UNIVERSITI PUTRA MALAYSIA

FUNCTIONAL PROPERTIES OF PALMYRA PALM (Borassus flabellifer L.) EXOCARP AND MESOCARP AND ITS POTENTIAL APPLICATION

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By

RODIAH BINTI MOHD HASSAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

Specially dedicated to my parents (mak and arwah ayah), my siblings, my beloved husband and children for their unconditional love and endless support throughout my study.

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

FUNCTIONAL PROPERTIES OF PALMYRA PALM (*Borassus flabellifer L.*) EXOCARP AND MESOCARP AND ITS POTENTIAL APPLICATION

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January 2021

Chairman : Prof. Jamilah binti Bakar, PhD
Faculty : Food Science and Technology

Borassus flabellifer (*B. flabellifer*) with its immature and soft juicy seed nuts is popular as a natural refreshing drink. However, the peel (mesocarp and exocarp) is discarded and very negligible information is available on the potential of the peel as a food ingredient. The presence of bitterness (flabelliferins) in the peel could also be a deterrent to its acceptablility. This present study aimed to explore the physicochemical, composition and functional properties of the mesocarp and exocarp of *B. flabellifer* before and after removal of the bitter component with naringinase. The debittered mesocarp (DMP) was incorporated into a muffin to determine its effect on such product characteristics. The exocarp had significantly higher ($p<0.05$) insoluble dietary fibre than the mesocarp but lower soluble dietary fibre. Fructose, galactose, glucose, mannose, and sucrose were detected in both samples including phenol and tannins. Radical scavenging activity (157.05 mM TE/g) and reducing power (213.05 mM Fe^{2+}) of the exocarp were significantly ($p<0.05$) higher compared to the mesocarp. Mesocarp and exocarp have good functional properties especially their water holding (7.11 and 5.99 g/g, respectively), swelling capacity (9.15 and 7.53%, respectively) and wettability (44.33 and 397.36 seconds, respectively). Subsequently, the mesocarp was selected for the enzymatic treatment, due to it has higher portion (39.6%-50.3%) than exocarp (5.5%-6.0%) from the whole fruit peel. It was found that the debittering treatment of mesocarp was best carried out at naringinase concentration of 2.0 g/L, 5 h, pH 5.0 and at 55 °C. A 63.8% of flabelliferin was successfully removed from the mesocarp. The DMP had good water-holding (9.4 g/g), swelling capacities (7.8 g/g) and wettability (12.3 seconds). Scanning electron microscope image showed that the structure of DMP become smaller fragment and more porous after debittering treatment. The changes in sturucture had increase the DMP surface area and trap more water/oil molecules thus leads to a higher water/oil capacity. However, the solubility,

swelling and wettability of DMP were markedly decreased. The substitution of DMP for wheat flour more than 1% resulted in a more compact muffin with a significant ($p<0.05$) increase in hardness and a significant ($p<0.05$) decrease in cohesiveness and resilience. The substitution of DMP in muffin formulations caused a significant ($p<0.05$) reduction in baking loss rate, specific volume and volume when the substitution level exceeded 3%. The DMP muffin had darker crumb and crust compared to control. The sensory quality of muffin with a 1% substitution of DMP was found closest to the control muffin with no significant different ($p>0.05$) of score for all quality attributes tested. Colour, appearance, aroma, taste/flavour and texture were perceived lower in a muffin with 3-6% substitution of DMP. DMP could be appropriate for use as food ingredients if bitterness was removed more than 60%. It is recommended that DMP be incorporated into low-calorie and high-fiber products such as baked confectioneries, noodles, meat products and breakfast cereals.

Keywords: *Borassus flabellifer,* bitterness, dietary fiber, muffin, naringinase, powder

.

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

SIFAT BERFUNGSI ESOKARP DAN MESOKARP PALMYRA PALM (*Borassus flabellifer L.)* SERTA POTENSI PENGGUNAANNYA

Oleh

RODIAH BINTI MOHD HASSAN

Januari 2021

Pengerusi : Prof. Jamilah binti Bakar, PhD
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Borassus flabellifer (*B. flabellifer*) dengan isi buah yang lembut dan berjus daripada buah yang muda popular sebagai minuman semula jadi yang menyegarkan. Walau bagaimanapun, kulit (mesokarp dan esocarp) dibuang dan terdapat maklumat yang sangat sedikit terhadap potensi kulit sebagai bahan makanan. Kehadiran kepahitan (flabelliferins) di dalam kulit juga boleh menjadi penghalang penerimaannya. Kajian ini bertujuan untuk mengkaji sifat fizikokimia, komposisi dan sifat berfungsi mesokarp dan esokarp *B. flabellifer* sebelum dan selepas penyingkiran komponen pahit dengan naringinase. Serbuk mesokarp dinyahpahit (DMP) dimasukkan ke dalam muffin untuk menentukan kesannya terhadap ciri produk tersebut. Esokarp mempunyai serat makanan tidak larut lebih tinggi ($p<0.05$) daripada mesokarp tetapi lebih rendah serat makanan larut. Fruktosa, galaktosa, glukosa, mannosa, dan sukrosa dikesan pada kedua-dua sampel termasuk fenol dan tanin. Aktiviti penimbunan radikal (157.05 mM TE/g) dan mengurangkan kuasa (213.05 mM $Fe2^{+}$) daripada esokarp secara signifikan ($p<0.05$) lebih tinggi berbanding mesokarp. Mesokarp dan esokarp mempunyai sifat berfungsi yang baik terutama kebolehan memegang air (7.11 dan 5.99 g/g, masing-masing), kapasiti pengembungan (9.15 dan 7.53%, masing-masing) dan keterbasahan (44.33 dan 397.36 saat, masing-masing). Seterusnya, mesokarp dipilih untuk rawatan enzimatik, kerana ianya mempunyai nisbah yang lebih tinggi (39.6%-50.3%) berbanding esokarp (5.5% -6.0%) bagi kulit buah secara keseluruhan. Didapati bahawa rawatan nyahpahit mesokarp paling baik dilakukan pada kepekatan naringinase 2.0 g/L, 5 jam, pH 5.0 dan pada 55 °C. Sebanyak 63.8% flabelliferin berjaya dikeluarkan daripada mesokarp. DMP mempunyai kebolehan memegang air (9.4 g/g), kapasiti mengembung (7.8 g/g) dan keterbasahan (12.3 saat). Imbasan mikroskop elektron menunjukkan bahawa struktur DMP menjadi fragmen lebih kecil dan berliang setelah rawatan nyahpahit. Perubahan struktur telah meningkatkan luas permukaan DMP dan menyebabkan lebih banyak molekul air/minyak sehingga menyebabkan kapasiti

