discarded as waste but many recent studies have been done to explore the potential of its commercial value. Rambutan seed has a considerable amount of fat that is beneficial for industrial application. In this review, we summarized the information about the nutritional content, lipid extraction method, anti-nutritional compound, reduction techniques for anti-nutritional compounds and the potential commercial values of rambutan seed. Soxhlet extraction is the common method for lipid extraction either using hexane or petroleum ether as the solvent. The pre-treatment and extraction conditions as well as the moisture content of the rambutan seed could affect the fat yield. In addition, rambutan seed contains considerable amount of beneficial nutrients including carbohydrate (22.18 - 64.19%), protein (8 – 16.21%), fat (6.01-39.09%), fibre (0.30 – 29%), moisture (2.67- 15.30%) and ash (1.06 – 2.4%). On the contrary, the presence of anti-nutritional compounds in the rambutan seed has contributed to its bitterness and toxicity. These include tannins, saponins and phenolic contents which can be reduced through fermentation, roasting or maceration techniques. Findings show that rambutan seed is highly potential as functional foods and further research can be carried out to extend the utilisation of rambutan seeds. The objectives of this review are to synthesise the research findings on the chemical composition and potential commercial values of rambutan (*Nephelium lappaceum* L.) seed.

Keywords: Rambutan seed, lipid extraction, nutritional, anti-nutritional, application

1. Introduction

Rambutan (*Nephelium lappaceum* L.) is a seasonal fruit that originated from tropical countries especially in Southeast Asia including Malaysia, Indonesia and Thailand (Wahini et al., 2018). In Malaysia, rambutan fruit will be harvested twice per year (July-September and December-February) (Chai et al., 2018b). Rambutan comes from the Sapindaceae family together with longan (*Dimocarpus longan*), lychee (*Litchi chinensis*) and pulasan (*Nephelium mutabile* Blume) (Chai et al., 2018a). Basically, rambutan comprises 38.6 to 70.8% of peel, 19.1 to 45.9% of pulp and 8.3 to 20.3% seed which the percentage varies depending on the species (Chai et al., 2018a). Either it is freshly eaten or being processed into another form of food products, only rambutan flesh or pulp will be consumed while their by-products which include the peel and seed will be discarded and disposed of as waste. Due to this factor, many researchers had figured out several alternatives in order to utilise the discarded by-products into something beneficial. Hence, this review will discuss the nutritional value, lipid extraction methods, anti-nutritional compounds and its reduction,

together with the applications of rambutan seed in the food and non-food industry.

2. Discussion

2.1. Nutritional value of rambutan seed

Dried rambutan seeds exhibit high amounts of macronutrients needed in the human diet, which are carbohydrate, protein and fat (Mahmood et al., 2018). Based on the previous studies, rambutan seed contains the highest amount of carbohydrate with 22.18% to 64.19%, followed by fat (6.01% to 39.09%) and protein (8.00% to 16.21%) (Manaf et al., 2013; Fila et al., 2013; Wahini et al., 2018; Onana et al., 2019). Based on these findings, it can be observed that a considerable amount of nutritional values in the rambutan seed, especially its fat content can be further utilised in various applications since the amount of fat found can be reached up to 39.09%. Nevertheless, the different value obtained in those studies might be because of several factors including the method used in analysing the fat content and type of rambutan seed selected.

2.2. Lipid extraction of rambutan seed

Significant amount of fat in rambutan seed can be a promising alternative for fat replacer and other usage in various applications. Due to its special properties, the right method of extraction is crucial in order to make sure that the highest yield of fat will be obtained. Most of the researchers had chosen the Soxhlet method extraction either by using hexane or petroleum ether as solvent. The range of percentage yield obtained by using hexane and petroleum ether as solvent are between 24.62% to 37.90% and 33.03% to 39.25% respectively. Nevertheless, the result cannot be directly compared since several factors have contributed to its percentage fat yield which include moisture content and pretreatment method. However, Buck and Barringer (2007) mentioned that hexane is better than petroleum ether due to its more non-polar and high stability.

2.3. Anti-nutritional compounds in rambutan seed

Anti-nutritional compounds found in rambutan seed are saponin, alkaloid, tannin, phytate, phenol, oxalate and flavonoid (Febrianto et al., 2013). There were many researchers who studied the presence of saponin, tannin and phenolic contents in the rambutan seed. These anti-nutritional compounds contribute to the toxicity and bitterness of rambutan seed causing it undesirable for consumption. Besides, this compound can react with nutrients and prevent them from being absorbed in the human body (Melini & Melini, 2021). Overall, the highest range of anti-nutritional compounds are total phenolic compounds (3.56 – 36.53 mg GAE/100 g) followed with tannin (4.40 – 26.68 mg CE/100 g) and saponin (0.44 – 18.96 mg soya saponin/100 g).

2.4. Reduction of anti-nutritional compound in rambutan seed

Since the availability of anti-nutritional compounds in the rambutan seed contributes to its bitterness and astringency, many researchers have carried out studies on this area in an effort to ensure that rambutan seed can be accepted for human consumption. According to several findings, most of the researchers had conducted fermentation, roasting and maceration in solutions to get rid of the alkaloids. The result showed that the fermentation method for eight to ten days produced the highest reduction rate for saponin (33-76%), tannin (28-60%) and total phenolic content (59%) (Mehdizadeh et al., 2015; Wahini et al., 2018; Chai et al., 2019a, 2019b, 2019c).

2.5. Rambutan seed application in food and non-food industry

In food industry, the rambutan seed can be processed into rambutan seed powder and produced into multi-purpose flour in cooking (Wahini et al., 2018). This has been applied by Mauren et al. (2021) where they had made biscotti, a type of Italian pastry and showed high acceptance value by the consumers. Besides, rambutan seed could act as cocoa butter substitute or alternative (Febrianto, 2013; Chai et al., 2019c) and also coagulant in water treatment by reducing the iron and manganese concentrations in ground water (Yap et al., 2017). On the other hand, in non-food industry, it was discovered that rambutan seed extracted fat could produce biodiesel through transesterification process (Jahurul et al., 2020) and also bar and liquid soaps through saponification process with combination of other vegetable oils including palm oil, olive oil and castor oil (Lourith et al., 2016).

3. Conclusion

In conclusion, it was found that the rambutan seed contains a considerable amount of lipids which is beneficial for the applications in the food and non-food industry. It is also recommended that further research needs to be carried out to extend the utilisation of rambutan seeds while getting rid of any undesirable components in the rambutan seed for desirable consumption.

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A REVIEW OF ANTIOXIDANT POTENTIAL OF PURPLE SWEET POTATO (*Ipomoea batatas L.*): EFFICACY OF BIOACTIVE COMPOUND IN REDUCING HYPERTENSION

Nur Hanis Jaiman[1] and Nur Rabiatul Adawiah Mohammad Noor[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: rabiatuladawiah@uitm.edu.my*

Abstract: Hypertension is a frequent worldwide health concern and a well-known cardiovascular disease risk factor. This illness is dependent on medicines which can cause a long-term effect. In recent years, purple sweet potato has been employed as an anti-hypertensive agent to prevent cardiovascular disease due to antioxidant activity and anthocyanin content in purple sweet potato. This study determines the efficacy of antioxidant potential in purple sweet potato *(Ipomoea batatas L.)* in reducing hypertension. Bioactive agents such as phenolic and anthocyanin will act as antioxidants and anti-hypertensive. In particular, the maximum extraction of the total anthocyanin and phenolic contents has been done by the ethanol extraction technique. Antioxidant activity of purple sweet potato was determined by 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical scavenging activity and ferric reducing power activity (FRAP) assay. The findings show that anthocyanins compound in purple sweet potato has a hypotensive effect on lowering systemic blood pressure and malonaldehyde (MDA) levels in the blood. The role of antioxidant activity in purple sweet potato includes regulating the mechanism of imbalance between free radicals, the cycle of oxidative stress in the body and indicative of lipid oxidation or oxidative stress. Consequently, a further study should explore the significance of antioxidant-active chemicals from purple sweet potatoes to promote health benefits in plant-based foodstuffs and promote natural antioxidants.

Keywords: *Ipomoea batatas* L., purple sweet potato, anthocyanin, hypertension, natural antioxidant

1. Introduction

Purple sweet potato (*Ipomoea batatas* L.) which contains peonidin, pelargonidin and cyanidin were the phenolic compounds found that acts as antioxidants. Bioactive compounds in purple sweet potato are known as anthocyanin The action of free radical scavengers correlates the phenolic compounds found in purple sweet potato with their chemical activities to reduce the properties of electron-gating agents. Recent studies have reported that high anthocyanin content in purple sweet potatoes was more stable than strawberry, purple cabbage and other plants. Salawu et al. (2015) proved that purple sweet potato can achieve almost three times better its antioxidant activity than plant components. Studies by Pouvreau et al. (2018) stated that inflammation and oxidative stress are the critical factors associated with hypertension and diabetes type 2. Concerning this, a study has been done on the protective effects of anthocyanin extract from purple sweet potatoes on MDA level of sample (rat) while determining the antioxidant capacity of purple sweet potato in reducing hypertension which is mainly caused by cardiovascular disease.

2. Discussion

Two major substances in purple sweet potatoes were anthocyanins and phenolic acids. Anthocyanins play a substantial anti-cancer effect through its antioxidant properties and anti-inflammatory activities to induce the cell proliferation inhibition, cell cycle arrest and apoptosis in specific cancer cells. Studies have shown that the main components of anthocyanin were cyanidin and peonidin that afford thermal and ultraviolet resistance and its antioxidant potential. While phenolic acids in purple sweet potato are chlorogenic, dicaffeoylquinic, caffeic and ferulic acid. Phenolic acids are very important in the human system as they are easily absorbed by the digestive tract walls which act as antioxidants and prevent cell damage. Phenolic content will determine its antioxidant effects in purple sweet potatoes. Tang et al. (2015) explained that value of phenolic content in purple sweet potato is 16.8±0.27 mg GAE/g is the highest while Wong and Tan (2020) reported that phenolic content ranged were from 279.76±24.78 µg GAE/g DW. Different anthocyanin content in purple sweet potatoes were recorded at different time and temperature as the highest was at 70°C heating temperature for 5 minutes with 215.08 mg/L with antioxidant activity of 90.63%.

Table 1. Total anthocyanin in purple sweet potato extract at different time and temperature.

Time	Heating Temperature		
	70ºC	80ºC	90ºC
5 mins	215.08 mg/L	181.01 mg/L	137.93 mg/L
10 mins	203.55 mg/L	175.00 mg/L	114.88 mg/L
15 mins	186.19 mg/L	148.28 mg/L	101.86 mg/L

Source: Dwiyanti et al. (2018).

The anthocyanin in purple sweet potato may act as an antioxidant in preventing oxidative stress due to the imbalance between free radicals. Thus, phenolic molecules are very crucial in protecting oxidative damage. Antioxidant activity of purple sweet potato can be measured by using 1,1-diphenyl-2-picryl-hydrazyl (DPPH) free radical scavenging activity of purple sweet potato based on the electron transfer mechanism with highest value of 27.8±0.34 µmol TE/g (Tang et al., 2015) while recent studies reported that purple sweet potato peel with 1.12±0.01 µmol TE/g is higher than purple flesh sweet potato with 0.24µmol TE/g. Antioxidant activity by ferric reducing power activity (FRAP) which turned ferric ion (Fe^{3+}) to ferrous ion (Fe^{2+}) formed. Zhu et al. (2010) reported that the highest FRAP assay of antioxidant purple sweet potato peel with 6.18±0.01 in Ea3-1 genotypes. Hypertension is a risk factor for cardiovascular disease where the blood pressure remains elevated for an extended period. The increment of hypertension cases is common in low-middle income nations due to lifestyle and food diet. Tsiropoulou et al. (2016) stated that oxidative stress which is an imbalance between pro-oxidants and antioxidants, causes endothelial dysfunction which results in vascular or tissue damage. Excessive ROS production resulted in protein oxidation and dysregulated cell signaling. In addition to inflammation, the processes of proliferation, apoptosis, and migration play a role in poor vascular function, cardiovascular remodeling, renal failure, immune cell activation, and sympathetic nervous system excitation in patients with hypertension. Herawati's findings are consistent with other studies that antihypertensive anthocyanin in purple sweet potato showed a reduction in oxidative stress. She

proved that rats given had a larger reduction in MDA levels in the blood, liver and renal system than rats given a purple sweet potato extract after 35 days of treatment.

Table 2. Malonaldehyde (MDA) levels in rats after 35 days of treatment.

Treatment group	Blood MDA (mmol/L)	Liver MDA (nmol/g)	Renal MDA (nmol/g)
Healthy	$2.32{\pm}0.14^{a}$	$3.55{\pm}0.23^{a}$	$2.97{\pm}0.12^{a}$
Hyperglycemic	$8.38{\pm}0.22^{d}$	$9.61{\pm}0.18^{d}$	$8.75{\pm}0.13^{d}$
Hyperglycemic + low dose APSP extract	$3.52{\pm}0.11^{c}$	$5.85{\pm}0.19^{c}$	$4.17{\pm}0.17^{c}$
Hyperglycemic + high dose APSP extract	$2.78{\pm}0.13^{b}$	$4.36{\pm}0.12^{b}$	$3.78{\pm}0.20^{b}$

Source: Herawati et al. (2020).

3. Conclusion

It can be concluded that the consumption of purple sweet potato significantly helps in reducing cardiovascular disease such as hypertension. Due to their antioxidant potential, including bioactive compounds, especially flavonoid (anthocyanin) and phenolic acids, indicated their effective potential and treatment in lowering the malonaldehyde (MDA) level in blood, liver and renal other than a reduction of oxidative stress and endothelial dysfunction. Future studies should explore the toxicological effects of using purple sweet potato as a natural antioxidant. Additionally, clinical trials on patients are needed to test the viability of purple sweet potato since recent studies on animals have raised some doubts.

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EDIBLE NANOCOATING: THE PROPERTIES OF DIFFERENT CASTING METHODS AND DIFFERENT TYPES OF NANOPARTICLES INCORPORATED WITH POLYSACCHARIDES-BASED MATERIALS

Nur Haznina Haron[1], Noor Asnida Asli[3,4], and Nadya Hajar[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[3]*NANO-SciTech Lab, Functional Materials and Nanotechnology Centre, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*
[4]*Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*

**Corresponding author: nadya1844@uitm.edu.my*

Abstract: Good quality foods, such as fresh fruits can be preserved by using nanotechnology which will prolong the shelf-life of the foods. Nowadays, environmental pollution and increment of food waste issues are concerned by the world community. Consequently, several studies have focused on developing and applying nanocoating technology based on edible and biodegradable materials. This review discusses the properties of solvent and extrusion of casting methods and the properties of different types of metal nanoparticles incorporated in polysaccharides, a biopolymers material. Casting is defined as a process of pouring a liquid material, such as plastics or metals into a mould and allowing it to dry and hard. The different casting methods will affect the bubble formation, water vapour permeability, and tensile strength properties of the coatings or films. Metal nanoparticles such as zinc oxide, silver, and titanium dioxide nanoparticles have become an interesting component of a biodegradable biopolymer coating involving polysaccharide-based materials. Polysaccharides-based materials such as chitosan, pullulan and cellulose based-materials are used to form edible coatings or films that have excellent film-forming properties. The incorporation of nanoparticles into polysaccharides-based coating or film leads to the development of nanocoating or films with improved antibacterial, antifungal, mechanical, and water-resistant properties. The nanocomposite polysaccharide incorporated with zinc oxide nanoparticles is the most effective in enhancing the antibacterial, antifungal, mechanical and water-resistant properties of the coatings or films which maintain the quality, extend the shelf-life and decrease food waste.

Keywords: Zinc oxide, silver, titanium dioxide nanoparticles, polysaccharides, biopolymer nanocoating properties

1. Introduction

The increase in food waste has always been a global issue. The development of nanotechnology in food packaging based on edible polysaccharides (PS)-based materials and nanoparticles (NPs) will become a new trend in food industry. The NPs of zinc oxide (ZnO), silver (Ag) and titanium dioxide (TiO_2) are selected to study their effect on the antibacterial, antifungal, mechanical and water-resistant properties of the edible PS-based coating or films, for example chitosan, cellulose and pullulan. Post harvested fruits most likely to be infected by fungi, for example, mangoes are infected with anthracnose disease caused by fungi *Colletotrichum gloeosporioides.* The

incorporation of NPs will affect and improve the functional properties of the edible and biodegradable nanocomposite coating on foods, especially fresh fruits. Thus, it helps to reduce the environmental pollution and food waste.