air/minyak lebih tinggi. Walau bagaimanapun, keterlarutan, pengembungan dan keterbasahan DMP nyata menurun. Penggantian DMP untuk tepung gandum lebih daripada 1% menghasilkan muffin yang lebih padat dengan peningkatan kekerasan yang ketara ($p<0.05$) dan penurunan yang signifikan ($p<0.05$) dalam dalam kohesif dan resilien. Penggantian DMP dalam formulasi muffin menyebabkan penurunan ($p<0.05$) yang signifikan dalam kadar kehilangan pembakaran, jumlah dan isipadu tertentu ketika tahap penggantian DMP lebih dari 3%. Mufin DMP mempunyai serpihan dan kerak yang lebih gelap berbanding dengan kawalan. Kualiti sensori muffin dengan penggantian DMP 1% didapati paling hampir dengan muffin kawalan tanpa skor yang berbeza ($p>0.05$) untuk semua kualiti atribut yang diuji. Warna, penampilan, aroma, rasa/perisa dan tekstur adalah lebih rendah pada mufin dengan penggantian DMP 3-6%. DMP mungkin sesuai digunakan sebagai bahan makanan jika kepahitan dihilangkan lebih dari 60%. Adalah disarankan agar DMP dimasukkan ke dalam produk rendah kalori dan tinggi serat seperti kuih-muih berbakar, mi, produk daging dan bijirin sarapan pagi.

Kata kunci: *Borassus flabellifer,* kepahitan, serat makanan, muffi, naringinase, serbuk.

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

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LIST OF ABBREVIATIONS

^{o}C	Degree centigrade
α	Alpha-
β	Beta-
ANOVA	Analysis of varience
DMP	Debittered mesocarp powder
DNS	3,5-dinitrosalicylic acid
DPPH	2,2-diphenyl-1-picrylhydrazyl
FDA	Food and Drug Administration
e.g.	For example
et al.	Latin phrase et alia, which means 'and others'
etc.	Et cetera, a Latin expression meaning 'and other things' or 'and so on'
Fe2+	Ferrous ion
Fe3+	Ferric ion
FRAP	Ferric reducing antioxidant power
GAE	Gallic acid equivalent
HCl	Hydrocloric Acid
H_2SO_4	Sulfuric Acid
HPLC	High performance liquid chromatography
IDF	Insoluble dietary fiber
LCMS	Liquid chromatography Mass spectrometer
M	Molar
min	Minute
mM	Millimolar

N	Normality
$NaClO_2$	sodium chlorite
NaOH	Sodium hydroxide
ND	Not detected
PCA	Principal component analysis
ppm	Part per million
PPFP	Processed palmyrah palm fruit pulp
ROS	Reactive oxygen species
rpm	Rotation per minute
RPFP	raw palmyrah palm fruit pulp
SDF	Soluble dietary fiber
SEM	Scanning electron microscope
TAE	Tannic acid equivalent
TDF	Total dietary fiber
TE	Trolox equivalent
TPC	Total phenolic compound
TPTZ	2,4,6-Tris(2-pyridyl)-s-triazine
x g	Units of Gravity
SPSS	Statistical Package for the Social Sciences

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Borassus flabellifer (*B. flabellifer*) Linn of the Arecaceae family is known as *kelapa laut* in Malaysia and globally called Palmyra palm. There are about 140 million palmyra palms distributed worldwide (Sathya, 2019). In Malaysia, *B. flabellifer* tree is grown in several states such as Perlis, Kedah, Perak and Kelantan but statistical data are not available on production and trade (Ghazali Zakaria, Former Deputy Director, Plant Biosecurity Division, DOA, Malaysia pers. comm. 20 March 2018). When they are at three to four months old, the immature seed nuts are very popular as a refreshing drink because of their soft and juicy taste. However, the peel which consisted of the mesocarp and exocarp (40%–55% w/w of fruit) are discarded. This discarded portion could be a potential source as food ingredient such as functional food and food fortifiers.

The pulp from the mature fruit was widely studied (Ariyasena et al., 2001; Kumar, Rajarajeshwari, & Narayana Swamy, 2012) for food and beverages for commercial use in the developing countries. Unfortunately, the utilization of the fruit pulp is deterred by the bitter compound present in the palmyrah fruit pulp; flabelliferin (FII), which is identified as a tetraglycoside (Nikawela et al., 2000; 2011). It is expected that the same bitterness compounds are present in the immature *B. flabellifer* fruit peel. It is important to reduce the bitter taste to make them more appealing to consumers (Siti Rashima, Maizura, Kang, Fazilah, & Tan, 2017). Due to this reason, the removal of bitterness from this immature fruit peel is highly required. It was reported that the bitter compound of flabelliferin (FII) in the fruit pulp can be hydrolysed by the glycolytic enzyme naringinase (Jansz et al, 2002 and Jayaratnam 2015). Based on the characteristics of naringinase and reported effectiveness in the removal of bitter compound, naringinase could have similar effect on the immature *B. flabellifer* fruit peel.

There is a negligible research on the exploitation of the Borassus fruit peel (mainly mesocarp) during the immature stage and the study of the removal of the bitterness from it. Thus, it is necessary to study these fruit peel to identify the alternatives for processing and reusing the by-product that are formed, overcoming environmental issues and adding value to these products. Furthermore, there was also scanty of research and innovation being ventured locally especially in utilizing high-fibre and nutritious edible raw material from *B. flabellifer* mesocarp as food ingredients for example into processed foods (i.e. noodles, energy bar and breakfast cereal) or bakery-based products (i.e. bread, cake and muffin). Therefore, by substituting potentially nutritive

ingredients in bakery products particularly in muffin will improve the nutritional quality of the baked products.

1.2 Problem Statements

Based on the observation, ASEAN countries produced a significant quantity of residues from immature *B. flabellifer* fruit. Unfortunately, no statistical data on percentage of accumulated residues from this fruit was reported. In Malaysia, negligible report on statistical data available for the amount of fruit residues. Since Malaysia is not the main producer of this plant therefore, data is recorded as negligible or no production (Ghazali Zakaria, Former Deputy Director, Plant Biosecurity Division, DOA, Malaysia pers. comm. 20 March 2018). Presently, the residues were disposed because they were assumed as non-edible due to its bitter taste and hard structure. As significant amount of residues were produced, it caused problems for their disposal. Thus instead of continuing with the wastage, an exploitation and conversion of these residues to a new source of functional food ingredients may be a significant option. To date many present researches focused mainly on the endosperm, mucilage and pulp (when it ripen). Therefore a study is warranted to evaluate the potential of *B. flabellifer* residues and for it to be viable for commercial functional food ingredient.

1.3 Significance of the Study

This study is significant both from the perspective of food biotechnology investigation and commercial application. Given the lack of investigation or experimentation on the viability of the *B. flabellifer* residues and the technique in bitterness removal, study will provide the methodological information to researchers. For the perspective of commercial application, the food industries shall benefit from the formulation and production of the *B. flabellifer*'s product, and eventually reach to the consumer. This is because the *B. flabellifer* discard has health-benefiting quality due to its dietary fibre content, antioxidants and good functional properties which may turn it into a new functional ingredient for the food industries. In fact, the commercial viability of the *B. flabellifer* residues can promote the development of *B. flabellifer* plantation in Malaysia.

1.4 Objectives

In general, the aim of this study is to analyze the potential utilization of *B. flabellifer* fruit peel as a functional food ingredient. The specific objectives of the study are as follows:

a) To evaluate the physicochemical, composition, and functional properties of mesocarp and exocarp of *Borassus flabellifer*.powders

b) To determine the effect of naringinase treatment in reducing bitterness of the mesocarp powders
c) To determine the physicochemical, composition and functional properties of the debittered mesocarp powders.
d) To evaluate the effect of substitution of debittered mesocarp on muffin's physicochemical and sensory properties.

REFERENCES

Abdel-Aal, E. S. M., Young, J. C., & Rabalski, I. (2006). Anthocyanin composition in black, blue, pink, purple, and red cereal grains. *Journal of Agricultural and Food Chemistry*, 54(13), 4696-4704.

Adepoju, O. T., & Onasanya, L. O. (2008). Nutrient composition and antinutritional factors of *Dialium guineense* willd fruit pulp. *Ife Journal of Science*, 10(1), 33-37.

Adom, K. K., & Liu, R. H. (2002). Antioxidant activity of grains. *Journal of Agricultural and Food Chemistry*, 50(21), 6182-6187.

Abdulrahman, F., Ismail, A., Abdul, A., Azlan, A., & Al-sheraji, S. H. (2011). Characterisation of fibre-rich powder and antioxidant capacity of *Mangifera pajang K*. fruit peels. *Food Chemistry*, 126(1), 283–288.

Abioye, V. F., Akande, E. A., & Aluko, B. O. (2014). Effects of Different Local Debittering Methods on Some Chemical Components and Antioxidants in Bitter Leaf (*Vernonia amygdalina*). *International Journal of Research in Chemistry and Environment* (IJRCE), 4(1), 96-101.

Agustiniano-Osornio, J. C., González-Soto, R. A., Flores-Huicochea, E., Manrique-Quevedo, N., Sánchez-Hernández, L., & Bello-Pérez, L. A. (2005). Resistant starch production from mango starch using a single-screw extruder. *Journal of the Science of Food and Agriculture*, 85(12), 2105-2110.

Ahmad, M., Baba, W. N., Wani, T. A., Gani, A., Gani, A., Shah, U., ... & Masoodi, F. A. (2015). Effect of green tea powder on thermal, rheological & functional properties of wheat flour and physical, nutraceutical & sensory analysis of cookies. *Journal of Food Science and Technology*, 52(9), 5799-5807.

Akpata, M. I., & Akubor, P. I. (1999). Chemical composition and selected functional properties of sweet orange (*Citrus sinensis*) seed flour. *Plant Foods for Human Nutrition*, 54(4), 353-362.

Akubor P. I. & Badifu G. I. (2004). Chemical composition, functional properties and baking potential of African breadfruit kernel and wheat flour blends. International *Journal of Food Science and Technology*, 39(2), 223-229.

Aiyegroro, O.A., & Okoh, A.I. (2010). Preliminary phytochemical screening and in vitro antioxidant activities of aqueous extract of *Helichrysum longifolium* DC. *BMC complementary and Alternative Medicine,* 10: 21

Ajila, C. M., Leelavathi, K., & Prasada Rao, U. (2008). Improvement of dietary fiber content and antioxidant properties in soft dough biscuits with the incorporation of mango peel powder. *Journal of Cereal Science*, 48(2), 319–326.

Alamelumangai, M., Dhanalakshmi, J. Mathumitha, M., Saranya, R. R., Muthukumaran, P., & Saraswathy, N. (2014). In vitro studies on phytochemical evaluation and antimicrobial activity of *Borassus flabellifer* Linn against some human pathogens. *Asian Pacific Journal of Tropical Medicine,* 7(1): 182-185.

Ali, B. H., Blunden, G., Tanira, M. O., & Nemmar, A. (2008). Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale Roscoe*): a review of recent research. *Food and chemical Toxicolology*, 46 (2): 409-420.

Alpaslan, M., & Hayta, M. (2006). The effects of flaxseed, soy and corn flours on the textural and sensory properties of a bakery product. *Journal of Food Quality*, 29(6), 617-627.

Aman, A., Jansz, R., & Sinha, S. (2018). The Palmyrah Palm (*Borassus flabellifer L* .): Overview of Biology , Uses , and Cultivation. *Biomolecule Reports*, (November), 1–5.