2. Discussion

2.1. Properties of solvent casting and extrusion casting methods

In solvent casting, the drying of polysaccharides (PS)-based films is the best at ambient temperature with airflow on in a hood to get a bubble-free film (Pavinatto et al., 2019). The plasticization of chitosan-glycerol films is better because there are no clusters and pores are observed. The addition of plasticizers can improve the wettability and water permeation of PS-based material films. In extrusion casting, the chitosan films produced at 120°C and 130°C do not develop bubbles or cracks (Pelissari et al., 2011). The opacity of films is negatively affected by the screw speed. The blow-up ratio of the films is positively affected by the die temperature (extrusion temperature sensored by the internal sensor during the film casting) and screw speed. The tensile strength of films is negatively affected by the die temperature and screw speed. The screw speed positively affected the water vapour permeability (WVP) of the films, while die temperature was negatively affected the WVP of the films.

2.2. Antibacterial and antifungal properties of nanocoating polysaccharide incorporated with zinc oxide, silver and titanium dioxide nanoparticles

The antibacterial activity of PS-based nanocomposite films against gram-negative bacteria is higher than gram-positive bacteria because the peptidoglycans layer of gram-positive bacteria is thicker than gram-negative bacteria (Jamróz et al., 2019). Moreover, the larger surface area of NPs also will increase the generation of relative oxygen species (ROS) and hydrogen peroxide (H_2O_2). The excellent antifungal activity of polysaccharide-TiO_2 nanocomposite was greatly induced by UV light (Siripatrawan & Kaewklin, 2018). Hence, the incorporation of ZnO, Ag, and TiO_2 NPs into PS-based films will enhance their antibacterial and antifungal properties.

2.3. Antimicrobial mechanism of edible coating film with nanoparticles

The main antimicrobial mechanism is the electrostatic binding between negatively charged of the outer membranes of the bacterial cell and positively charged of the biopolymer (Xing et al., 2019). Next, the antimicrobial mechanisms of edible polysaccharide-based coating or films with NPs depends on the properties of the nanoparticles (size, surface area, concentration and photocatalytic properties) besides on the species and properties of the bacteria (Jamróz et al., 2019). The application of UV light also plays an important role in photocatalytic degradation or photocatalysis of TiO_2 NPs (Siripatrawan & Kaewklin, 2018).

2.4. Mechanical and water resistant properties of nanocoating polysaccharide incorporated with zinc oxide, silver and titanium dioxide nanoparticles

The incorporation of ZnO NPs and TiO_2 NPs showed the highest effectiveness in enhancing the mechanical properties of the PS films by increase both the tensile strength and Young's modulus, but decrease the elongation at break. Meanwhile, the Ag NPs is less effective to enhance the

mechanical properties of PS-based coating or films but it can be improved with the aid of an active agent, such as lignin. Usually, the parameters used to determine the physical properties of water-resistance of coating or films were determined by moisture or water content, moisture absorption, water solubility and water vapour permeability. The water-resistance of PS-based films increased with the well dispersion of nano-scale ZnO NPs and TiO_2 NPs. But, Ag NPs is less effective to enhance the water-resistant properties of PS-based coating or films.

2.5. Practical applications of nanocoating or films of polysaccharides incorporated with zinc oxide, silver and titanium dioxide

The surfaces of the papaya flesh covered with edible chitosan-ZnO NPs nanocomposite coating lead to inhibition of microbial growth (Lavinia et al., 2020). The infection of anthracnose disease on mango in chitosan-Ag NPs composite coating treatment is lower than chitosan composite coating (Chowdappa et al., 2014). Next, chitosan impregnated with TiO2 NPs is applicable to slow down the decaying rate and prolong the shelf life of mangoes (Xing et al., 2020).

3. Conclusion

The solvent and extrusion casting methods show different properties because of different temperatures and processes involved in the production of the films. In addition, the nanocomposite PS-based incorporated with ZnO NPs is the most effective in enhancing and improving the antibacterial, antifungal, mechanical and water resistant properties of PS-based coating or films. It is important to study the migration of NPs (ZnO, Ag and TiO_2 NPs) from the nanocomposite coating and films onto the foods and their effects on human health if consumed.

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EDIBLE NANOCOATING: THE EFFECT OF DIFFERENT TYPES OF NANOPARTICLES INCORPORATED WITH POLYSACCHARIDE-BASED MATERIALS ON ANTIBACTERIAL AND ANTIFUNGAL ACTIVITY

Nur Izzah Azhar[1], Noor Asnida Asli[3,4], and Nadya Hajar[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[3]*NANO-SciTech Lab, Functional Materials and Nanotechnology Centre, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia.*
[4]*Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*

**Corresponding author*: *nadya1844@uitm.edu.my*

Abstract: The demand rate for fruits supply increases over the years due to their nourish nutrients and rich flavours. However, they can be easily deteriorated by bacterial and fungal activities when stored at room temperature. Regarding this matter, it is necessary to rejuvenate the quality of the fruits by reducing the possibilities of the infection from happening. Polysaccharide-based material is considered as an edible source that promises protection from microbes' contamination if coated on the fruits. Several recognisable metal nanoparticles such as zinc oxide, silver and titanium dioxide nanoparticles could alter the interaction of microorganism development when incorporated with polysaccharides-based materials. The purpose of this review is to study the effect of different types of nanoparticles incorporated with polysaccharide-based materials, for example, chitosan, cellulose, guar gum, xanthan gum and sodium alginate on antibacterial and antifungal activity. The combination of these elements helps to inhibit the growth of microbial colonies and fungus such as *Staphylococcus aureus*, *Escherichia coli*, *Bacillus subtilis*, *Phyllosticta psidicola*, *Colletotrichum gloeosporioides*, *Alternaria alternata*, mould, and yeast. The observation methods of the microorganism were done based on disk-diffusion agar, pour plate agar, nutrient agar, potato dextrose agar, plate count agar and physical counts according to lesion rot on the fruit's surface. Hence, the bacterial and fungal activities can be inhibited when the nanoparticles are incorporated with polysaccharide-based materials and result in increasing the shelf life of the fruits.

Keywords: Edible nanocoating, metal nanoparticles, polysaccharide, antibacterial, antifungal

1. Introduction

Breaking down of chemical structures drives the spoilage of fruits to happen. Most of the fruits are susceptible towards the internal and external changes including the temperature, storage, moisture, pH as well as the microbial activity. The way fruits deteriorate is by releasing the unpleasant smell, discolouration, loss of flavour and firmness. The use of nanoparticles in agriculture and food industries are reported to offer better quality and improve the shelf life of fruits. One of the nanoparticles' properties is that they act as antibacterial and antifungal agents.

Zinc oxide (ZnO), silver (Ag) and titanium dioxide (TiO_2) nanoparticles combined with polysaccharide-based materials are the most studied nanocoating due to their excellent attributes shown on the fruits. Fruit diseases such as anthracnose, black mould and fruit rot can be inhibited on the edible nanocoated fruits. Every metal nanoparticle has its own functional properties. So, the objectives of this review are to determine and analyse the different types of nanoparticles ($ZnO/Ag/TiO_2$) incorporated with different polysaccharide-based materials (chitosan, cellulose, xanthan gum, guar gum, and sodium alginate) on antibacterial and antifungal activity coating on fruits.

2. Discussion

2.1. Types of polysaccharide-based materials

Several common polysaccharide-based materials widely used as coating solutions in the food industry are chitosan, cellulose, xanthan gum, guar gum and sodium alginate. They have the ability to maintain firmness, delay the ripening process and act as anti-browning agents. In recent research, they are integrated with $ZnO/Ag/TiO_2$ nanoparticles to promote better protection on behalf of physical, chemical and biological quality of the fruits.

2.2. Properties of edible nanocoating

The properties of this edible nanocoating are similar among the different polysaccharide-based materials incorporated with $ZnO/Ag/TiO_2$ nanoparticles. Most researchers reported that they are safe, non-toxic, can improve the mechanical barrier and physical properties of the coated fruits. Furthermore, those three nanoparticles can encourage the action of antibacterial and antifungal to defend the fruits from microorganism development. ZnONP and TiO_2NP propose natural photocatalytic effects while AgNP performs electrostatic force to release the free radical ions and they penetrate into microbial cells (Lavinia et al., 2020; Chand et al., 2020).

2.3. Effect of different edible nanocoating on antibacterial activity

Reactive oxygen species (ROS) are generated by photocatalysis processes that happen with the presence of $ZnO/Ag/TiO_2$ nanoparticles and UV light. The free radicals that were originally released by ROS start to attack the cell wall of bacteria or fungi then shut off the reproduction of their DNA. The disruption of internal structure continues to happen by breaking down the membrane thus increasing the cell permeability. Oxidative stress then takes place after the penetration of free radicals hence killing the bacteria cell. The observation of microbial growth is done on agar and also direct count. Nanocoating is capable of securing the quality of banana, strawberry and blueberries (Qin et al., 2019; La et al., 2021; Xing et al., 2021).

2.4. Effect of different edible nanocoating of antifungal activity

Fungi initiate the development of mould and black spots that are physically seen on the fruit's peel. The action of antifungal activity on coated fruits has a similar mechanism as the antibacterial activity. However, it depends on the toxins content of the fungi. The killing of the fungal spores poses to drive the membrane destruction, then causes the responsible cell to die. The reduction of fungal growth on nanocoated persimmon, tomatoes and mangoes were claimed in recent findings (Saekow et al., 2019; Xing et al., 2020).

2.5. The best material as edible nanocoating

Regarding the outstanding function of antimicrobial activity of nanoparticles, AgNP is stated to be the finest compound to fight against microbes. Besides, chitosan provides the best physical properties such as reducing weight loss, maintaining the colour and firmness to the coated fruit as compared to other reviewed polysaccharide-based materials. As a result, this review indicates that chitosan-AgNP is the most decent corporation as an edible nanocoating to coat on fruit surface.

3. Conclusion

The application of edible nanocoating on the fruits is proven to hinder the development of bacteria and fungi. The proliferation of pathogen cells can be inhibited with the presence of ROS which at first is generated by nanoparticles itself. The incorporation of coating material might as well improve the physicochemical and biological features of the fruits. Thus, the best nanocoating combination for fruit coating is chitosan-AgNP. This nanotechnology topic is fiercely explored by most researchers in current days to dig for greater discovery. Therefore, further study is needed relating to ozone treatment incorporated with sonication, the toxicity of nanocoating film and the antifungal effects on coated fruits when coating with ZnONP and polysaccharides-based materials.

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A COMPARATIVE REVIEW: PHYSICOCHEMICAL PROPERTIES AND ANTIOXIDANT ACTIVITIES OF STINGLESS BEES (*Heterotrigona itama* & *Geniotrigona thoracica*) AND HONEY BEE (*Apis mellifera*) HONEY

Nur Nael 'Awateef Harun[1] and Mohd Hilmi Hassan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hilmi@uitm.edu.my*

Abstract: Numerous studies regarding the physicochemical and antioxidant properties of stingless bee honey have been carried out and commonly compared with the honey bee, *Apis mellifera* honey. The various compositions in each species may affect the purity and originality of the honey thus comparing the honey properties are essential. The properties are capable of determining the quality of honey. This review evaluates and compares the physicochemical and antioxidant properties of honey samples produced by three different bee species namely *Heterotrigona itama*, *Geniotrigona thoracica* and *Apis mellifera*. The bee species were classified into two major groups, stingless bee, *H. itama* and *G. thoracica* and honey bee, *A. mellifera*. Both physicochemical and antioxidant properties of honey were different according to their bee species. The physicochemical analysis includes moisture content, ash content, colour characteristic, pH, free acidity, total soluble solids (TSS), and several antioxidant analysis including total phenolic content (TPC), total flavonoid content (TFC), free radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP). The results from the different authors showed that stingless bee honey possessed significantly higher moisture content, ash content, colour characteristic, free acidity, TPC, TFC, DPPH and FRAP compared to the honey bee, *A. mellifera* honey which exhibited higher pH and total soluble solids (TSS). Among the stingless bee honey samples, *H. itama* honey exhibited higher ash content, colour characteristic, free acidity, TPC and FRAP while *G. thoracica* honey possessed higher moisture content, pH, total soluble solids (TSS), TFC and DPPH. Bee species fundamentally affect the physicochemical properties and antioxidant activities of honey samples.

Keywords: Physicochemical characteristics, antioxidant properties, *Heterotrigona itama*, *Geniotrigona thoracica*, *Apis mellifera*

1. Introduction

Honey is a natural supersaturated solution that is thick, sweet, and has golden coloured liquid produced by bees extracted from the secretions of plants. Bees are insects with wings that are closely related to wasps and ants. Approximately 20 000 different bee species have been discovered all over the world (Patel et al., 2021). Honey can be obtained from two types of beekeeping, stingless bees and honey bees. Stingless bee is commonly found in the tropical and subtropical regions around the globe, mainly in Australia, Africa, Southeast Asia, and South America (Kek et al., 2018; Shamsudin et al., 2019; Wong et al., 2019). Stingless bees are lacking functional stingers. Throughout the Malaysia region, *Heterotrigona itama (H.itama)* and *Geniotrigona thoracica (G. thoracica)* are reported most commercially producing honey. Honey

bees consist of 11 total species in the single genus *Apis*. Among those species, *A. mellifera (A. mellifera)* is the most widely spread species around the world. *A. mellifera* is historically produced and distributed throughout Africa, Asia, Middle East and Europe (Kek et al., 2014). The honey bee is a cultured bee that has functional stingers.

2. Discussion

Properties of honey are essential to be evaluated to determine the quality of honey. The properties are the physicochemical and antioxidant properties. Six (6) physicochemical properties have been reviewed based on several research papers. For moisture content, the amount of water present in honey determines its stability. The results show that *H. itama* and *G. thoracica* possessed higher moisture content compared to the honey bee, *A. mellifera* honey. Between the stingless bee honey, *G. thoracica* honey recorded higher moisture content compared to *H. itama* honey. According to Wong et al. (2019), stingless bee colonies are widely found in the tropical and subtropical regions of the world where the areas have the benefit of receiving abundant rainfall. This causes the stingless bee colonies to be exposed to high humidity hence exhibit higher moisture content. Besides that, determining ash content is crucial for evaluating the mineral content in food. Stingless bees have been reported to exhibit a higher amount of minerals in their honey compared to honey bee honey. Among stingless bee honey, *H. itama* honey exhibited a higher ash value than *G. thoracica* honey. The variations of mineral contents in honey are mainly dependent on the amount of pollen contained in honey. The higher the amount of pollen collected, the higher the mineral content in honey. Furthermore, colour is one of the most important features which can affect consumer's preferences. *H. itama* honey was reported to contain the highest colour intensity compared to other commercial honey in Malaysia (Kek et al., 2014; Maringgal et al., 2019). The available data stated that *G. thoracica* honey recorded a lower colour characteristic value than the *H. itama* honey sample. Honey bee, *A. mellifera* honey, recorded a lower value compared to stingless bee honey. Numerous studies have discovered that the honey colour variation correlates to the floral origin/native plant sources, geographical and botanical origin, minerals, light exposure, contaminating pigments, storage time and the temperature being applied to the honey samples.

pH is a measurable parameter used to measure the acidity and alkalinity of liquid or semi-solid compounds. Based on my review, *H. itama* honey is reported to have the lowest pH value and is followed by *G. thoracica* honey. Honey bee, *A. mellifera* honey recorded the highest pH value. Fuad et al. (2017) has discovered that temperature can be one of the factors that significantly influence the pH value. Low temperature causes the reaction rate of enzymes to drop thus reduces their pH value. Researchers reported that the pH value of *H. itama* honey is lower, thus the capability of honey to forbid the growth of microorganisms will be higher (Kek et al., 2018; Shamsudin et al., 2019). In addition, the free acidity contained in honey shows the presence of organic acids. Based on the reviews, stingless bee honey contains higher free acidity compared to honey bee honey. Honey from *H. itama* species recorded higher free acidity than honey from *G. thoracica* species. The difference in the total free acidity is mainly due to the fermentation process of sugars that convert to organic acids. A study has identified that the free acidity value will become greater when the moisture content in honey is higher. Total soluble solids (TSS) is a parameter to indicate the sweetness of food products. Based on my review, the lowest value of TSS is detected in *G. thoracica* honey, the stingless bee honey. The highest value of TSS is detected in the *A. mellifera* honey, the honey bee honey. Between stingless bee honey, *H. itama*

honey exhibited higher TSS compared to *G. thoracica* honey. TSS shows the relationship between water and sugar content. Stingless bee honey recorded a lower amount of soluble solids due to the high amount of water they contained.

For antioxidant properties, there are four (4) parameters have been reviewed. For the total phenolic content (TPC) parameter, honey with the highest total phenolic content comes from the species of *H. itama*, followed by *G. thoracica* and then *A. mellifera*. Stingless bee honey has been found to exhibit higher TPC compared to honey bee honey. The significant different composition of phenolic contents in honey is affected by the nectar source chosen by the bee species. Factors that contribute the phenolic contents to present in honey are the harvest season, weather, nectar source, botanical resources, floral origins, propolis, mode of storage, harvest technology and processing conditions (Kek et al., 2014; Maringgal et al., 2019; Shamsudin et al., 2019; Wong et al., 2019). Furthermore, flavonoid is a bioactive compound that functions as a superior antioxidant. Honey that recorded the highest total flavonoid content (TFC) is *G. thoracica* honey, followed by *H. itama* and *A. mellifera* honey. Honey bee, *A. mellifera* honey contains lower TFC compared to stingless bee honey. Studies have discovered that the variations of TFC in honey are greatly affected by the botanical origins, bee species, floral species and specific foraging activities. Furthermore, the free radical scavenging activity (DPPH) is used to measure compounds that act as free radical scavengers or hydrogen donors. It can also determine the antioxidant activity of foods. Based on the reviews, honey from *G. thoracica* species recorded a lower DPPH value compared to *H. itama* while *A. mellifera* honey possessed the highest DPPH value among the other two honey. According to several researchers, the variations of DPPH in honey can be due to the differences of phenolic contents and their types. Different geographical locations of nectar sources, floral sources, harvesting time, and seasonal can also be the factors that influence the DPPH in honey. Lastly, ferric reducing power assay (FRAP) is widely known to measure the total antioxidant activity in foods. Based on the results collected, the lowest FRAP value has been observed in the honey bee, *A. mellifera* honey, while the highest FRAP value has been detected in the stingless bee, *H. itama* honey. A high FRAP value indicates high reducing power and strong antioxidant activity. Factors that cause the variations of FRAP could be the different types and concentrations of phenolic and flavonoid compounds in honey.

3. Conclusion

In conclusion, this review demonstrated that the properties of stingless bees and regular bee honey are significantly different. Findings also indicated that the properties of honey are greatly dependent on the bee species. As for a recommendation, an extensive study with a significant number of bee species must be carried out to obtain more perceptions regarding the effect of bee species on the properties of honey.

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A REVIEW ON ALOE VERA GEL AS EDIBLE COATING ON POSTHARVEST ACTIVITIES OF FRUITS

Nur Syafiqah Idzreen Mohd Azam[1], Eddie Ti Tjih Tan[1,2], Nur Rabiatul Adawiah Mohammad Noor[1,2], and Siti Azima Abdul Muttalib[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: sitiazima@uitm.edu.my*

Abstract: Postharvest activity is a key factor that affects the loss of nutritional and quality of fruits which consequently led to agricultural wastage. Therefore, edible coating from polysaccharide-based is widely used to overcome this issue as they act as protective barrier on the fruit's surface against microbial, enzymatic and chemical spoilage. Hence, aloe vera gel (AG) is extensively used as edible coating to provide an optimum preservation effect of fruits. So far, there has been little discussion about the studies of functional properties of AG. This review aims to describe the effectiveness of AG as edible fruits coating concerning the protective barrier and antioxidant agent against the postharvest activity. The findings from this review unveil that the good coating properties of AG is due to the glucomannans that can act both as gel (barrier) and antioxidant agent. On the other side, this study also bring to light regarding the potential toxicity by anthraquinone (aloe-emodin) compound in AG on human health.

1. Introduction

Fruit is known to be a high-demand food due to its practical value and importance in agro-industry (Kuyu & Tola, 2018). The increased demand for fruit is related to the excellent nutrient contents such as minerals, vitamins and fibre (Pareek, 2016). However, the fruit has to face some circumstances in the economic field due to the short shelf life that is affected by several factors such as chemical reactions, microbial infections and physical forces. The factor to be highlighted in this study is due to metabolic and enzymatic activities (chemical reactions) which alter the carbohydrate content, colour, appearance, texture, aroma volatiles, phenolic compounds and organic acid (M. Ibrahim et al., 2017; Tripathi et al., 2016). All these changes indicate that the fruits entering the ripening phase and ready to be harvested and acceptable for consumption. However, under circumstances, it will lead to the reduction of postharvest quality. Therefore, natural edible coating from aloe vera gel (AG) is recommended to apply in order to preserve the postharvest quality longer and slower the metabolic reactions. This study will be beneficial to the consumer and fruit supplier as the coating from AG is edible, non-toxic, less harmful than chemical preservatives and able to reduce wastage (Passafiume et al., 2020). Hence, this review described the functional properties of AG on their property as a barrier and antioxidant agent as well as potential toxicity.

2. Discussion

AG has been studied for its edible coating properties recently for several years. It has been classified as polysaccharide based edible coating. This type of edible coating is good as it brings various characteristics such as perform as a barrier toward gases (oxygen and carbon dioxide) as well as provide a strength for structural integrity on the fruits preserved (Desobry & Arab-Tehrany, 2014). Glucomannans is the main polysaccharide that can be found at the center of aloe vera leaves. Glucomannans is a polymer of glucose and mannose that responsible for the plasticity of the gel which forms as film. Basically, the high amount of water storage in the gel is responsible by mannan. This mannan also can be partially acetylated which later turns to acemannan. The beneficial effects of acemannan's acetyl and hydroxyl groups are shown to have free radical scavenging properties, as well as chelating features and be able to reduce against iron ions (Nicolau-Lapeña et al., 2021). Therefore, AG is good as it can provide both good barrier properties also as an antioxidant agent.

Several studies have shown that aloe vera edible coating is helpful in maintaining firmness and phenolic compounds of the coated fruits. The firmness eventually related to the increasing value of TSS during ripening. During the escalation of TSS value, most of polysaccharide are converted into simple sugar including pectin (cell wall polysaccharide). The analysis of firmness has been reported, where the papaya that has been coated using 30% AG showed only 35.8% loss of the firmness while the control has lost until 78.3% of firmness after 12 days of storage (Farina et al., 2020). Therefore, the coated papaya had lower TSS value and slow ripening process than the control which maintained the firmness. According Chrysargyris et al. (2016) and Mirshekari et al. (2019), the highest concentration of AG contributed to the highest number of phenolic, flavonoid and antioxidant content. Therefore, as the concentration increased, the antioxidant activity increased. A study by Hassanpour (2015) has reported that AG with concentration 50 and 75% possessed the highest amount of phenolic compound and antioxidant capacity after 8 days of storage under cold temperature rather than 25% AG and control sample that were gained slightly lower amount in that analysis. This showed that 50 and 75% AG able to elevate, preserve and slower the reduction of active compounds in the raspberry.

Recent studies have identified an uncontrolled amount and improper of consumption manner of AG anthraquinones can lead to adverse health issue for human body (Guo & Mei, 2016; A. Ibrahim et al., 2019; Liu et al., 2020). A study by Liu et al. (2020) had performed an in vitro cytotoxicity analysis of AG anthraquinones in concerning of liver toxicity in humans. This paper claims that an active compound named aloe-emodin in AG can give toxicity effects and eventually affected liver. However, the issues emerging from this finding of toxicity is related specifically to the high dosage of the anthraquinone (aloe-emodin) with prolong usage which has been determined the unfavorable effects toward human health (Guo & Mei, 2016). The prolong consumption might show an initial symptom before it goes into severe stage such as diarrhea, abdominal pain, vomiting and even worse it could lead to colon cancer or kidney failure.

3. Conclusion

To sum up, AG is a good candidate to apply as edible coating on preservation of postharvest fruits due to the main polysaccharide (glucomannans) and other active compounds that can bring good properties as edible film and antioxidant agent. Despite of all these functional properties, the potential of toxicity from both AGs can be controlled by following the estimated daily intake that

has been approved by authorizes/government as well as by ensuring to perform a proper usage method (consumption/application on skin or surface).

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A REVIEW: INFLUENCE OF PROCESSING TECHNIQUES ON NUTRITIONAL COMPOSITION AND ANTINUTRITIONAL COMPONENTS OF CORN (*Zea mays* L.) KERNELS

Nur Syazana Shahabuddin[1] and Marina Zulkifli[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: marina547@uitm.edu.my*

Abstract: Corn (*Zea mays* L.) has been widely cultivated in Malaysia and it is the most prevalent cereal grains crop globally. The majority of essential nutrients can be found in the kernel parts of the corn which are edible and industrially processed to produce various kinds of food products. However, the presence of antinutritional components in the corn kernels is worrying as they can block the absorption of nutrients. Therefore, this paper aimed to review the processing techniques available in lowering the deleterious effects caused by consuming the antinutritional components such as saponin, tannin, and phytate. Boiling, roasting, fermentation, and germination are the processing techniques being studied. The findings revealed that all processing techniques done on yellow corn kernels caused reductions in the level of antinutritional components as compared to the raw corn kernels. Roasting and germination have the utmost reduction in the level of antinutritional components followed by fermentation, and boiling. Additionally, the processing techniques in enhancing the nutritional compositions are positively proven as it is believed to increase the kernels' protein digestibility, enhance the mineral extractability, and extend the shelf life of the product. Despite consuming antinutrient is reported to be risky, taking them at low concentrations may favourably give positive effects on human health. Obtained results suggested that processed corn kernels could be used in the food industry before processing them into end products. For that reason, more comprehensive research should be carried out in the future to explore the variety of other corn species, especially pigmented corn.

Keywords: Corn kernel, antinutrient, nutritional composition, processing techniques

1. Introduction

Corn (*Zea mays* L.) is also known as maize in some countries is an important annual grain that belongs to the grass family Poaceae and genus *Zea.* An ear of corn consists of an edible and non-edible part which is kernels, husk, and silks. Nowadays, there are many varieties of corn that have been grown but yellow corn is the most common cereal grain crop worldwide. Usually, the unripe corn is eaten raw or cooked, while the mature corn kernels are industrially processed to produce various kinds of products such as corn starch, corn oil, and corn flour that are used in various food preparations (Nawaz et al., 2018).

However, despite their promising nutritional significance, the seed part of corn contains some inherent antinutrients or natural toxicants, limiting their nutritive value by exerting certain deleterious effects. This antinutrients substance interferes with the absorption or utilization of minerals in corn kernels (Samtiya et al., 2020). Several studies conducted showed that levels of tannins, phytate, trypsin inhibitor, and oligosaccharides in mung beans, cowpea, legumes and kidney bean seeds were drastically reduced after heat treatment. Hence, differing from previous research, the variable that will be reviewed is the effect of boiling, roasting, fermentation and germination towards the nutrient and antinutrient components including saponin, tannin, and phytate of the yellow corn kernels.

2. Discussion

2.1. Yellow corn kernels

Yellow corn kernel has a good source of many nutrients including proteins, carbohydrates, fats, and some of the essential vitamins and minerals. Yellow corn kernels have a huge portion of fat content which helps to hold fat-soluble vitamins A, D, E, and K that function as antioxidants and scavenge free radicals for cancer defense (Kaul et al., 2019). Besides, the fat content in the yellow corn kernel is also important because it contains about 45–50% of oil extracted from the germ in the corn kernels part. The extracted oil is beneficial in producing corn oil which can be used for cooking purposes (Kaul et al., 2019). Additionally, yellow corn kernels are high in mineral sources and also small amounts of calcium and potassium that are essential for the formation of red blood cells (Samtiya et al., 2020). Thus, it is crucial to absorb all of the nutrient content in the yellow corn kernel to get its benefit as it is only the main part that is edible and also used in industry for product making.

2.2. Effect of processing techniques on nutritional composition of corn kernels

Most processing techniques such as boiling, roasting, fermentation, and germination will affect the nutritional composition and mineral content of corn kernels due to the heat treatment and activation of enzymes. However, when comparing between types of processing techniques, roasting and germination showed a higher increment of nutrients and minerals. Roasting increased most of the nutrients and minerals except for moisture content. But, a low moisture content is a desirable phenomenon since it reduces the microbial activity of food, and increases the shelf life of food (Eleazu et al., 2021). Boiling only increases the moisture content of corn kernels due to the softening of the cell wall, allowing more water to enter the corn granule by osmosis (Eleazu et al., 2021). Meanwhile, fermentation and germination also show an increase in the mineral contents and some nutritional composition. This is due to the breakdown of complex compounds with non-digestible materials into simpler forms and make them readily bioavailable (Nkhata et al., 2018).

2.3. Effect of processing techniques on antinutritional components of corn kernels

Antinutritional components are heat labile and may be inactivated by processing techniques involving heat generation, microorganisms, and sprouting the seed. The reduction to the barest stage of these undesirable components via processing techniques is vital for lowering the antinutritional substance in the corn kernels. Both heat treatment roasting and boiling was effective in reducing saponin, tannin and phytate content in the corn kernels. Meanwhile, only activation of enzymes through germination positively reduced all of the antinutritional components including saponin, tannin and phytate. Fermentation reduced all antinutritional components except for saponin. This is due to the activation of some enzymes, resulting in decrease antinutritional

components in germinated and fermented yellow corn kernels (Nkhata et al., 2018) and heat treatment period is enough to breaks down the complex antinutrient bonds resulting in lower antinutritional components (Paterne et al., 2019).

2.4. The advantages of antinutrient-depleted foods on human health

Consuming large amounts of antinutrient food poses a health risk. Nonetheless, at low concentrations, the antinutrients may also exert health benefits. Consuming phytates in low amounts have been found to decrease triglyceride levels in the blood, as well as glucose levels after consuming starchy meals (Gemede & Ratta, 2014). Additionally, a low concentration of saponins were reported to be helpful in maintaining liver function, avoiding osteoporosis, and preventing platelet agglutination (Popova & Mihaylova, 2019). Despite this, the balance between beneficial and hazardous effects of plant bioactive and antinutrients relies on their concentration, chemical structure, time of exposure, and interaction with other dietary components (Popova & Mihaylova, 2019; Gemede & Ratta, 2014).

3. Conclusion

The study has shown that processing techniques decrease the level of antinutritional components as compared to the raw yellow corn kernels. Roasting and germination have the utmost reduction in the level of antinutritional components followed by fermentation, and boiling. Processing techniques in enhancing the nutritional compositions are positively proven to increase the kernels' protein digestibility, enhance the mineral extractability, and extend the shelf life of the product. Further research should be carried out to explore the effect of processing techniques on pigmented corn since it is rich in anthocyanins and antioxidants.

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POTENTIAL THERAPEUTIC EFFECT OF CITRUS PEEL COMPONENTS AGAINST CANCER

Nursyifa' Yusri[1] and Hisham Mohd Nooh[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hishamnooh@uitm.edu.my*

Abstract: Cancer is a globally significant death cause. However, drug development for cancer treatment has always been associated with side effects and several limitations in applications. Citrus fruit belonging to the family *Rutaceae* has many health-promoting activities such as anticancer, antitumor, anticarcinogenic, anti-inflammatory and antiproliferative which have been linked with many active compounds while at the same time is highly consumed worldwide. Citrus peels that are generally discarded as waste to the environment can act as potential therapeutic resources in addition to their low-cost and easy availability. Flavonoids are bioactive components in the citrus peel that are largely related to anticancer potential. Among the flavonoid derivatives, particularly flavone glycosides and polymethoxy flavones have shown potent anticancer properties as found in many scientific studies. Action mechanism of flavonoids modulated including apoptosis, metastasis, angiogenesis, cell proliferation and cell cycle regulation. These bioactive rich citrus extracts also have been utilized as a chemotherapeutic agent against the growth of different cancer cells such as breast cancer, colon cancer, prostate cancer, and others. This review highlights new research in the field, especially the nanoparticles from citrus peel used to treat cancer and the signal pathways or action mechanisms modulated by potent compounds in citrus peel on the cancer cell line. Besides, this study also showed the great potential of citrus peel as a plant-based substance to be developed as the source of a chemopreventive agent in suppressing and inhibiting the cancer cells growth. Therefore, further study about the citrus peel potential needs to be conducted.