Ambigaipalan, P., & Shahidi, F. (2015). Date seed flour and hydrolysates affect physicochemical properties of muffin. Food bioscience, 12, 54-60. Aminah A. (2000). Panduan Makmal Penilaian Sensori. Malaysia: Penerbit UKM.

Andersen, C. J., & Fernandez, M. L. (2013). Dietary approaches to improving atheroprotective HDL functions. *Food & function*, 4(9), 1304-1313.

AOAC International. (1993). Methods of Analysis for Nutrition Labelling. Chapter 33. Sugars (Mono and Di), Glucose, Fructose, Sucrose and Maltose in Presweetened Cereals Liquid Chromatograpic Method (982.14); Sugars (Mono and Di), Separation of Sugars in Honey Liquid Chromatographic Method (977.20)

AOAC International – Association of Analytical Communities. (2000). Official methods of analysis of AOAC international (17th ed.). Gaithersburg, MD, USA: AOAC International.

AOAC. (2005). In W. Horwitz, & G.W. Latimer (Eds.), Official methods of analysis of AOAC International 18th ed, p. 2200. Gaithersburg: AOAC.

Ariyasena, D.D., Jansz, E.R. & Baeckstrom, P. (2002). Direct Isolation of Flabelliferins of Palmyrah By MPLC. *Journal of the National Science Foundation of Sri Lanka*, 30(1-2)

Ariyasena, D. D., Jansz, E. R., Abeysekera, A. M. (2001). Some studies directed at increasing the potential use of palmyrah (*Borassus flabellifer* L) fruit pulp. *Journal of Science of Food and Agriultural,* 81: 1347-1352.

Ariyasena, D. D., Jansz, E. R., Jayesekera, S., & Abeysekara, A. M. (2000). Inhibitory effect of bitter principle of palmyrah (*Borassus flabellifer* L.) fruit pulp on the growth of mice: evidence using bitter and non-bitter fruit pulp. *Journal of Science and Food of Agricultural*, 80: 1763-1766.

Asma, F.Z., Rodiah, M.H., & Aziah, M.Y. 2016. Microwave-assisted extraction of natural colorant extracted from mesocarp and exocarp of *Cocos nucifera* (coconut palm). *European Journal of Biotechnology and Bioscience*, 4(4):1-5.

Ateş, G., & Elmacı, Y. (2019). Physical, chemical and sensory characteristics of fiber-enriched cakes prepared with coffee silverskin as wheat flour substitution. *Journal of Food Measurement and Characterization*, 13(1), 755-763.

Ayala-Zavala, J. F., Vega-Vega, V., Rosas-Domínguez, C., Palafox-Carlos, H., Villa- Rodriguez, J. A., Siddiqui, W., et al. (2011). Agro-industrial potential of exotic fruit byproducts as a source of food additives. *Food Research International*, 44(7), 1866–1874.

Aydogdu, A., Sumnu, G., & Sahin, S. (2017). Effects of addition of different fibers on rheological characteristics of cake batter and quality of cakes. *Journal of Food Science and Technology*, 55(2), 667–677.

Azelee, N. I. W., Jahim, J. M., Rabu, A., Murad, A. M. A., Bakar, F. D. A., & Illias, R. M. (2014). Efficient removal of lignin with the maintenance of hemicellulose from kenaf by two-stage pretreatment process. *Carbohydrate polymers*, 99, 447-453.

Baixauli R., Salvador A. & Fiszman S. M. (2008). Textural and colour changes during storage and sensory shelf life of muffins containing resistant starch. *European Food Research and Technology*, 226, 523-530.

Basanta, M. F., de Escalada Plá, M. F., Raffo, M. D., Stortz, C. A., & Rojas, A. M. (2014). Cherry fibers isolated from harvest residues as valuable dietary fiber and functional food ingredients. *Journal of Food Engineering*, 126, 149-155.

Bayton, R. P. (2007). A revision of *Borassus L.* (Arecaceae). Kew Bulletin, 62(4), 561–585. Retrieved from http://www.jstor.org/stable/20443389

Belscak-Cvitanovic, A., Benkovic, M., Komes, D., Bauman, I., Horzic, D., Dujmic, F., & Matijasec, M. (2010). Physical properties and bioactive constituents of powdered mixtures and drinks prepared with cocoa and various sweeteners. *Journal of Agricultural and Food Chemistry*, 58(12), 7187-7195.

Belitz, H. D., & Wieser, H. (1985). Bitter compounds: occurrence and structure-activity relationships. *Food Reviews International*, 1(2), 271-354.

Benković, M., Tušek, A. J., Belščak-Cvitanović, A., Lenart, A., Domian, E., Komes, D., & Bauman, I. (2015). Artificial neural network modelling of changes in physical and chemical properties of cocoa powder mixtures during agglomeration. *LWT-Food Science and Technology,* 64(1), 140-148.

Benítez, V., Mollá, E., Martín-Cabrejas, M. A., Aguilera, Y., López-Andréu, F. J., & Esteban, R. M. (2011). Effect of sterilisation on dietary fibre and

physicochemical properties of onion by-products. *Food chemistry*, 127(2), 501-507.

Berlin, A., Gilkes, N., Kurabi, A., Bura, R., Tu, M., Kilburn, D., & Saddler, J. (2005). Weak lignin-binding enzymes. *Applied Biochemistry and Biotechnology*, 121(1), 163-170.

Bisswanger, H. (2019). Practical enzymology. John Wiley & Sons.

Buamard, N., & Benjakul, S. 2015. Improvement of gel properties of sardine (*Sardinella albella*) surimi using coconut husk extracts. *Food Hydrocolloids,* 51:146–155.

Buriti, F. C., Freitas, S. C., Egito, A. S., & dos Santos, K. M. (2014). Effects of tropical fruit pulps and partially hydrolysed galactomannan from *Caesalpinia pulcherrima* seeds on the dietary fibre content, probiotic viability, texture and sensory features of goat dairy beverages. *LWT-Food Science and Technology*, 59(1), 196-203.