Keywords: Citrus peel, anticancer, flavonoids, cytotoxic activity, chemopreventive

1. Introduction

Regardless of advancements in illness detection, prevention and treatment strategies, cancer is a severe metabolic syndrome and one of globally significant death causes (Iqbal et al., 2017). The unregulated multiplication of aberrant cells, which causes genetic instabilities and mutations, builds up within cells and tissues, transforming a healthy cell into a cancerous one (Iqbal et al., 2017). The spreading pattern of proliferative cancerous cells can be characterised or developed by several mechanisms such as transformation, proliferation, angiogenesis, apoptosis malfunction, invasion and metastasis (Shirisha et al., 2019).

This deadly disease is associated with several adverse effects that are usually treated with synthetic drugs and treatments (Shafique et al., 2019). However, conventional chemotherapy treatment has the potential to have negative and toxic side effects on normal cells during treatment, and it fails to achieve the goal of curing cancer (Shirisha et al., 2019). Thus, plant-derived natural

compounds, which give an excellent addition to current treatments due to their cytotoxic and cancer-preventive activities, have been chosen as an alternative to synthetic drugs' adverse effects in combating cancer (Diab, 2016).

2. Discussion

2.1. Anticancer activity of citrus peel

According to recent scientific investigations, fruits high in phenolics and flavonoids have substantial antioxidant and anticancer properties (Shirisha et al., 2019). In addition, the mechanism of interaction between several phytochemicals and cancer cells also has been thoroughly investigated (Selim et al., 2019). In vitro cytotoxic assay study, it was found that all the tested citrus peel extracts significantly reduced cell viability in human leukaemia HL-60 cells in a concentration-dependent manner (Diab, 2016).

Besides, it is also able to suppress the lymphocyte proliferation response where interestingly, at low doses of 100 and 50 µg/mL, grapefruit and mandarin peels respectively had no significant increase in the stimulation index on proliferation of mouse splenocytes. Furthermore, the protective activity of citrus peel extracts was also examined with chemotherapeutic agent cisplatin (CDDP) which the result showed the reduction rate for the lemon peel ranged from 32.4 % to 69.1 %, for the grapefruit peel from 42.6 % to 73.5 %, and for the mandarin peel from 52.9 % to 79.4 % (Diab, 2016).

2.2. Citrus peel flavonoid as chemopreventive agent

Chemopreventive agents are substances that can prevent, delay, or stop the cancer progression and citrus fruits are a type of chemopreventive agent that contains flavonoids, which have been linked to cancer treatment (Arafa et al., 2021). This is consistent with an in vivo study in which *Citrus reticulata* peels ethanolic extract at a dose of 500 mg/kgBW reduced the number of cells expressing N-Ras in dimethylbenz[a]anthracene (DMBA)-induced rats' hepatic carcinogenesis and suppressed c-Myc expression (Meiyanto et al., 2012). Besides, nobiletin, a flavonoid derived from *Citrus reticulata* peels, inhibited carcinogenesis on the skin of DMBA-induced mice.

Another citrus species, *Citrus aurantifolia* peels that can be found containing flavonoids such as naringin, hesperidin, naringenin, rutin, nobiletin and tangeretin inhibited DMBA-induced breast carcinogenesis in female sprague sawley rats by inducing apoptosis and inhibiting cell proliferation (Meiyanto et al., 2012). In an in vivo study, Tajaldini et al. (2020) reported that the combination of doxorubicin (Dox) with orange peel extract and naringin reduced the volume of the oesophagal cancer cell (YM1) tumour in naked mice by increasing the cell cycle arrest in S phase as well retained the body weight of nude mice compared to Dox alone treatment. As stated by Goh et al. (2019) body weight is frequently employed as a proxy indicator for toxicity, with the expectation that if toxicity develops, the weight will drop significantly.

2.3. Effectiveness of nanoparticle from citrus peel in preventing cancer

Synthetization of zirconium nanoparticles (NPs) with combining its ion and lemon peel was stated to be more stable and may be stored for a long time compared with lemon peels (Salih et al., 2021). The NPs and the citrus extracts were studied for their activity against MCF-7 (human breast

cancer) cell line where it was reported that there was a synergism effect between the NPs and the extract, with NPs + Peel having the highest inhibitory percentage impact (95.16) at a concentration of 300 µg/ml and 25 µg/ml of NPs having the lowest impact (18.42) (Salih et al., 2021). Therefore, it can be concluded that zirconium lemon peel nanoparticles have shown good anticancer activity potential against breast cancer based on a cytotoxic test conducted. This is in accordance with the statement of Meiyanto et al. (2012) who stated that citrus flavonoids also have a promising anti-cancer impact when combined with various chemotherapeutic drugs.

3. Conclusion

Many proven evidence exhibited that flavonoids are bioactive components abundantly found in the citrus peel are largely related to strong anticancer potential and this is evidenced by the ability of citrus peel flavonoid to be used as an effective chemopreventive agent for cancer in chemotherapy treatment. Therefore, further studies on the significant anticancer properties of citrus peel flavonoid for cancer prevention are very meaningful to be carried out in the future.

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A COMPARATIVE REVIEW: PHYSICOCHEMICAL AND ANTIOXIDANT PROPERTIES OF STINGLESS BEE (*Heterotrigona itama*) HONEY AND TUALANG (*Apis dorsata*) HONEY

Nurul Afiqah Mohammad Nadzree[1] and Mohd Hilmi Hassan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: hilmi@uitm.edu.my*

Abstract: Stingless bee honey and tualang honey are the most two common multi-floral honey available in Malaysia which is produced by *Heterotrigona itama* and *Apis dorsata* respectively. Currently, there is limited data on the comparative physicochemical and antioxidant properties of Malaysian honey. This review aims to evaluate and increase knowledge about the physicochemical composition and antioxidant activity of Malaysian honey produced by these two different species of bees. Parameters such as moisture content, pH, hydroxymethylfurfural (HMF), diastase activity, colour intensity, ash content, total phenolic content (TPC), FRAP and DPPH assays were analysed. Findings revealed that tualang honey showed higher pH, HMF reading and diastase number. Meanwhile kelulut honey is higher in moisture, ash content, total phenolic content and greater colour intensity. Besides, the antioxidant capacity was analysed to be higher in kelulut honey as it possessed lower DPPH values and greater FRAP values than tualang honey. Overall, both types of honey violate the Codex Alimentarius standard for honey in terms of moisture and diastase activity. The international standard for honey is unfavourable to the honey produced by these two types of bees. Apart from the different types of bees, the physicochemical properties of honey are diverse due to geographical origin, botanical source and seasonal factors. Further research is required to discover and understand the potential development of these honey into various food products.

Keywords: Stingless bee honey, kelulut honey, tualang honey, physicochemical properties, antioxidant activity

1. Introduction

Malaysia has a wide variety of blooms throughout the year and is considered to be the main reason for the various kinds of bees. Tualang honey and stingless bee honey are believed to be the two most common honey found in this country (Ranneh et al., 2018). Generally, honey is mainly produced by *Apis mellifera* which is mostly found in Europe and Africa, and they are being widely distributed all over the world. The other *Apis* subspecies such as *Apis dorsata*, *Apis cerana* and *Apis florea*, on the other hand, are discovered in tropical regions like Southern and Southeastern Asia. Unlike the *Apis* spp, stingless bees from the *Meliponini* tribe consist of more than one genus type, such as *Trigona*, *Melipona* and *Scaptotrigona* (Kek et al., 2014). Stingless bee honey is called kelulut honey by Malaysians.

Kelulut and tualang honey are multifloral honey produced by *Trigona spp* and *A. dorsata* respectively, which both are mostly found in tropical rainforests. Compared with *A. mellifera* honey, the production and consumption of tualang and kelulut honey are still scanty because they have not reached the industrial level, lack quality standards and limited information regarding the honey. Honey can be divided into monofloral and multifloral. Monofloral honey is made from only one type of plant nectar or one predominant nectar. On the other hand, multifloral honey has a variety of plant sources, but none of them is predominant. It can be seen as a mixture of several monofloral honeys, which have important contributions from nectar from different plants (Kharsa, 2017). The *A. mellifera* honey falls into the monofloral group while tualang and stingless bee honey are multifloral honey.

2. Discussion

2.1. Physicochemical properties of honey

2.1.1. Moisture content

The range of moisture content in kelulut honey is 21.32 - 31.67% meanwhile the tualang honey is ranging from 16.39 - 26.51%. Since kelulut honey contains lower moisture content as compared to tualang honey, it was expected to have a longer shelf-life. The reason is honey with a high-water content further leads to a higher fermentation capacity, which makes it more difficult to preserve and store (Nordin et al., 2018), hence becoming a challenge for trading and distribution practices.

2.1.2. pH

The data shows that the pH values obtained for the stingless bee honey varied between 2.92 and 3.81. Meanwhile tualang honey had higher pH values compared to the kelulut honey with a range of 3.14 – 4.13. The acidity of honey is highly related to the moisture of honey. This is because the high water content in honey contributes to high water activity which makes it vulnerable to yeast fermentation. Hence, kelulut honey which consists of about 30% moisture is susceptible to yeast growth and multiplication.

2.1.3. Hydroxymethylfurfural (HMF)

Tualang honey recorded higher HMF reading (0.75 – 8.08 mg/kg) when compared to kelulut honey (0.05 – 2.27 mg/kg). These honey samples could be considered fresh as their HMF values were much lower than the limit for honey freshness (80 mg/kg). The higher HMF concentration of honey may be due to the different types of sugar content as well as its ratio of fructose and glucose (Wu et al., 2020). These results indicated that kelulut honey is more resistant to the formation of HMF.

2.1.4. Diastase activity

Observing the results for diastase activity, the honey of *H. itama* had lower values (1.62 – 3.41 DN) and the *A. dorsata* honey had larger values (2.00 – 5.48 DN). Although all honey samples were fresh, pure and unheated, their diastase activity is below the minimum 8 DN required by the Codex Alimentarius. In the Malaysian standard for kelulut honey, there is no standard set for the enzyme. Thus, both types of honey possess another parameter that does not comply with the quality standard of honey.

2.1.5. Colour intensity

The range of colour intensity of kelulut honey was 280.00 – 990.30 mAU whereas tualang honey was 475.50 – 869.00 mAU. The results indicate the kelulut honey has a broad range of colour intensity than tualang honey. The present review also showed that these two kinds of honey contain a lot of phenolic compounds.

2.1.6. Ash content

The ash content of Malaysian *H. itama* honey has greater variability which ranges from 0.08 to 0.67 g/100g. Tualang honey on the other hand was documented to have a range of 0.16 to 0.34 g/100g of ash content. All the stingless bee honey examined have ash contents within the suggested by Malaysian standard (max 1.0 g/100g). The ash content is not included in the standard of honey by Codex Alimentarius.

2.1.7. Total phenolic content (TPC)

Kelulut honey demonstrated a range of 26.45 – 791.50 mg GAE/100 g for TPC whereas the variation of TPC in tualang honey is between 16.32 to 589.20 mg GAE/100 g. Despite being analysed with the same method and collected from the same region, there is a significant difference in total phenolic contents for both kinds of honey. This is expected because the honey's characteristics and composition are severely influenced by many factors including the source of nectar, harvest time, storage, harvesting techniques and conditions

2.2. Antioxidant properties of honey

Honey is considered a rich source of antioxidant activity due to the presence of phenolic acids and flavonoids. This antioxidant potential can be measured by DPPH free radical scavenging activity (DPPH) and Ferric Reducing Antioxidant Power (FRAP). The IC_{50} values of the honey from *H. itama* ranged from 32.58 to 47.40 g/L while honey made by *A. dorsata* varied from 34.93 to 72.75 g/L. These results suggest that kelulut honey has a higher antioxidant activity compared to tualang honey. As for FRAP assay, the data from the literature show that the reducing ability of kelulut and tualang honey has a broad range, which indirectly depends on the type of flower and geographic origin because they are factors that affect the antioxidant content.

3. Conclusion

To sum up, tualang honey showed higher pH, HMF value and diastase activity meanwhile kelulut honey is higher in moisture, ash content, TPC, antioxidant capacity and greater colour intensity. Both kinds of honey violated the Codex Alimentarius standard for honey in terms of moisture (max 20%) and diastase activity (min 8 DN) while meeting the HMF parameter (max 80 mg/kg). Additionally, further studies are required to give insight into the potential development of both honeys either in food, cosmetics or nutraceuticals.

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CORRELATION OF LEGUMES' GLYCEMIC INDEX WITH ITS DIGESTIBILITY: A REVIEW

Nurul Diyanah Mohd Tahar[1] and Nur Rabiatul Adawiah Mohammad Noor[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: rabiatuladawiah@uitm.edu.my*

Abstract: Legumes are a carbohydrate-containing food that has become a staple food for some individuals due to their ability to give people extended satiety. This is due to the slow digestion of foods for glucose utilization, implying a low glycemic index (GI). However, a sedentary lifestyle might prefer to consume high amounts of a carbohydrate-rich food such as white rice or white bread, commonly known as high GI foods. As a result, blood sugar levels rise rapidly, causing people to feel fuller for a short period, driving them to obesity or type II diabetes. This study includes a discussion of major findings related to the intrinsic and extrinsic factors that influence the starch digestibility in legumes. The intrinsic factors are the amylose-amylopectin ratio, starch structure, dietary fibre, and phytic acid. At the same time, the extrinsic factors are the rigid cell wall, the cooking methods, and the retrogradation process. These factors were evaluated by using the in-vitro or in-vivo method. According to a recent study, legumes with high amylose: amylopectin ratio had a higher tendency to retrograde during gelatinization, resulting in a crystal structure resistant to digesting enzymes. Legumes have robust cell walls that make it difficult for the enzyme to penetrate the starch. Thus, the digestion process took longer. Daily food intake of legumes could improve better health and guard against type-II diabetes, lower blood pressure, and even cholesterol. The food manufacturing industry should be considered in the extensive production of legume-based food products.

Keywords: Legumes, starch digestibility, low GI

1. Introduction

Legumes including lentils, beans, peas and pulses consist of high carbohydrates composition which are 65-72 % of starch and 10-20 % dietary fibre along with other significant components such as protein and polyunsaturated fatty acids. Starch can be classified as rapid digestible starch (RDS), slowly digestible starch (SDS), or resistant starch (RS) due to its susceptibility to amylases and subsequent digestibility. Legumes are also considered a low GI due to slow digestion starch, resulting in a low postprandial glucose and insulin response. However, people nowadays prefer processed food which have high GI over legumes, which is detrimental to their health (Grela et al., 2017). Therefore, legumes can be an ideal option for replacing grain, cereal or tuber starch for food and enhance human health. The main objective of study is to determine the factors influencing the legumes starch digestibility.

2. Discussion

2.1. Methods of Glycemic index estimation of legumes and starch digestion mechanism by α-amylase

The majority of researchers preferred *in vitro* (enzyme-based technique) over experiments using experimental animals or human volunteers (*in vivo*), which need blood sampling and appropriate ethical permission. Additionally, the *in vitro* method produces more precise results and requires less time than the *in vivo* method, as the rate and amount of starch digestion can be determined quickly and easily in the laboratory. However, no consensus exists regarding the technique or the findings. Each process requires a distinct strategy for sample preparation. Several of these procedures relied entirely on amylases, while others mixed amylases and proteolytic enzymes.

The human body's digestion of carbohydrate-containing foods happens in the mouth, stomach and small intestine. This enzyme is responsible for the breakdown of starches into maltose and polysaccharides. This digestion process is also similar for monogastric animals. The appropriate enzyme concentrations such as amylase, pepsin, trypsin, and AMG are implicated in hydrolysing the starch into simple units in the *in vitro* model (Lal et al., 2021). Besides, Guggenheim or log of slope (LOS) plots were used in those methods to properly analyse the starch digestibility curve.

2.2. Factors influencing the starch digestibility

2.2.1. Intrinsic factors

Legumes have a significant proportion of starch over cereals, generally containing between 30-37 % amylose and 72–75 % amylopectin. A study by Lu et al. (2018), cooked lentil flours possessed highest in RDS, lowest in SDS and intermediate in RS compared to raw lentil flours despite having a similar composition of amylose starch. This happens as amylose molecules' chains begin to disintegrate and separate into amorphous form during heating, reducing the size of the crystalline region and becoming diffuse. Thus, cooked lentil flours may facilitate hydrolysis by digestive enzymes, enhancing starch digestibility.

Legumes consist of high in resistant starch where it penetrates the small intestine resulting in a reduction in postprandial glucose and insulin responses and a reduction in starch digestion (low in RDS and high in SDS and RS). Therefore, it offers multiple health benefits, including diabetes management and reducing the risk of colon cancer.

2.2.2. Extrinsic factors

The integrity of the cell wall structure influences *in vitro* starch digestion in legumes. This is because the entire cell walls function as a barrier to the diffusion of amylase within the cells. Amylolytic enzymes cannot penetrate the intact bean cells, regardless of whether the legume has been cooked or not.

Furthermore, the gelatinization process also affects the starch digestibility of legumes because of inflated amylose and amylopectin due to water penetration inside those molecules during cooking, forming an easily hydrolysed paste by enzymes. Thus, cooking legumes could decrease their RS content and increase their RDS content. Pressure cooking are one of the cooking methods that boosted the starch digestibility of legumes further compared to conventional cooking, which could be ascribed to the increased degree of starch gelatinization and degradation of antinutrients

in the legume matrix (Jeong et al., 2019).

The retrogradation process occurs when the amylose and amylopectin molecules in gelatinized starch realign into more ordered structures during cooling and storage. The storage of legumes at 4 °C resulted in faster and more perfect crystallization of amylopectin than storage at 25 °C. Therefore, more resistant starch (decreasing RDS and increasing SDS and RS fractions) is formed when the samples held for a longer period of time (Yadav et al., 2010).

2.3. The benefits of legumes consumption on human health

According to the Ministry of Health (2017), each person should consume at least 30 g of legumes to achieve 50–70 % of total energy in daily carbohydrate intake. Legumes can help people lose weight, which the American Diabetes Association recommends for overweight, obese and at risk of developing type 2 diabetes mellitus. Legumes digest more slowly than cereal starch, resulting in less abrupt fluctuations in plasma glucose and insulin levels upon ingestion, which is tremendously favourable to human health.

3. Conclusion

As a conclusion, there is a positive relationship between low GI meals and factors such as amylose and amylopectin concentration and resistant starch, which contribute to starch slow digestion. Consumption of foods with a low glycemic index is associated with a decrease in modern lifestyle diseases such as diabetes and obesity. Legumes food products can also be obtained at affordable prices and not costly with better nutritional values than purchasing the cereal product. Further investigation of the starch digestibility and GI value between low glycemic index foods and other carbohydrates-rich foods is necessary since this study solely discussed the rate of starch digestion in low GI foods.

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BIOPROCESSING AND CHEMICAL COMPOSITIONS OF MALAYSIA PALM SUGAR: A REVIEW

Nurul Izzati Medihi[1], Eddie Ti Tjih Tan[1,2], Mardiana Ahamad Zabidi[1,2], and Siti Azima Abdul Muttalib[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Coressponding author: sitiazima@uitm.edu.my*

Abstract: Palm sugars had been traditionally used as a sweetener for decades in Malaysia. Palm sugars are produced by heating the filtered palm sap until it becomes concentrated and the desired colour and aroma are obtained. Then, the concentrated sap will be moulded, cooled for about an hour, and lastly, it will be packed. Their popularity is increasing globally due to their natural properties, minimal processing steps, and health benefits. Palm sugars typically do not undergo any purification process or use any synthetic chemical in their production. Although they are suggested to be a better sweetener than refined cane sugar, a comprehensive review of their nutritional qualities and product characteristics is not widely covered. Hence, this paper review aimed to explicate the chemical compositions and functional properties of Malaysia palm sugars as a potentially nutritious alternative sweetener. This paper was carried out by reviewing previously published studies on chemical compositions and functional properties of palm sugars. The key finding from this review unveiled that the bioprocessing of palm sugar highly affected the characteristics of the finished product. The two important processes that occurred during the heating stage of palm sap are the Maillard reaction and caramelisation process. These two processes greatly influenced the colour, flavor, and aroma of palm sugars. Palm sugars are considered nutritious because they contain adequate moisture, ash, protein, and fat. The chemical compositions of palm sugar are also a result of the minimal chemical processing of palm sugar.

Keywords: Palm Sugar, bioprocessing, flavour, colour, chemical compositions

1. Introduction

Palm sugar such as nipa palm sugar (gula apong), coconut palm sugar (gula melaka), and palm sugar (gula enau) is one of the various types of natural food resources that can be found in Malaysia. These palm sugars are produced from different species of palms, such as nipa palm (*Nypa fruticans Wurmb*), coconut palm (*Cocos nucifera*), sugar palm (*Arenga pinnata*), and palmyra palm (*Borassus flabellifer Linn*) (Phaichamnan et al., 2010; Saputro et al., 2019). Locals often made palm sugars from scratch without the addition of any artificial food additives or other refining processes. Palm sugar has been traditionally used as a sweetener for a long time in Malaysia, and it typically does not undergo any purification process or use any synthetic chemical in its production (Victor & Orsat, 2018). As a result, it is easier to be digested than refined sugar. However, limited research has been carried out to highlight the nutritional qualities and product characteristics of local palm sugars since they are still a niche product in many countries. Therefore, this paper aimed to review the bioprocessing and chemical compositions of palm sugar,

including its health benefits and risks as a potentially nutritious and healthy alternative sweetener. As a result, the paper review can help increase awareness about the health benefits of palm sugar among Malaysians.

2. Discussion

Conventional palm sugar production involves heating the filtered palm sap in a big wok at about 100ºC for several hours until it becomes concentrated and a typical aroma is obtained. For food safety reasons, the concentrated total soluble solids of palm sap should be at least 65 ˚Brix or higher (Phaichamnan et al., 2010). After the heating process is completed, the hot viscous brown sugar is poured into a plastic container or bamboo mould, and then the sugar will be cooled down for about an hour before being packaged. Palm sugar typically will last up to two years if stored properly. It should be tightly wrapped in plastic or an airtight container and kept in a cool, dark, and dry place. Maillard reaction and caramelisation, which occur during the heating process of palm sap, are responsible for producing the taste and colour of palm sugar (Saputro et al., 2019). Many studies (Ho et al., 2007, 2008; Naknean et al., 2010; Saputro et al., 2019) have claimed that the flavour of palm sugar is influenced by the presence of volatile compounds in palm sugar such as furans and pyrazines, which are formed during the thermal processing (Lee et al., 2019). The nutty and roasted flavour of palm sugar results from the high total concentration of pyrazines, while a higher ratio of furans derivative leads to sweet caramelize-like and burnt flavour (Naknean et al., 2010). The sugar colour can vary from light to dark brown due to Maillard reaction and caramelisation (Saputro et al., 2019) and the heating period during palm sugar processing (Wrage et al., 2019). Their influence on palm sugar colour can be proved by the decrease in L* value and an increase in a* value in the CIE colour system (L*, a*, b*) with the increased temperature and heating time (Naknean et al., 2013). Higher temperatures may cause more reducing sugar to react with amino acids during the Maillard process, resulting in brown pigment or melanoidin, contributing to the dark brown hue.

Palm sugars are generally considered nutritious because they contain adequate chemical compositions, including moisture, fat, protein, fibre, and carbohydrate content. These attributes are influenced by the minimal processing of palm sugar (Saputro et al., 2019). According to Choong et al. (2016), the increase in the total soluble solids heating temperature and time would reduce the water content of the sugars. Moreover, moisture content and water activity are used to monitor the shelf-life of sugar during storage because water can increase stickiness, microbial deterioration, and biochemical degradation reactions (Choong et al., 2016). The protein content which was reported by the previous literature is based on the Kjeldahl method. However, the principal of this method that measures total nitrogen, will overestimate the protein value in sugar. Thus our current review suggested that a more reliable method such as liquid chromatography should be employed to determine the protein value in palm sugar. According to nutrition facts, the fibre content of sugar is expected to be low as fibre, and most of the other nutrients in the plant are extracted during the processing (Choong et al., 2016). Therefore, the low content of crude fibre found in sugars could be due to the residue of the fibre left during sap collection, which was not filtered adequately during the manufacturing process. Ash content determines the total mineral content by oxidizing organic matters in sugar. A high carbohydrate content in palm sugar was attributed to the simple carbohydrate units, which allowed glucose to form long-chain polymer molecules such as starch, cellulose, and dextran, which might be linear or branched (Choong et al., 2016).

3. Conclusion

Maillard reaction and caramelisation are the two reactions that occur during the heating stage of palm sugars which contribute to their flavour and colour. As palm sugars are processed minimally, they retain various natural constituents that possess a wide range of biological actions advantageous to human health. These can be proven by the significant amount of chemical compositions, including ash, fat, protein, moisture, fibre, and carbohydrate found in palm sugars. Further research should be carried out to determine the ability of active ingredients of Malaysia palm sugar to perform various biological functions such as antibacterial and anticancer properties.

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EDIBLE NANOCOATING: THE EFFECT OF DIFFERENT STARCH-BASED MATERIALS INCORPORATED WITH NANOPARTICLES ON THE ANTIMICROBIAL ACTIVITY

Nurul Jannah Ruzlan[1], Noor Asnida Asli[2,4], Eddie Ti Tjih Tan[1,2], Siti Azima Abdul Muttalib[1,2], and Nadya Hajar[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[3]*NANO-SciTech Lab, Functional Materials and Nanotechnology Centre, Institute of Science, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*
[4]*Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia*

**Corresponding author: nadya1844@uitm.edu.my*

Abstract: The application of starch-based film is extensively used as fruit coating in the agricultural sector in the assurance of postharvest quality. A starch-based film such as cassava, corn, and rice film can provide a semi-permeable barrier to moisture and water vapour, however poor in mechanical strength. Thus, several attempts have been made to overcome this limitation by incorporating metal-based antimicrobial agents such as zinc, silver, and titanium into the starch-based coating at the fruit's outer layer. Although extensive study is being done in this field, the comprehensive review focussing on the antimicrobial activity of metal-starch nanocomposite is still lacking. Hence, this study aims to review the effectiveness of different starch materials incorporated with a different metal-based antimicrobial agent as edible nanocoating in the assurance of the postharvest quality of fruits. Zinc oxide nanoparticles (ZnONP), silver nanoparticles (AgNP), and titanium dioxide nanoparticles (TiO_2NP) incorporated into cassava, rice, sago, and corn exhibited antimicrobial activity. Therefore, a comprehensive study on the inhibition of metal-starch-based nanocomposite on fungal that affects the post-harvest quality of fruit is recommended.

Keywords: Edible nanocoating, starch, metal nanoparticle, antimicrobial, antifungal

1. Introduction

Fruits are well recognized as good in balancing the diet and promoting a healthy lifestyle. However, fruits could be infected by postharvest diseases that arise from bacteria and fungi which could cause quality losses, affect the shelf-life stability of fruits and contribute to the wastage and losses in economies. Microbes and fungi affect the quality of fruits during pre-harvest and post-harvest causing the quality reduction. The post-harvest disease problem can be encountered by applying nanotechnology in the disease's prevention method that improves the mechanical action of particles. For example, using zinc oxide nanoparticle (ZnONP), silver nanoparticle (AgNP), and titanium dioxide nanoparticle (TiO_2NP).

Starch is one of the biodegradable polymers that is highly preferred by the consumer as it can reduce the environmental impact. However, starch is also known as having the limitation in mechanical properties and barrier properties. The addition of metal nanoparticles into starch

improves the mechanical, water vapour barrier, and antimicrobial properties (Ji et al., 2016; Kotharangannagari & Krishnan, 2016).

2. Discussion

Zinc oxide is an inorganic compound with the chemical formula of ZnO and it is present in white powder. The solubility of zinc oxide is quite different according to its sizes of particles, and basically, crude zinc oxide (ZnO) is generally insoluble in water. The synthesis of zinc oxide nanoparticles (ZnONPs) can be carried out by many physicochemical routes such as co-precipitation, laser vaporization, sol-gel processes, microemulsion, and ball milling (Alamdari et al., 2020). Zinc oxide nanoparticle is functioning as antimicrobial activity and has potential to inhibit the spoilage of the food products with and without the photocatalytic activity.

Silver is a metal element with the chemical formula of Ag and it is known as transition metal with a soft and shiny surface. The synthesis of AgNP can be applied using several methods such as photo- irradiation, chemical, biological and photochemical methods (Jafarzadeh et al., 2021). Furthermore, AgNP possesses a higher antimicrobial effect because they can easily integrate within the cell membrane due to their smaller size and the release of silver ions from the silver particle will be easier (Echegoyen & Nerín, 2013).

Titanium dioxide or also known as titania is a semiconductor metal oxide with a chemical formula of TiO_2, non- toxic, bright white colour. The photocatalytic activity in the presence of oxygen and water molecules, resulting in the production of reactive oxygen species and hydroxyl radicals that are accountable for the bactericidal function (Lin et al., 2015). The synthesis of titanium dioxide nanoparticle can be conducted by the method of chemical vapor deposition, chemical precipitation, microemulsion hydrothermal, and sol-gel methods.

The mechanism of action of Zinc Oxide against microbes is by releasing of antimicrobial ions and damaging the integrity of the bacterial cell (Naveed Ul Haq et al., 2017). Meanwhile, the mechanisms' reaction of silver against microbes is through intrusion with vital cellular processes by binding to sulfhydryl or disulfide functional groups on the surfaces of membrane proteins and other enzymes, disruption of DNA replication (Duncan, 2011). All metals have mechanisms of reactive oxygen species (ROS), and TiO_2NP with under the exposure to UV light.

Starch is the most promising biocompatible and biodegradable material because of its advantages in low cost and readily available from many sources of plants (Tunma, 2018). Starch is a major polysaccharide composed of two macromolecules amylose and amylopectin. Thus, the mechanical strength of its starch depends on the amylose/amylopectin ratio, the average granule sizes, and the percentage of distribution of the different sized groups of granules (Vafina et al., 2018). Table 1 shows the effect of different types of starch incorporated with metal-based nanocomposite on the particle distribution.

Table 1. Particle distribution of metal-starch based nanocomposite film.

Metal-starch Based		Mechanical
Cassava	ZnONP, AgNP	Agglomerates
	TiO_2NP	Hard-brittle
Rice	ZnONP, TiO_2NP	Agglomerates
	AgNP	Coarse and rough surface
Sago	ZnONP, TiO_2NP, AgNP	Almost uniform
Corn	ZnONP, TiO_2NP, AgNP	Evenly distributed

3. Conclusion

Post-harvest diseases threaten the quality and shelf life of the fruits; however, the diseases can be controlled by using edible coating. The coated fruits using starch-metal-based nanocomposite able to reduce the post-harvest diseases on the fruit's surfaces. With the process of releasing ions, cell disruption, DNA replication disruption, and reactive oxygen species (ROS), the inorganic metals zinc oxide, silver, and titanium are useful as an edible coating in their antimicrobial activity. The morphology of starch metal-based influences the particle distribution of the coating and thus affects the antimicrobial effectiveness. However, the study of antifungal using metal-starch based is still limited.

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AN OVERVIEW OF EFFECTIVENESS PLANT-BASED SHORTENING IN SUBSTITUTING LARD PROPERTIES TOWARDS BAKERY PRODUCTS

Nurul Nadhirah Said[1] and Nur Rabiatul Adawiah Mohammad Noor[1,2]*

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: rabiatuladawiah@uitm.edu.my*

Abstract: Animal-based fat like lard is a fatty substance known for imparting a flavourful, yeasty aroma and the perfect soft texture towards bakery products like cakes, pastries, and bread. The prohibition under religious restriction in using lard and high saturated fat content drove the usage of modified vegetable oils in the bakery industry. However, legislative limitations and health considerations of the trans-fat produced from modified vegetable oil causes abundant research on reduction of trans fat content in modified vegetable oils are conducted. Hence, this review aims to distinguish modification processes of vegetable-based fats and oils besides to study the simplest and economical vegetable-based fats and oils blends in replacing physicochemical and mechanical properties of lard and its effectiveness on bakery products. Several findings reported that the vegetable-based fat and oil blends displayed both β' and β- form polymorphs comparable to the polymorphic behaviour of lard. In addition, previous studies found similar consistency of vegetable-based fat and oil blends to lard in the range of 319.20 to 326.26 g/cm^2 that yields a satisfactory plastic and spreadable. Subsequently, the vegetable-based fats and oil blends in substituting lard properties have been successfully proven by uniform thickness and width cookies produced by the lard and the blends. Despite the emerging trends of the modified vegetable fats and oil blends used in bakery products that possess a better reduction of trans-fat and saturated fat, conducting further investigation on the limitation of using them commercially in the food industry should be considered since these involve potential public health impact.