Busto, M. D., Meza, V., Ortega, N. & Perez-Mateos, M. (2007). Immobilization of naringinase from *Aspergillus niger* CECT 2088 in poly (vinyl alcohol) cryogels for the debittering of juices. *Food Chemistry*,104, 1177-1182.

Cervera S. M., Sanz T., Salvador A. & Fiszman S. M. (2012). Rheological, textural and sensorial properties of low-sucrose muffins reformulated with sucralose/polydextrose. *LWT- Food Science and Technology,* 4, 213-220.

Chakraborty, M., & Mitra, A. 2008. The antioxidant and antimicrobial properties of the methanolic extract from *Cocos nucifera* mesocarp. *Food Chemistry,* 107(3): 994–999.

Chandra, R. P., Ewanick, S. M., Chung, P. A., Au-Yeung, K., Del Rio, L., Mabee, W., & Saddler, J. N. (2009). Comparison of methods to assess the enzyme accessibility and hydrolysis of pretreated lignocellulosic substrates. *Biotechnology letters*, 31(8), 1217-1222.

Chang, R. C., Li, C. Y., & Shiau, S. Y. (2015). Physico-chemical and sensory properties of bread enriched with lemon pomace fiber. *Czech Journal of Food Sciences*, 33(2), 180-185.

Chau, C. F., & Huang, Y. L. (2003). Comparison of the chemical composition and physicochemical properties of different fibers prepared from the peel of *Citrus sinensis L*. Cv. Liucheng. *Journal of Agricultural and food chemistry*, 51(9), 2615-2618.

Chaubey, P. S., Somani, G., Kanchan, D., Sathaye, S., Varakumar, S., & Singhal, R. S. (2018). Evaluation of debittered and germinated fenugreek (*Trigonella foenum graecum L*.) seed flour on the chemical characteristics, biological activities, and sensory profile of fortified bread. *Journal of Food Processing and Preservation*, 42(1), 13395.

Chauchan, A., Saxena, D. C., & Singh, S. (2016). Physical, textural, and sensory char- acteristics of wheat and amaranth flour blend cookies. *Cogent Food and Agriculture*, 2, 1125773.

Chaurasiya, A. K., Chakraborty, I., & Saha, J. (2014). Value addition of Palmyra palm and studies on the storage life. *Journal of food science and technology*, 51(4), 768-773.

Chavez-Santoscoy, R. A., Gutierrez-Uribe, J. A., & Serna-Saldívar, S. O. (2009). Phenolic composition, antioxidant capacity and in vitro cancer cell cytotoxicity of nine prickly pear (*Opuntia spp*.) juices. *Plant Foods for Human Nutrition,* 64: 146–152.

Chikezie, P. C., Akuwudike, A. R., & Chikezie, C. M. (2013). Thermal and pH stabilities of partially purified polyphenol oxidase extracted from *Solanum melongenas* and *Musa sapientum* fruits. *African Journal of Biotechnology*, 12(38).

Chu, Y. H., Chang, C. L., & Hsu, H. F. (2000). Flavonoid content of several vegetables and their antioxidant activity. *Journal of the Science of Food and Agriculture,* 80(5), 561-566.

Chung, K. T., Wong, T. Y., Wei, C. I., Huang, Y. W., & Lin, Y. (1998). Tannins and human health: a review. *Critical reviews in food science and nutrition*, 38(6), 421-464.

Collar, C., Rosell, CM, Muguerza, B., & Moulay, L. (2009) Breadmaking performance and keeping behavior of cocoa-soluble fiber- enriched wheat breads. *Food Sci Technol Int,* 15:79–87.

Corke H., De Leyn I., Nip W. K. & Cross, N. A. (2008). Bakery products: science and technology. John Wiley & Sons: United Kingdom

Coupland, J. N., & Hayes, J. E. (2014). Physical approaches to masking bitter taste: lessons from food and pharmaceuticals. *Pharmaceutical research*, 31(11), 2921-2939.

Costa, S. A., Tzanov, T., Carneiro, F., Gübitz, G. M., & Cavaco-Paulo, A. (2002). Recycling of textile bleaching effluents for dyeing using immobilized catalase. *Biotechnology letters*, 24(3), 173-176.

Das, B. C., & Das, S. N. 2003. Cultivation of minor fruits. India: Kalyani Publishers.

Debenthini, S., Brasathe, J., & Sarananda, K. H. (2014, December). Antioxidant Properties of Palmyrah (*Borassus flabellifer L.*) Fruit Pulp and Effect of Heat Treatment on Bitterness. *In Proceedings of the Faculty of Agriculture Undergraduate Research Symposium*.

de Escalada Pla, M. F., González, P., Sette, P., Portillo, F., Rojas, A. M., & Gerschenson, L. N. (2012). Effect of processing on physico-chemical

characteristics of dietary fibre concentrates obtained from peach (*Prunus persica L*.) peel and pulp. *Food research international*, 49(1), 184-192.

de Moraes Crizel, T., Jablonski, A., de Oliveira Rios, A., Rech, R., & Flôres, S. H. (2013). Dietary fiber from orange byproducts as a potential fat replacer. *LWT-Food Science and Technology,* 53(1), 9-14.

Dhen N., Román L., Rejeb I. B., Martínez, M. M., Garogouri, M. & Gómez M. (2016). Particle size distribution of soy flour affecting the quality of enriched gluten-free cakes. *LWT-Food Science and Technology*, 66, 179-185

Din, A., Aftab, S., Bukhari, H., Salam, A., Ishfaq, B. 2011. Development of functional and dietetic beverage from bitter gourd. *Food Technology*, 13, 355–360.

Dizhbite, T., Telysheva, G., Jurkjane, V., & Viesturs, U. 2004. Characterization of the radical scavenging activity of lignins-natural antioxidants. *Bioresource Technology,* 95: 309–317

Dizlek, H. (2015). Effects of amount of batter in baking cup on muffin quality. *International Journal of Food Engineering*, 11(5), 629–640.

Donadini, G.; Fumi, M.D.; Lambri, M. The hedonic response to chocolate and beverage pairing: A preliminary study. *Food Res. Int.* 2012, 48, 703–711.