Keywords: Lard, modification vegetable oils, shortenings, bakery products

1. Introduction

Food preparation widely used animal-based fats and vegetable oils not only for cooking, grilling and baking but also as food dressing to enhance the flavour of food and meet people's palatability. One of the versatile uses of fats and oils is for bakery products. Several previous studies stated that butter and lard was the most well-known animal-based fat used in baking applications as they produce baked goods with flavourful impact (Culetu et al., 2021). Earlier studies proposed that the lard has a higher smoke point around 182˚C to 204˚C than butter at about 176˚C although butter had a higher amount of saturated fats (Marcus, 2013). Interestingly, the lard has the richest cis-oleic acid proportion although it derived from animal origin causes it was more favourable to be used (Culetu et al., 2021). However, the religious prohibition causes the substitution of lard by modified vegetable-based fats and oils for baking applications was considered. Nevertheless, the modification process of vegetables-based fats and oils need to be concerned since the process develops formation of trans fat which will cause severe health problems (Chavasit et al., 2019).

Besides, the encouragement in eliminating industrially-produced trans-fat by the World Health Organizations (WHO) drove abundant research on reducing trans-fat in several modification methods of vegetable-based fats and oils in the food industry. Hence, this review aims to distinguish the modification methods of vegetable-based fats and oils besides to study the simplest yet economical vegetable-based fat and oil blends in replacing the physicochemical and mechanical properties of lard and its effectiveness on the quality of bakery products.

2. Discussion

2.1. Modification methods of vegetable oils

There are several modification methods of vegetable oils that have applied in the food industry; hydrogenation, interesterification and blending. However, the trans isomer of unsaturated fatty acids produced from modified vegetable oils by partial hydrogenation process led to several adverse health effects causes a several study conducted for reducing the trans-fat in hydrogenation process including the inclusion of anti-isomerization effect during the process (Guo et al., 2021). Meanwhile, interesterification consists of either chemical or enzymatic methods that have a wide range of application and do not generate trans-fat but the stability of catalysts is poor and high cost are required (Gupta, 2017). Hence, this review focussed on the blending method as it was the simplest yet specifically developed for desired oxidative, textural and physical properties of fat-based products (Kittipongpittaya et al., 2020).

2.2. Physicochemical and mechanical properties of vegetable-based oil and fat blends

Several studies have shown that physicochemical properties of different proportions of various blending vegetable oils and fats have compatibility with the lard properties (Noor et al., 2017a; Noorzyanna et al., 2017; N. A. Yanty et al., 2018). The fatty acid composition exhibits high content of oleic acid > palmitic acid > linoleic acid > stearic acid while triacylglycerol composition exhibits high content of POO (dioleoyl-palmitoyl-glycerol) > POL (palmitoyl- linoleoyl-oleoyl glycerol) > PPO (dipalmitoyl-3-oleoyl glycerol) > StPO (palmitoyl- oleoylstearoyl glycerol). The solid fat content (SFC) of the blends showed to have similar range with lard but they have different temperature as the SFC becomes 0%, the high melting transition formed for the vegetable blends is higher when comparing to lard as the three blends consists of palm oil and its fraction, palm stearin. Lastly, the polymorphism behaviour of the vegetable blends displayed to have both β' and β-form polymorphs comparable to lard.

A study of different proportions of vegetable blends showed a similar consistency to lard in the range of 319.20 to 326.26 g/cm2 in which the range value yields a satisfactory plastic and spreadable (N. A. M. Yanty et al., 2017). Besides, the similar study showed a compatibility in hardness and compression force between lard and the blends due to the increment of solid fat content in every blend contribute a well structural stronger network.

2.3. Effect of vegetable oil and fat blends on the quality of bakery products

The hardness of the dough cookies and baked cookies made from several vegetable oil and fat blends showed a correspondence with the lard (Manaf et al., 2019; Noor et al., 2017b). These are because the distribution of trisaturated and monounsaturated in the vegetable blends and lard

affects the solid fat content profile and develops a link between dough hardness and the cookies hardness. Besides, the similar studies also revealed that the cookies made with lard had thickness at ranging from 9.42 to 13.94 mm and width at ranging from 72.95 66.37 mm respectively which has been concluded to be similar to both vegetable blends due to a similar solidification behaviour between the blends and lard at specific range of temperature.

3. Conclusion

In conclusion, the difference of modification methods of vegetable oils has been distinguished, the compatibility of different vegetable blends in substituting lard properties and its effect towards the quality of bakery products have been synthesized. As a recommendation, a further investigation on the limitation of using them commercially in the food industry should be considered since these involve potential public health impact.

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LABORATORY SCALE EGGSHELL MEMBRANE SEPARATION AND HYDROLYSIS

Nurul Syazwina Nor Hisamuddin[1], Siti Azima Abdul Muttalib[1,2], Nur Farah Syahirah Abd Kadir[1], Sharifah Aminah Syed Mohamad[3], Nor Monica Ahmad[4], and Eddie Ti Tjih Tan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 7200 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[3]*School of Biology, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Malaysia*
[4]*School of Chemistry & Environment, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: eddietan@uitm.edu.my*

Abstract: Eggshell membrane (ESM) has a variety of nutrients including fibrous protein and glycosaminoglycans. The ESM can be separated and hydrolysed from Eggshell (ES) prior to further usage. However, there are not many reviews on the separation and hydrolysis methods of ESM so far. Hence, the present review compiles the ESM separation and hydrolysis studies reported to date. The literature search in this review was conducted by looking into a Web of Science (WoS) database. Most of the papers reported the use of manual peeling as a separation method followed by acid separation (hydrochloric acid and acetic acid) and mechanical separation (foam separator and stirred tank). The mechanically stirred tank is reported to be the most efficient separation method with the highest yield of ESM (80.2% to 90.9%). In addition, the ESM hydrolyses reported were predominantly done by using alcalase. The hydrolyses were done with various hydrolysis duration (1 – 12 hours) and temperatures (50ºC – 55ºC). In conclusion, most of the current separation of ESM prior to further usage was still focussing on manual hand peeling, while a large amount of the reported ESM hydrolysates was done by using alcalase.

Keywords: Eggshell membrane, separation techniques, parameters, hydrolysis, hydrolysate

1. Introduction

Eggshell membrane (ESM) is a thin layer that exists between the calcified eggshell (ES) and the egg albumen. Furthermore, the ESM structure was made up of an inner and outer membrane which was discovered by using scanning electron microscopy (SEM). According to the result of SEM, the outer layer has a thickness of 50-70 µm, and the inner layer has a thickness of 15-30 µm (Park et al., 2016).

Consequently, the ESM contains several nutritional components such as sulphated glycoproteins (Görögh et al., 2017), glycosaminoglycan (polysaccharide), hyaluronic acid, and fibrous protein (collagen types I, V, and X) which 88–96% contribute to its dry weight (Baláž, 2014; Hewlings, Kalman, & Schneider, 2019). Apart from that, other proteins including osteopontin, sialoprotein, and keratin, have also been discovered in ESM (Torres et al, 2010; Baláž, 2014). These nutritional components could be received after a few processes of ESM such as ESM separation from the ES and ESM hydrolysis. Firstly, the ESM should be separated from ES prior to further analysis. Next, the ESM yield was collected and proceeded to the hydrolysis process. The complex structure of the protein from ESM should undergo a hydrolysis process in order to obtain ESM protein hydrolysate.

The aim of this paper is to examine the ESM separation and hydrolysis methods of ESM, and discuss the specific parameters involved in procedures. Despite the fact that ESM's nutritional potential has been recognised, while several ESM separation and hydrolysis processes have been carried out, the current trends of ESM separation and hydrolysis for research investigation are seldom discussed. Hence, the present review compiles the ESM separation and hydrolysis studies recently developed.

2. Discussion

2.1. Eggshell membrane separation

A literature search from WoS database indicated several separation techniques were available for ESM namely, manual separation, mechanical separation, and acid separation. Firstly, the manual peeling technique was predominantly used by most of the researchers (Lee & Huang, 2019; Li et al., 2018; Pant et al., 2017; Makkar et al., 2015; Abdolmohammad-Zadeh & Talleb, 2014; Shi et al., 2014a). Even though manual peeling was the preferred ESM separation method, however, all of these articles did not report the ESM yield from the peeling process. Thus, the efficacy of this technique is unknown.

Next, there are 2 types of mechanical separation methods that have been reported, namely, foam separator and stirred tank. The stirred tank recorded the highest ESM yield is in the range of 80.2 % - 90.9% (Chi et al., 2019) while the foam separator between 34 % - 77 % (Bayraktar et al., 2021).

It is worth noting that the manual ESM peeling process is usually coupled with acid treatment. The reported acids used to assist ESM peeling process are hydrochloric acid (Zhang et al., 2021; Andreassen et al., 2020; Moreno Araújo Pinheiro Lima & de Oliveira, 2020; Peigneux et al, 2020; Jyothi et al., 2018), acetic acid (Mahmoodi et al., 2019; Santana et al., 2016; Cheng et al., 2011) and ethylene diamine tetraacetic acid (EDTA) (Zhang et al., 2016).

2.2. Eggshell membrane hydrolysis

Subsequently, the separated dried ESM was hydrolysed to produce ESM hydrolysates. The ESM protein hydrolysates were produced either by using chemical hydrolysis (Ruff et al., 2015; Yoo et al., 2014) or enzymatic hydrolysis (Jain & Anal, 2016; Andreassen et al., 2020) process. The hydrolysis processes were used to break up the polypeptide bonds in the ESM protein structure. The products from this disruption process will produce amino acids and peptides (Baharuddin et al., 2016).

The chemical hydrolysis was performed using sodium hydroxide (Ruff et al., 2015; Yoo et al., 2014). However, one of these hydrolysis methods has utilised ethanol together with sodium hydroxide. The ethanol was used to catalyse the breaking of a peptide bond in the ESM via a nucleophile substitution process by the addition of water (Speight, 2018). There are not many reports available for ESM chemical hydrolysis, hence, more research could be done to explore further for its abilities to produce ESM hydrolysates.

Literature work shows that most of the ESM hydrolysate studies utilised enzymatic hydrolysis. The alcalase enzyme was the most used enzyme for ESM hydrolysis. To date, a study has started the investigations on the ESM hydrolysed by using several enzymes. The enzymes combination such as alcalase with different types of proteases (Shi et al., 2014a). It was found that enzyme combination in hydrolysis increases the degree of hydrolysis (DOH). The ESM enzymatic hydrolysis studies reported were predominantly done by using alcalase enzyme with the duration ranged from 1 to 12 hours (Jain & Anal, 2016; Santana et al., 2016; Shi et al., 2014a) with temperature ranged within 50^{o}C – 55^{o}C (Andreassen et al., 2020 Shi et al., 2014b; Shi et al., 2014a). ESM chemical hydrolysis should be widely discovered because the research reported so far is insufficient to make any conclusion either this method is better than enzymatic hydrolysis or not.

3. Conclusion

In conclusion, laboratory separation of ESM from the ES for the ESM related research works were mostly based on the hand manual peeling due to its potential to preserve the protein content in ESM structure, while the usage of the mechanical stirred tank can improve the production of ESM, though it was not a commonly used laboratory method for ESM separation. The alcalase enzyme usage in hydrolysis was the most common one with a better DOH. In addition, the usage of multiple enzymes in ESM hydrolysis can improve DOH.

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A REVIEW ON FACTORS THAT AFFECT THE DIFFERENT PHYSICOCHEMICAL AND ANTIOXIDANT PROPERTIES OF STINGLESS BEE *(Heterotrigona itama)* HONEY IN MALAYSIA

Reem Mat Asli[1] and Mohd Hilmi Hassan[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author*: *hilmi@uitm.edu.my*

Abstract: Predominantly, it has been stated that stingless bee honey is higher nutritional values than honeybee honey. However, there have been limited studies on its quality. The quality of stingless bee honey also has been questioned and documented to not meet the International Honey Commission (IHC) quality standards set for honey. This review aims to identify the factors that affect the different physicochemical characteristics and antioxidant properties of stingless bee honey in Malaysia. Based on recent studies, the physicochemical and antioxidant properties of Malaysian stingless bee honey were gathered and compared. Various aspects such as moisture content, pH, colour, electrical conductivity (EC), ash content, hydroxymethylfurfural (HMF), total phenolic content (TPC), total flavonoid content (TFC) and free radical scavenging activity (DPPH) and ferric reducing antioxidant power (FRAP) were analysed. As a result, stingless bee honey possessed greater moisture content ranging between (17.07 - 41.49%), pH (2.92 – 5.50), DPPH (1.98 – 44.05%), TPC (3.04 – 9.37mg GAE/100g), TFC (3.63 – 14.44mg QUE/100g), colour intensity (0.09 – 1.056mAU), EC (0.19 – 1.187mS/cm), lower ash content (0.01 – 3.11%), HMF (0.04 – 85.9mg/kg) and FRAP (0.19 – 0.22abs). The findings revealed that the physicochemical and antioxidant properties of the stingless bee honey investigated were highly dependent on several factors such as botanical sources, geographical origins, climatic condition, environmental pollution, beekeeping's processing, handling, and storage conditions which must be taken into consideration for future research.

Keywords: Stingless bee, physicochemical, antioxidant, geographical origin

1. Introduction

Kelulut honey or stingless bee *(Heterotrigona itama)* honey is complex multiflora honey produced by stingless bees from *Trigona spp.* It is primarily composed of sugar, fructose and glucose. Proteins, amino acids, enzymes, organic acids, mineral elements, and vitamins are also found in stingless bee honey but in a small proportion. Some of these components are naturally found in nectar or pollen, while others are added or inserted by bees during the honey maturation process. Predominantly, it has been stated that stingless bees honey is higher in antioxidant activity, moisture content, ash content, water activity, polyphenol, and flavonoids content than *Apis mellifera* bees which carries remarkable health benefits to humans (Shamsudin et al., 2019; Yap et al., 2019).

Honey produced by different species of stingless bees has different physicochemical characteristics and antioxidant properties. However, various factors such as botanical source, geographical origin, harvesting seasons, climate condition, environmental status, bees species, processing method, and storage condition may affect the quality and antioxidant of the honey itself (Zarei et al., 2019). Many difficulties have been faced in determining the purity and originality of stingless honey.

2. Discussion

The findings revealed that the physicochemical and antioxidant properties of the *kelulut* honey investigated were different and highly dependent on factors such as botanical sources, geographical origins, climatic condition, environmental pollution, beekeeping's processing, handling, and storage conditions. Due to their smaller size, the speciality of *H. itama* species is the tendency to pollinate tiny flowers that cannot be accomplished by other large honeybees (Rao et al., 2016). Therefore, it is possible for them to collect many types of nectar and pollen during foraging activity which resulted in different physicochemical and antioxidant properties. This stingless bee honey is distinguished by the fact that it is naturally kept in the pot (cerumen), which contributes to its therapeutic characteristics, particularly in the wound healing process. (Shamsudin et al., 2019). As the result of the honey being stored in cerumen pots, the quality of the stingless bee honey is impacted by the penetration of phytochemicals from the cerumen (Abd Jalil et al., 2017). The nectars must go through three separate transformation stages resulted in different properties of honey.

Apart from that, botanical origins have been shown to have a major impact on its physical and chemical properties due to the wide variability in the chemical structure of plant nectars and secretions. According to Gismondi et al. (2018) and by Tomczyk et al., (2019), the chemical composition of honey strongly depends on the kind of nectar flow. In turn, the biochemical profile of nectar is qualitatively influenced by genetics and physiology of the source plant, environmental factors (climatic conditions), soil characteristics and typology of pollinators. Each geographical area is characterized by specific climatic conditions that favour the growth of specific plants. The climatic conditions of a specific area also can be affected by pollution, which affects the plants and animals living in that area.

Honey also can be affected by environmental pollution such as heavy metals, pesticides, organic pollutants, pathogens, and radioactivity, and so on. Besides, air pollution and agricultural events also influence the sources of honey nutrients as heavy metals are adsorbed via organic matters, minerals, and carbonates from the soil to the nectars (Alahabadi et al., 2017). The chemical pollutants also increased due to the usage of several chemical compounds which affected environmental mediums such as water, soil, and air as a result of urbanization, agricultural activities, and industrialization (Matin et al., 2016). High density of heavy metals, metallic and toxic chemical elements in honey may affect the different values obtained and can be a threat to health.

Since honey can be considered a heat-sensitive material, some alteration on its physicochemical characteristics might occur. It is essential to control the temperature as the hot air should be hot enough to reduce the moisture content but not exceed the temperature limit above 40 °C. Honey contamination also can arise from different sources, such as the manner of collecting honey by beekeepers, as well as the storage of honey by the consumer (Soares et al., 2017).

3. Conclusion

Several variables impact honey quality, including bee species, botanical sources, geographical origins, climates condition, pollution, handling, processing, and storage conditions. As a result, assessing these variables is critical for determining the quality and authenticity of honey. A wider study with a significant number of samples must be carried out to obtain more insights into the effect of these factors on the parameters that have been studied.

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EVALUATION OF SMOKING TECHNIQUE TOWARDS FOOD PRESERVATION

Siti Aishah Rashid[1] and Safiyyah Shahimi[1,2]*

[1]Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia
[2]Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia

**Corresponding author: safiyyahshahimi@uitm.edu.my*

Abstract: Smoking technique has gained attention among the food industry players in extending the shelf life of the food products and maintaining the quality. Since most research involving the food smoking techniques was only focusing on the biological evaluation of smoked meats, this review highlights some chemical and biological quality evaluation of smoked food products. The effects of smoking technique with or without general-curing on the microbial population and pH of the smoked food products were evaluated. The bacterial number of *Salmonella* sp. was reduced along the processing chains from raw food to smoked food and cured smoked food with some negative detection after the smoking. Besides that, the significantly decreased pH ($p<0.05$) of the smoked food product has benefited the food preservation condition. Smoking technique with curing showed a decreasing trend on the bacterial population which increased the product shelf life. Hence, the smoking technique is recommended for extending the shelf life of food considering the initial microbial and also the food properties before and after smoking. This review will be a significant endeavour to the smoked food sellers and the consumers with an upgraded quality of food.

Keywords: Smoked products, food preservation, curing, quality, shelf life

1. Introduction

Smoking can be defined by cooking the food slowly and indirectly with the presence of smoke. In order to extend the shelf life of food products with the addition of improving flavour, smoking as the preservation technique has been introduced back to the historical period and gained more attention especially in food industries nowadays. As a modification of the salting method used back in ancient times, nitrates and nitrites are used in order to fasten the curing time (Govari & Pexara, 2015). In this review, the general curing agent evaluated was the combination of nitrite, sodium chloride (salt) and turmeric powder. The pH of the food before and after smoked preservation will be determined as the pH of the smoked cured food also raises the question on how does smoking affect the pH of the food products? Previous studies have identified several spoilage microorganisms in raw and smoked products. Due to there is no in-depth review of foodborne pathogens, the determination of *Salmonella* sp. in smoked food will be reviewed further.

2. Discussion

2.1. Evaluation of *Salmonella* sp. presence in smoked food

In a study by Sheng and Wang (2021), 156 smoked fish samples were collected from both domestic and international sources; the domestic samples were found to be *Salmonella*-free, whereas five imported samples were found to be infected. Meanwhile, a total of 66 fish samples were obtained by Gildas et al. (2019), including both fresh and processed fish. In a number of samples, *Enterobacteriaceae*, *E. coli*, *B. cereus*, *C. perfringens*, yeasts, and moulds were found, but *Salmonella* sp., *L. monocytogenes*, and *S. aureus* were not detected. According to Chau et al. (2017), there is no presence of *Salmonella* sp. in the sampling of pre-packaged smoked salmon from supermarkets between September 2011 and January 2012. In addition, Dien et al. (2019) concluded that liquid smoke at a concentration of 1% successfully inhibited bacterial growth in general by reducing TPC, as well as harmful bacteria like *Salmonella*.

2.2. Effect of smoking technique on pH

According to Rana et al. (2021), the pH level in smoked Chub mackerel fillets decreased significantly ($p<0.05$) with smoking time at 20, 25, and 30 minutes, respectively, before it reached its acceptable limit (pH = 6.32–6.22). Meanwhile, a study by Popelka et al. (2021) on whole mackerel discovered that the pH of the (unpacked) group began to rise significantly ($p<0.05$) on day 28 of the experiment and then increased non-significantly until day 42. Indiarto et al. (2020) stated that the expected pH value at initial storage shows a decrease with the increased concentration of liquid smoke added. Lastly, Ratsimba et al. (2019) found that pork dried products had a higher pH than smoked products (6.48 ± 0.30 and 6.09 ± 0.54, respectively).

2.3. Effect of curing agents in smoked products preservation

According to Ziarati et al. (2018), sodium nitrite, $NaNO_2$ has been used as the curing agent on chicken meat and resulting in improvement of colour and taste, inhibits the antimicrobial activity with the addition of preservation and also as a cooking agent. The maximum amount of 300 mg of nitrite per kg can be used for the processing of ripening ham. However, not more than 150 mg of nitrite per kg is permissible in cooked meat products (Wójciak et al., 2019). If turmeric powder is added with nitrite, the colour of meat will be maintained, while not affecting the chemical composition of the meat. Furthermore, it was stated that with the addition of turmeric powder to the samples that were treated with nitrite, some factors would be affected to the upper level such as the moisture content, pH and also the microbial load of meat products (Gull et al., 2014). In the other hand, Ruiz-alonso et al. (2021) found that salting tilapia fillets for 4 hours in a brine containing 10% NaCl and then applying liquid smoke to the salted fillets resulted in smoke-flavored fillets with physical–chemical and microbiological qualities that met industry standards.

3. Conclusion

The findings show that the bacterial number of *Salmonella* sp. was reduced along the processing chains from raw food to smoked food and cured smoked food with some negative detection after the smoking. Besides that, the significantly decreased pH ($p<0.05$) of the smoked food product has

benefited the food preservation condition. Smoking technique with curing has improved the texture of the food products significantly ($p<0.05$) and showed a decreasing trend on the bacterial population which increased the product shelf life. More research needs to be conducted for better understanding the contribution of the smoking process combined with the curing agent and the amount of addition to be considered to improve smoked food quality.

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APPLICATION OF IMMOBILIZED ENZYMES IN FOOD TECHNOLOGY INDUSTRY

Siti Nadhirah Supardi[1] and Hisham Mohd Nooh[1,2*]

[1]Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia
[2]Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia

**Corresponding author: hishamnooh@uitm.edu.my*

Abstract: Enzymes found in living organisms accelerate a wide range of chemical and biological reactions. The lack of long-term working stability, shelf-life, and challenging recovery and reusability limit all of enzymes' promising applications in the food sector. The enzyme must be immobilized using an encapsulating technique to overcome this disadvantage. Carrier components for the encapsulation process, such as carbohydrates, protein, and lipid-based encapsulation, must be carefully chosen. Therefore, different support materials have varying degrees of influence on immobilized enzyme activity. Support materials for immobilizing enzymes must satisfy the enzymes' needs while also being sturdy enough to withstand the enzymatic processes' circumstances. The goals of this research are to discover new immobilized enzymes and to determine the role of immobilized enzymes in the baking, sugar, juice, and dairy industries. Furthermore, to investigate ways for improving immobilized enzymes by considering immobilization practice and carrier support. Additionally, to determine whether immobilized enzymes would affect the physical and chemical qualities of food, as well as to determine how many times immobilized enzymes have been utilized. The data revealed that different types of supports have a significant impact on the surrounding environment's hydrophilicity or hydrophobicity, altering whether chemicals partition towards or away from the enzyme. This approach is commonly used to stabilize enzymes in the presence of inactivating substances such as organic solvents, hydrogen peroxides, oxygen, and other dissolving gases. The carrier materials were identified to have biodegradability, biocompatibility, multivalent functionalization, good reusability, money savers, unique structural features, and remarkable stabilities. Carrier materials play an important role in enzyme immobilization. Consequently, higher scrutiny of enzyme catalytic performance on a commercial scale may be applied based on new matrices that could improve biocatalytic potentialities, novel enzyme immobilization methods, and advanced functional and innovative materials to fulfil expanding international needs.

Keywords: Encapsulation, carrier materials, encapsulating materials, enzyme immobilization, enzyme reusability

1. Introduction

Enzymes are recognized for their high substrate specificity, which is determined by the substrate's chemical and structural configuration in a certain environmental setting without generating any unwanted by-products. Enzymes are employed in their natural state for the most part. Salts, surfactants, alkalis, and trace amounts of chemicals are more vulnerable to free-form enzymes, which can operate as inhibitors and spiral manufacturing costs. Free-form enzymes can be lost as the reaction advances because of changes in reaction conditions, leading to decreased enzyme

healing from the reaction mixture. Variations in enzyme activity have an impact on product quality and quantity. Because the enzyme synthesis process is relatively expensive, post-reaction healing of enzymes can lower operational expenses. The recovery and reuse of enzymes from the reaction solution, on the other hand, is difficult and expensive (Fabra et al., 2019).

Immobilization of enzymes is a well-known approach for eliminating the drawbacks of employing free enzymes while simultaneously improving the production process' capability and cost-effectiveness. The attachment of enzymes to support material to restrict the movement of molecules, hence decreasing loss and allowing for spontaneous healing with little or no loss of enzyme activity, is known as enzyme immobilization. Immobilization improves enzyme stability against structural deformation and various denaturing organic solvents by engaging the amino acids with activated carrier functional groups. The presence and density of functionalized groups on the enzyme surface impact the immobilization process' ability and the strength of immobilized enzymes in storage and operations. However, because scaling up processes using immobilized enzymes is primarily cost-driven, an economic assessment of the overall process is performed before using an immobilized enzyme, considering all related costs such as a native enzyme, immobilization resin, downstream manufacturing, reactors, immobilized enzyme disposal after use, and carrier regeneration (Bilal & Iqbal, 2019).

2. Discussion

2.1. Gluten free bread

To date, there are no new immobilized enzymes. Most of the researchers used Maltogenic amylase (MAase) or α-amylase in gluten free bread. The encapsulated enzymes help to postpone the staling of gluten-free bread and stabilize the enzymes in acidic medium of batter. To date, encapsulation enzymes in the supporting carrier such as maltodextrin and beeswax are the latest discoveries that help to stabilize the enzymes. Encapsulated MAase-loaded bread showed a darker crust, white and softer crumb, more aerated structure, and higher sensory acceptability. There remains a knowledge deficit in the field of enzyme reusability. Apart from that, the enzyme concentration is not measured during the procedure. This is a critical parameter for measuring the stability of enzymes (Haghighat-Kharazi et al., 2020).

2.2. Dairy industry

Galactosidase is the most common enzyme used in the production of low amounts of lactose in milk. The stabilized enzymes help to catalyze the hydrolysis of lactose efficiently as the free enzyme is easily denatured, and it may not be reused. The encapsulation of lactase in k-carrageenan-based with buffer, alginate-agarose hydrogel, and chitosan with genipin as the cross linker produced a good result in lowering the amount of lactose in milk. The immobilized enzymes did not alter the physical or chemical properties of the food. The immobilized enzymes can be reused 4-10 times in a continuous cycle (Lima et al., 2021).

2.3. Juice industry

To date, only the enzyme pectinase is used in juice clarification. The immobilized pectinase helps to reduce the turbidity in the fruit juice that is caused from hydrocolloid called pectin. The enzymes

were immobilized on Magnetic nanoparticles (MNPs), silanized glass beads with cross linkers, Montmorillonite clay (MC), and chitosan beads. No physical or chemical properties of the juice were altered by the immobilized enzymes (Dal Magro et al., 2021). According to the findings, immobilized enzymes can be reused a minimum of 7 times and a maximum of 10 times.

2.4. High fructose corn syrup (HFCS)

Based on the recent findings, amyloglucosidase and glucose isomerase (GI) were used in producing high fructose corn syrup (HFCS). The immobilized enzyme demonstrated outstanding operational stability in the face of environmental change. Different carriers were used to immobilize the enzymes, including silica/chitosan hybrid, chitosan, and supported cross-linked enzyme aggregates (CLEAs). The physical and chemical qualities of the syrup are not affected by the enzymes. Within three months, the enzymes can be reused 6-15 times (Wahab et al., 2020).

3. Conclusion

While the immobilized enzymes were being introduced to the process, there was no negative impact on the end products. However, enzyme concentration tests, activity of free enzymes under immobilization conditions, and evolution of activity in the supernatant should be performed because the strength of the immobilized enzymes is critical. Moreover, the form of immobilization, cross-link agent, reactor, and carrier employed, should be the first focus before starting the procedure.

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A REVIEW ON THE EFFECTS OF CHEMICAL PRE-TREATMENTS ON PHYSICOCHEMICAL, SENSORIAL, ANTIOXIDANT, HUMAN HEALTH, AND MICROBIOLOGICAL SAFETY OF DRIED FRUIT

Siti Nurida Kamaruddin[1] and Naemaa Mohamad[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: naemaa953@uitm.edu.my*

Abstract: Dried fruits known as a nutritious snack, a substitute to sweet or salty snacks due to their flavour, nutritional, and health benefits. In producing dried fruit, it generally undergoes a drying process. However, fruit usually will encounter physical and chemical degradation after drying. Chemical pre-treatment is commonly used before the drying process as it helps to inactive enzymes and produce better quality dried fruit. It is of interest to study the effect of chemical pre-treatment on qualities of dried fruits. In this review, an overview of dried fruits in terms of processing, composition and the effect of chemical pre-treatment on physicochemical properties (colour, texture, pH, total soluble solid, titratable acidity, water activity and moisture content), sensory acceptability, antioxidants (vitamin C and total phenol content), human health and microbiological safety have been discussed. Chemical pre-treatment such as citric acid and potassium metabisulfite among the most commonly used pre-treatments. Moreover, chemical pre-treatment helps enhance colour and minimize the shrinkage of dried fruit as compared to untreated one. It also enhances the dried fruit's acceptability and increases vitamin C, total phenol content and provides microbiological safety of dried fruit. Therefore, chemical pre-treatment before drying is important in producing good quality dried fruits. This research will be beneficial to the food industry which produces dried fruit products as this review provides more information about chemical pre-treatments that are suitable to be applied on their product.

Keywords: Dried fruit, chemical pre-treatment, citric acid, physicochemical, sensory

1. Introduction

Chemical pre-treatments are usually used before drying to inactive enzymes and produce better quality dried fruits The enzymatic reactions transform the colour of the dehydrated fruit to darker colour because of the oxidation of phenols to o-quinones (polymeric pigment). To enhance dried fruit quality, applying chemical pre-treatment on fruit before the drying process is one of the solution to prevent quality deterioration of the dried fruit.

Previous studies only focus on phytochemicals and antioxidant efficacies of dried fruit. There is still a lack of review papers done so far on the effect of chemical pre-treatment on qualities such as physicochemical, sensorial, antioxidant, effects on human health, and microbiological safety of dried fruits. Moreover, this review will enhance the knowledge about chemical pre-treatments available for fruits and reflects which area researchers need to focus on. This research will also be beneficial to the food industry which produces dried fruit products as this review provides more information about chemical pre-treatments to be applied on their product. In this review, an

overview of dried fruits in terms of processing, nutrient composition, the chemical pre-treatment available for fruits and the effects of chemical pre-treatment on physicochemical, sensorial, antioxidants, human health and microbial safety of dried fruits have been discussed.

2. Discussion

2.1. Overview of dried fruit

The term "dried fruit" refers to a variety of various processing methods of fresh products. Dried fruits such as dates, figs, apples, and pears are convectional dried fruits that are produced by the elimination of water. Table 1 shows several recent studies on the nutrient content of dried fruits (USDA, 2020; Khairuddin et al., 2017). Each type of dried fruits has different nutrient composition which make them unique from one another. Pre-treatment is commonly used to inactivate enzymes and improve the consistency of dried products prior to the drying. Chemical pre-treatment including ascorbic acid, citric acid, potassium metabisulfites among the most commonly used chemical pre-treatments for fruit (Dereje & Abera, 2020a).