Drewnoswki, A. (2001). The science and complexity of bitter taste. *Nutrition Reviews*, 59(6), 163–169.

Drewnowski, A., Gomez-Carneros, C. 2000. Bitter taste, phytonutrients, and the consumer: A review. *The American Journal of Clinical Nutrition*, 72(6), 1424–1435

Duddukuri, G. R., Sastry, Y. N., Kaladhar, D. S. V. G. K., Rao, K. K., & Chaitanya, K. K. (2011). Antibacterial activity of methanolic seed coat extract of *Borassus flabellifer L*. *International Journal of Pharmaceutical Sciences and Research,* 2(9), 2435.

Eleazu, C. O., Okafor, P. N., & Ahamefuna, I. 2010. total antioxidant capacity, nutritional composition and inhibitory activity of unripe plantain (*Musa paradisiacae*) on oxidative stress in alloxan induced diabetic rabbits. *Pakistan Journal of Nutrition,* 9(11):1052-1057.

Eleazu, C.O., Eleazu, K.C., Awa, E & Chukwuma, S.C. 2012. Comparative study of the phytochemical composition of the leaves of five Nigerian medicinal plants. *Journal of Biotechnology and Pharmaceutical Research,* 3(2):42-46.

Elleuch, M., Bedigian, D., Roiseux, O., Besbes, S., & Blecker, C. (2011). Dietary fibre and fibre-rich by-products of food processing : Characterisation , technological functionality and commercial applications : A review. *Food Chemistry*, *124*(2), 411–421.

Emojorho, E. E., & Akubor, P. I. (2016). Effect of Debittering Methods on the Minerals, and Phytochemical Properties of Orange (*Citrus Sinensis*) Seeds Flour. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, *10*(9), 134-139.

EU (2011) Regulation (EU) No 1169/2011 of the European parliament and of the Council on the provision of food information to consumers. *Official Journal of the European Union (2011) L 304* p. 18–63

Falade, K. O., & Okafor, C. A. (2013). Food Hydrocolloids Physicochemical properties of fi ve cocoyam (*Colocasia esculenta* and *Xanthosoma sagittifolium*) starches. *Food Hydrocolloids,* 30(1), 173–181.

Femenia, A., Sastre-Serrano, G., Simal, S., Garau, M. C., Eim, V. S., & Rosselló, C. (2009). Effects of air-drying temperature on the cell walls of kiwifruit processed at different stages of ripening. *LWT-Food Science and Technology*, 42(1), 106-112.

Ferreira, L., Afonso, C., Vila-Real, H., Alfaia, A. and Ribeiro, M. H.L. (2008). Debittering of grapefruit juice with naringinase, *Food Technology and Biotechnology*, 46 (2): 146– 150.

Figuerola F., Hurtado M.L., Estévez A.M., Chiffelle I. & Asenjo F. (2005). Fibre concentrates from apple pomace and citrus peel as potential fibre sources for food enrichment. *Food Chemistry*, 91(3), 395-401.

Fuentes-alventosa, J. M., Rodríguez-gutiérrez, G., Jaramillo-carmona, S., & Espejo-calvo, J. A. (2009). Effect of extraction method on chemical composition and functional characteristics of high dietary fibre powders obtained from asparagus by-products. *Food Chemistry*, 113(2), 665–671.

Galet, L., Patry, S., & Dodds, J. (2010). Determination of the wettability of powders by the Washburn capillary rise method with bed preparation by a centrifugal packing technique*. Journal of Colloid and Interface Science, 346(2), 470–475.*

Garau, M. C., Simal, S., Rosselló, C., & Femenia, A. (2007). Effect of air drying temperature on physico-chemical properties of dietary fiber and antioxidant capacity of orange (*Citrus aurantium cv. Canoneta*) by-products. *Food Chemistry*, 104, 1014–1024

García Herrera, P., Sánchez-Mata, M. C., & Cámara, M. 2010. Nutritional characterization of tomato fiber as a useful ingredient for food industry. Innovative *Food Science and Emerging Technology,* 11(4):707–711.

GEA Niro. (2005). GEA niro method, No. A 5A: Wettability. Retrieved from http://www.niro.dk/niro/cmsdoc.nsf/WebDoc/ndkw6dknxs. on 13 November 2018.

Georges, A. N. Z., & Simard, R. E. (1992). Characteristics of juice from Palmyrah palm (Borassus) fruit. *Plant Foods for Human Nutrition*, 42(1), 55-70.

George, J., & Karun, A. (2011). Marker assisted detection of seed sex ratio in palmyrah palm (*Borassus flabellifer L.*). *Current Science*, 922-925.

Goswami D, Gupta R. K., Mridula D., Sharma M. & Tyagi S. K. (2015). Barnyard millet based muffins: Physical, textural and sensory properties. *LWT- Food Science and Technology*, 64, 374–380.

Goyal, A., Sharma, V., Kumar, M., Tomar, S. K., Arora, S., Sabikhi, L., & Singh, A. K. (2015). Development and physico-chemical characterization of microencapsulated flaxseed oil powder : A functional ingredient for omega-3 fortification. Powder Technology, 286, 527–537.

Grigelmo-Miguel, N., Carreras-Boladeras, E., & Martín-Belloso, O. (2001). Influence of the Addition of Peach Dietary Fiber in Composition, Physical Properties and Acceptability of Reduced-Fat Muffins. *Food Science and Technology International,* 7(5), 425–431.

Gularte, M. A., Gómez, M., & Rosell, C. M. (2012). Impact of legume flours on quality and in vitro digestibility of starch and protein from gluten-free cakes. *Food and Bioprocess Technology*, 5(8), 3142-3150.

Gularte, M. A., Gómez, M., & Rosell, C. M. (2012). Impact of legume flours on quality and in vitro digestibility of starch and protein from gluten-free cakes. *Food and Bioprocess Technology*, 5(8), 3142-3150.

Gummadi V. P., Battu, G. R., Keerthana Diyya M. S., & Manda K. (2016). A review on palmyra palm (*Borassus flabellifer)*. I*nternational Journal of Current Pharmaceutical Review and Research*, 8(2), 17–20.

Harwood, M.L.; Ziegler, G.R.; Hayes, J.E. (2012). Rejection thresholds in chocolate milk: Evidence for segmentation. *Food Qual. Prefer*., 26, 128–133

Hasnaoui, N., Wathelet, B., & Jiménez-Araujo, A. (2014). Valorization of pomegranate peel from 12 cultivars: dietary fibre composition, antioxidant capacity and functional properties. *Food chemistry*, 160, 196-203.

Hassan, R. M., Bakar, J., Rahman, R. A., & Muhamad, S. K. S. (2019). Flabelliferin removal by sodium salts and sodium hydroxide: Pretreatment in *Borassus flabellifer* mesocarp. *Malaysian Journal of Fundamental and Applied Sciences*, 15(2-1), 313-318.

Hennermann, J. B., Roloff, S., Gellermann, J., Vollmer, I., Windt, E., Vetter, B., & Querfeld, U. (2013). Chronic kidney disease in adolescent and adult patients with phenylketonuria. *Journal of inherited metabolic disease*, 36(5), 747-756.

Hogekamp, S., & Schubert, H. (2003). Rehydration of food powders. *Food Science and Technology International*, *9*(3), 223-235.

Huang, Y. L., & Hsieh, I. (2019). Physicochemical Properties and Intestinal Health Promoting Water-Insoluble Fiber Enriched Fraction Prepared from Blanched Vegetable Soybean Pod Hulls. *Molecules*, 24(9), 1796.

Ibrahim, A. H. (2009). Physico-chemical and Health-promoting Properties of Dietary Fibre Powder from Pink Guava By-products (Doctoral dissertation, Universiti Putra Malaysia).

Igbonekwu, A. (2017). Production and Characterization of Naringinase Obtained from *Aspergillus niger* in Submerged Fermentation System using Naringin Extracted from Lemon as Carbon Source (Doctoral dissertation).

Jaeger, S. R., Axten, L. G., Wohlers, M. W., & Sun-Waterhouse, D. (2009). Polyphenol-rich beverages: insights from sensory and consumer science. *Journal of the Science of Food and Agriculture*, 89(14), 2356–2363.

Jahurul, M. H. A., Zaidul, I. S. M., Ghafoor, K., Al-Juhaimi, F. Y., Nyam, K. L., Norulaini, N. A. N., & Omar, A. M. (2015). Mango (*Mangifera indica L*.) by-products and their valuable components: A review. *Food chemistry*, 183, 173-180

Jamkhande, P. G., Suryawanshi, V. A., Kaylankar, T. M., & Patwekar, S. L. (2016). Biological activities of leaves of ethnomedicinal plant, *Borassus flabellifer Linn.* (Palmyra palm): An antibacterial, antifungal and antioxidant evaluation. Bulletin of Faculty of Pharmacy, Cairo University, 54(1), 59-66.

Jansz, E. R., Nikawela, J. K., & Gooneratne, J. (1994). Studies on the bitter principle and debittering of Palmyrah fruit pulp. *Journal of the Science and Food Agricultural* 65:185-189.

Jansz, E. R., Wickremasekara, N., & Sumuduni, K. A. V. (2002). A review of the chemistry and biochemistry of seed shoot flour and fruit pulp of the palmyrah palm (*Borassus flabellifer L*). *Journal of the National Science Foundation of Sri Lanka,* 30(1-2).

Jayaratnam, M. (2015). The chemistry and biochemistry of palmyrah products (Doctoral dissertation).

Ji, J., Fitzpatrick, J., Cronin, K., Crean, A., & Miao, S. (2016). Assessment of measurement characteristics for rehydration of milk protein based powders. *Food Hydrocolloids*, *54*, 151-161.

John, M. J., & Anandjiwala, R. D. (2008). Recent developments in chemical modification and characterization of natural fiber-reinforced composites. *Polymer composites*, 29(2), 187-207.

Kaack, K., Pedersen, L., Laerke, H. N., & Meyer, A. (2006). New potato fibre for improvement of texture and colour of wheat bread. *European Food Research and Technology*, 224(2), 199-207.

Karaman, E., Yılmaz, E., & Tuncel, N. B. (2017). Physicochemical, microstructural and functional characterization of dietary fibers extracted from lemon, orange and grapefruit seeds press meals. *Bioactive carbohydrates and dietary fibre*, 11, 9-17.

Kaushal, P., Kumar, V., & Sharma, H. K. (2012). Comparative study of physicochemical, functional, antinutritional and pasting properties of taro (*Colocasia esculenta*), rice *(Oryza sativa*) flour, pigeonpea (*Cajanus cajan*) flour and their blends. *LWT - Food Science and Technology*, 48(1), 59–68.

Keast, R. S. J., Breslin, P. A. S., & Beauchamp, G. K. (2001). Suppression of bitterness using sodium salts. Chimia, 55(5), 441–447.

Keerthi, A. A. P., Ekanayake, S., & Premakumara, G. A. S. (2013). A new cytotoxic flabelliferin from palmyrah (*Borassus flabellifer*L.) flour.

Kelly, G. M., Mahony, J. A. O., Kelly, A. L., Huppertz, T., Kennedy, D., & Callaghan, D. J. O. (2015). Influence of protein concentration on surface composition and physico-chemical properties of spray-dried milk protein concentrate powders. International Dairy Journal, 51, 34–40.

Koffi, E., Sea, T., Dodehe, Y., & Soro, S. (2010). Effect of solvent type on extraction of polyphenols from twenty three Ivorian plants. *Journal of Animal and Plant Sciences (JAPS)*, 5(3), 550-558.

Kondapalli, N., Sadineni, V., Variyar, P. S., Sharma, A., & Obulam, V. S. R. (2014). Impact of γ-irradiation on antioxidant capacity of mango (*Mangifera indica* L.) wine from eight Indian cultivars and the protection of mango wine against DNA damage caused by irradiation. *Process Biochemistry*, 49(11), 1819-1830.