Table 1. Nutrient composition of selected dried fruits.

Dried fruit	Mangoes	Dates	Apples	Figs	Apricots	Raisins
Water content (%)	16.60	21.68	31.76	30.00	30.89	15.46
Energy (kJ)	319.00	303.00	243.00	249.00	241.00	299.00
Protein (g)	2.45	2.93	0.93	3.30	3.39	3.30
Fat (g)	1.18	0.20	0.32	0.92	0.51	0.25
Carbohydrate (g)	78.60	72.20	65.89	63.90	62.64	79.32
Total sugar (g)	66.30	48.60	57.19	47.90	53.44	65.18
Calcium (mg)	0.00	71.34	14.00	162.00	55.00	62.00
Iron (mg)	0.23	0.95	1.40	2.03	2.66	1.79
Magnesium (mg)	20.00	49.33	16.00	68.00	32.00	36.00
Potassium (mg)	273.00	868.70	450.00	680.00	1162.00	744.00

Note: Data is for convectional dried fruits which is defined as those with no added sugars, typically sun-dried or dried with minimal processing.
Source: USDA (2020); Khairuddin et al. (2017).

2.2. Effects of chemical pre-treatments on physicochemical properties and sensory acceptability of dried fruit

Chemical pre-treatments such as citric acid and sodium metabisulphite showed higher lightness value and help reduce the enzymatic browning. In terms of texture, chemical pre-treatment such as a combination of 0.15% sodium metabisulfite and 3% calcium chloride before oven drying showed minimum hardness compared to untreated fruits (Wijaya, 2018). Next, in terms of pH and water activity, chemical pre-treatment lowered the pH and water activity of dried fruit due to the absorption of the filling solution such as citric acid (Dereje & Abera, 2020a).

Besides that, chemical pre-treatment before fruits drying also resulted in increment of total soluble solid in dried fruits due inactivation of enzymes to avoid loss of organic acids, mineral salts, sugar and amino acids (Dereje & Abera, 2020a). Moreover, fruit treated with citric acid pre-treatment results in higher value of titratable acidity due to reaction between free amino groups and reducing sugars available in fruits causing the formation of intermediate compounds such acid and carbon dioxide. Besides, chemical pre-treatments such as citric acid help lowering the moisture

content of dried fruits due to leaching results that affect the tissue of fruit that encourages elimination of water during the drying process (Zzaman et al., 2021). Furthermore, the chemical pre-treatments such as 3% citric acid helps increase the sensory acceptability of dried fruits as citric acid prevents the crystallization of sugar, thus enhancing the quality of dried fruits especially in terms of texture (Pawar et al., 2017).

2.3. Effect of chemical pre-treatments on antioxidants of dried fruit

Most chemical pre-treatments such as sodium chloride with a combination of drying methods will affect degradation of vitamin C content due to temperature sensitivity. However, when comparing between types of chemical pre-treatment, citric acid pre-treatment showed higher vitamin C content in dried fruit as compared to sodium chloride pre-treatments because of the nature of this organic acid pre-treatment that contains vitamin C (Dereje & Abera, 2020a). In terms of total phenolic content, pre-treatments before drying methods help to increase the total phenol content and minimize the phenolic degradation on dried fruit. This is due to the ability of chemical pre-treatment to prevent the tissue damage in dried fruits (Zzaman et al., 2021).

2.4. Effects of chemical pre-treatments on human health effect and microbiological safety

Chemical pre-treatment such as sulfites pre-treatments including potassium metabisulphite and sodium sulfate showed adverse effects on human health especially those who have allergy and sulfites sensitivity such as people who have asthma. Finally, chemical pre-treatment has a positive impact on microbiological safety. Pre-treatment with acidic solutions such as ascorbic acid, citric acid, or pre-treatment by immersion in sodium metabisulfite conjointly improves the degradation of possibly pathogenic bacteria (Dereje & Abera, 2020b).

3. Conclusion

The study showed that chemical pre-treatment methods before the drying process overall give better effects on qualities of the dried fruit. Chemical pre-treatments such as citric acid and sodium metabisulphite help reduce the enzymatic browning of dried fruit. Chemical pre-treatments are proven to enhance the dried fruit's acceptability from the sensorial point of view and recorded increases in vitamin C and total phenol contents. Further research should be done to investigate the effects of chemical pre-treatments on active compounds such as flavonoids. The issue about the mycotoxins that were found in dried fruits could also be explored in further research.

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A REVIEW ON CRUCIAL ASPECTS IN UP-SCALING CULTURED MEAT PRODUCTION

Syazwani Washi[1] and Naemaa Mohamad[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: naemaa953@uitm.edu.my*

Abstract: Current meat consumption pattern is putting a lot of burden on the environment by taking up a lot of resources and releasing emissions from activities such as rearing animals that cause environmental pollution. One of the alternatives on the market is plant-based meat which is made from plant ingredients which is favourable among vegetarians. However, meat eaters are not satisfied with plant- based meat and are looking for other options. Cultured meat is introduced to overcome the issue related to conventional meat and provide a better alternative to meat. No massive animal rearing is needed to produce cultured meat since it is produced by cell culturing methods from cells obtained through painless biopsy on living animals. Many studies are conducted to produce cultured meat for commercialization and to up-scale the production of cultured meat. Current method to produce cultured meat is on the lab-scale and very expensive. Up-scaling of cultured meat must ensure that it is cost- effective, sustainable, and acceptable. This review paper highlights the important aspects in up- scaling cultured meat production from maintaining the stemness of satellite cells to sustainable alternatives of cell growth medium and scaffold as well as components that improved the cell growth. The cost for cultured meat is still expensive, but by making changes through possible alternatives on the materials used can reduce the cost and make cultured meat acceptable by the public.

Keywords: Cultured meat, cell culture, stem cell, cell growth medium, scaffold

1. Introduction

Serious consequences from conventional meat production that contribute to environmental pollution have initiated scientists to look for meat alternatives that could give the similar sensory experience as meat. One of the meat alternatives that could imitate conventional meat is cultured meat. The environmental problems related to conventional meat are large requirements of global land surface up to 38% (Alexander, Reddy, Brown, Henry, & Rounsevell, 2019), green gas and methane emission, and 8% global freshwater usage (Bhat, Bhat, & Kumar, 2020). Meat alternatives, especially cultured meat, could overcome the problem stated above and support the growing global meat consumption that is expected to increase up to 465 million tonnes by 2050 (Bhat et al., 2020). This study aims to provide information about meat alternatives and contribute to the development of cultured meat which is currently in the research phase.

2. Discussion

2.1. Overview of cultured meat

Cultured meat is produced from cell culturing method that aims to produce meat without requiring animal breeding and slaughtering (Bekker, Fischer, Tobi, & Van Trijp, 2021). Cell culturing method produces cultured meat by obtaining muscle stem cells via small biopsy on the animals and the cells will undergo two phases which are proliferation and differentiation phases.

2.2. Production of cultured meat

There are 4 essential components for cultured meat production which are stem cells, cell culture medium, scaffold and bioreactor to produce meat from stem cells into edible tissues.

2.3. Essential component 1: Starter cell lines

Cell culturing method requires stem cell lines from animals to begin the process. There are few types of starter cells including muscle satellite cells, embryonic stem cells and mesenchymal stem cells (Ketelings, Kremers, & De Boer, 2021). Muscle satellite cells can be isolated from muscle tissue and have multilineage potential which is promising for cultured meat (Bhat et al., 2020). Whereas, embryonic stem cells and mesenchymal stem cells can be isolated from the embryo or umbilical cord of the animals (Ketelings et al., 2021).

2.4. Essential component 2: Cell growth medium

Growth medium is an essential component for cell growth in cultured meat production. Fetal bovine serum is a serum added to culture medium to supplement nutrients for cell growth. However, since the serum is obtained from the clotted blood of the bovine fetus has led to ethical issues regarding the method to obtain the serum (Liu et al., 2016). An example of substitute for the serum is sericin which is a major component of silkworm silk protein that could promote cell viability (Hajarian, Aghaz, & Karami Shabankareh, 2017).

2.5. Essential component 3: Scaffold for cultured meat

Scaffold is a three-dimensional biodegradable material used in cell culturing as a temporary template for promoting and guiding the neo-tissue formation in a pre-determined manner. The properties of a scaffold able to guide cells into a desirable organization (Werner, Kurniawan, & Bouten, 2020). Scaffolding is required to mimic in vivo environments of tissues such as porosity, flexibility and stiffness to allow cells to grow, proliferate and differentiate (Orellana et al., 2020). Another option of scaffold other than biomaterial scaffold is plant-derived scaffold which has shorter developmental time and is cost-effective (Fontana et al., 2017).

2.6. Essential component 4: Bioreactor

Bioreactor is an equipment that provides a suitable environment and condition to support cell growth into tissue culture. It creates a mechanical environment that resembles the niche environment of the cells during development and maturation of tissue culture (Cook et al., 2016). Up-scaling off cultured meat production will require large-scale bioreactors to generate high cell numbers (Bhat et al., 2020).

3. Conclusion

Cultured meat is a novel product that serves as one of the meat alternatives to support the growing meat demand. Production of cultured meat via cell culturing method eliminates the requirements of large land surface and water resources as well as reduced green- house gas emissions. Cultured meat production is still in its infancy. In addition, many studies are needed in this field to produce a convincing, safe and acceptable product and to make large-scale bioreactors available to support mass production of cultured meat

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CHEMICAL COMPOSITION AND POTENTIAL COMMERCIAL VALUES OF RAMBUTAN (*Nephelium lappaceum*) PEEL: A REVIEW

Syazwani Najwa Zulkurnain[1] and Nurul Azlin Tokiman[1,2*]

[1]*Department of Food Science and Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*
[2]*Alliance of Research & Innovation for Food (ARIF), Universiti Teknologi MARA, Cawangan Negeri Sembilan, Kampus Kuala Pilah, 72000 Kuala Pilah, Negeri Sembilan, Malaysia*

**Corresponding author: nurulazlin@uitm.edu.my*

Abstract: Rambutan (*Nephelium lappaceum*) peel will be discarded upon processing or consumption but due high antioxidant content, it could attract the interest of experts in related fields. This study summarised the findings on the colouring compound, antioxidant and antimicrobial properties of rambutan peel, as well as the applications of rambutan peel in both food and non-food industries. It showed that flavonoid and anthocyanin are among the natural colouring compounds found in rambutan peel but due to instability on the fabrics, mordant was used for this purpose. On the other hand, a high amount of phenolic content has proved that rambutan peel is high in antioxidants and geranin was reported to be the highest contributor. Antioxidant extraction using methanol reported the highest yield, 67.57% followed by ethanol and water. While phenolic content was employed to determine the antioxidant capacity, ABTS, FRAP, and DPPH assays were used to measure the antioxidant properties of the rambutan peel extract. In addition, the rambutan peel extract also possesses the antimicrobial properties towards gram-positive bacteria such as *Staphylococcus aureus*. The objective of this paper is to discuss the research findings on the chemical composition and potential commercial values of rambutan (*Nephelium lappaceum*) peel.

Keywords: Rambutan peel, antioxidant, phenolic compounds, antimicrobial, application

1. Introduction

Rambutan (*Nephelium lappaceum*) is a tropical fruit native to Southeast Asia, particularly Malaysia, Thailand, and Indonesia. It is also one of the Sapindaceae family (Sekar, 2020). Rambutan fruit consists of peel, seed and pulp. Rambutan peels contribute to 50% of its total weight depending on the maturity of the cultivar. It is abundant in phenolic compounds such as geranin, ellagic acid, rutin, quercetin, and corilagin (Phuong, Le, Dang, Van Camp, & Raes, 2020). Besides, it is also known as rich source for natural dye compounds including anthocyanin and flavonoids (Amalia, Paramita, Kusumayanti, Sembiring, & Rani, 2019) while having antimicrobial properties (Sekar, 2020). Thus, due to the benefits and bioactive compounds in rambutan peel, the waste of rambutan peel from processed rambutan can be utilized in food and non-food applications (Mahmood et al., 2018).

2. Discussion

2.1. Colouring compounds in rambutan peel

Rambutan peel extract contains colouring compounds such as anthocyanin and flavonoids yet they are unstable on fabric (Amalia et al., 2019). Thus, a few methods were established to stabilize the colour by adding some chemicals such as mordant, blanching (Aadil, Roobab, Sahar, ur Rahman, & Khalil, 2019) and preservative compounds (Amalia et al., 2019). However, mordant is the most common method that has been used by researchers due to mordant being water insoluble and results in colour retention on fabric.

2.2. Antioxidant in rambutan peel

Besides that, in order to obtain the bioactive compounds in the rambutan peel, these peels need to be extracted. Most of the rambutan peel extraction was using methanolic, ethanolic and aqueous (Phuong et al., 2020). Based on the study, the highest yield was 67.57% by using methanol extraction (Mahendra, Lestari, & Aprillia, 2020) then ethanol extraction to which give a yield 33.2% (Palanisamy et al., 2011) then lastly aqueous extraction 29.97% (Yunusaa, 2018). The different yield produced from rambutan peel extraction due to the different types of solvent and technique which are affected by their solubility in the solvent used for extraction (Phuong et al., 2020). Phenolic compounds found in rambutan peel are geranin, ellagic acid, rutin, quercetin, and corilagin. The total phenolic compounds were determined by using Folin-phenol Ciocalteu's reagent (FC). The highest total phenolic content found in rambutan peel is 781.84 mg/g and geranin is the highest phenolic compound found (781.84 mg/g) (Phuong et al., 2020). However, different concentrations and types of solvent give different amounts of phenolic content in rambutan peels. To obtain a greater level of phenolic content, it is critical to use the appropriate extraction process.

Antioxidant capacity in rambutan peel was studied through DPPH, ABTS and FRAP assays. The ABTS test has been commonly used to assess the antioxidant activity of aqueous and lipophilic systems in vitro, whereas the DPPH assay has been used to examine the scavenging activities of antioxidants in lipophilic systems, while FRAP effective in screening antioxidant capabilities and comparing the efficacy of various substances (Phuong et al., 2020). One of the analysis from shows that the result for DPPH assay is 46.38 ± 0.31 g/100 g for soluble phenolic, while ABTS assay is 54.09 ± 2.40 TE/100 g dm for soluble phenolic and FRAP assay is 66.05 ± 2.74 Fe^{2+}/100 g dm for soluble phenolic (Nguyen et al., 2019).

2.3. Antimicrobial properties of rambutan peel

Study shows that rambutan peel extract inhibits gram-positive bacteria such as *Staphylococcus aureus*, *Streptococcus mutans*, *Bacillus subtilis*, and *Staphylococcus epidermidis* while insensitive most of Gram-negative bacteria such as *Escherichia coli*, *Candida albicans*, and *E. faecalis* (Sekar, 2020; Sukatta et al., 2021). This is because RPE is more efficient against Gram-positive bacteria than Gram-negative bacteria, which have a more complex cell wall. (Sukatta et al., 2021).

2.4. Applications of rambutan peel

There are several examples for applications of food and non-food application. Rambutan peel extract was added into oil to improve the shelf life and flavour retention (Mei et al., 2014). Besides that, anthocyanin in rambutan peel extract is used as a colour change indication for increased meat pH owing to chicken meat deterioration (Mahendra et al., 2020). On the other hand, rambutan peel also benefits in non-food applications such as in filler in packaging which can lower the cost of manufacture or to provide a specific function (Nadhirah, Sam, Noriman, Ragunathan, & Ismail, 2015). Rambutan peel was reportedly utilized in whey protein isolate film due to bioactive compounds such as corilagin, ellagic acid, geranin and gallic acid which exhibited antioxidant and antimicrobial activities. The film was dark-brown, which is appropriate for a food packaging application with UV light sensitivity (Sukatta et al., 2021).

3. Conclusion

In conclusion, it is proved that rambutan peel provides beneficial applications either in food or non-food areas because of its significant amount of colouring compound, antioxidant and antimicrobial properties. However, there are still limited resources on the comparison study between different species of rambutan especially in Malaysia and further study can be carried out to fulfil this gap.

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