Kraehenbuehl, K., Page-zoerkler, N., Mauroux, O., Gartenmann, K., Blank, I., & Bel-rhlid, R. (2017). Selective enzymatic hydrolysis of chlorogenic acid lactones in a model system and in a coffee extract. Application to reduction of coffee bitterness. *Food Chemistry*, 218, 9–14.

Krawinkel, M. B., Keding, G. B. 2006. Bitter gourd *(Momordica Charantia*): A dietary approach to hyperglycemia. *Nutrition Reviews,* 64, 331–337

Ku, C.S., Mun, S.P., 2008. Optimization of the extraction of anthocyanin from Bokbunja (*Rubus coreanus Miq*.) marc produced during traditional wine processing and characterization of the extracts. *Bioresource Technology* 99, 8325–8330.

Kuan, Y. H., & Liong, M. T. (2008). Chemical and physicochemical characterization of agrowaste fibrous materials and residues. *Journal of agricultural and food chemistry*, 56(19), 9252-9257.

Kumar, R., Rajarajeshwari, N., & Narayana Swamy, V. B. (2012). Isolation and evaluation of *Borassus flabellifer* mucilage as a natural suspending agent. *International Journal of PharmTech Research*, 4(4), 1614–1630.

Kumar, V. V. (2010). Comparative studies on inducers in the production of naringinase from *Aspergillus niger* MTCC 1344. *African Journal of Biotechnology*, 9(45), 7683-7686.

Kurian Alice & Peter, K.V. (2007). Commercial Crops Technology,Vol. 8, pp. 321

Lalel H. J. D., Mahayasa I. N. W., Hidayah Z. & Kartiwan K. (2017). Effort to explore the potential use of palmyrah fruit for functional food. *British Food Journal*, 119(10), 2253-2266.

Lan, G., Chen, H., Chen, S., & Tian, J. (2012). Chemical composition and physicochemical properties of dietary fiber from *Polygonatum odoratum* as affected by different processing methods. *Food Research International*, 49(1), 406-410.

Langley-Evans, S. C. 2000. Antioxidant potential of green and black tea Lario, Y., Sendra, E., Garcıa-Pérez, J., Fuentes, C., Sayas-Barberá, E., Fernández-López, J., & Pérez-Alvarez, J. A. (2004). Preparation of high dietary fiber powder from lemon juice by-products. Innovative Food Science & Emerging Technologies, 5(1), 113-117.

Lario, Y., Sendra, E., Garcıa-Pérez, J., Fuentes, C., Sayas-Barberá, E., Fernández-López, J., & Perez-Alvarez, J. A. (2004). Preparation of high dietary fiber powder from lemon juice by-products. *Innovative Food Science & Emerging Technologies*, 5(1), 113-117.

Lebesi, D. M. & Tzia, C. (2011). Effect of the addition of different dietary fiber and edible cereal bran sources on the baking and sensory characteristics of cupcakes. *Food Bioprocess Tech*, 4:710–22.

Lee, J. W., Kim, G.-J., Rho, K.-A., Chung, K.-H., Yoon, J.-A., & An, J. H. (2015). Quality characteristics and antioxidant activity of muffins containing lemongrass powder. *The Korean Journal of Food and Nutrition*, 28(5), 794–801.

Ley, J. P. (2008). Masking bitter taste by molecules. Chemosensory Perception, 1(1), 58-77.determined using the ferric reducing power (FRAP) assay. *International Journal of Food Science and Nutrition*, 51(3):181–188.

Liu, S.C., Lin, J.T., Wang, C.K., Chen, H.Y., Yang, D.J. (2009). Antioxidant properties of various solvent extracts from lychee (*Litchi chinenesis Sonn*.) flowers. *Food Chemistry*, 577–581.

López-Vargas, J. H., Fernández-López, J., Pérez-Álvarez, J. A., & Viuda-Martos, M. 2013. Chemical, physico-chemical, technological, antibacterial and antioxidant properties of dietary fiber powder obtained from yellow passion fruit (*Passiflora edulis var. flavicarpa*) co-products. *Food Research International,* 51(2)*,* 756–763.

Lorent, J. H., Quetin-leclercq, J., & Mingeot-leclercq, M. 2014. Biomolecular chemistry the amphiphilic nature of saponins and their effects on artificial and biological membranes and potential consequences for red blood and cancer cell, *Organic and Biomolecular Chemistry,* 12:8803–8822.

Ma, M. M., & Mu, T. H. (2016). Effects of extraction methods and particle size

distribution on the structural, physicochemical, and functional properties of dietary fiber from deoiled cumin. *Food chemistry*, *194*, 237-246.

Marchetti, L., Califano, A. N., & Andrés, S. C. (2018). Partial replacement of wheat flour by pecan nut expeller meal on bakery products. Effect on muffins quality. *LWT Food Science and Technology*, 95, 85-91.

Martínez-Cervera S., Salvador A., Muguerza B., Moulay L. & Fiszman S. M. (2011). Cocoa fibre and its application as a fat replacer in chocolate muffins. *LWT-Food Science and Technology 44(3),* 729-736.

Martínez-Cervera S., Salvador A. & Sanz T. (2015). Cellulose ether emulsions as fat replacers in muffins: Rheological, thermal and textural properties. *LWT-Food Science and Technology, 63(2)*, 1083-1090.

Masi, C.; Dinnella, C.; Pirastu, N.; Prescott, J.; Monteleone, E. Caffeine metabolism rate influences coffee perception, preferences and intake. *Food Qual. Prefer*. 2016, 53, 97–104.

Masoodi, F. A., Sharma, B., & Chauhan, G. S. (2002). Use of apple pomace as a source of dietary fiber in cakes. *Plant Foods for Human Nutrition*, 57(2), 121–128.

Matos, M. E., Sanz, T., & Rosell, C. M. (2014). Establishing the function of proteins on the rheological and quality properties of rice based gluten free muffins. *Food Hydrocolloids*, 35, 150-158.

Mildner-Szkudlarz S., Bajerska J., Gornas P., Seglina D., Pilarska A. & Jesionowski T. (2016). Physical and bioactive properties of muffins enriched with raspberry and cranberry pomace powder: A promising application of fruit by- products rich in biocompounds. *Plant Foods for Human Nutrition, 71*, 165–173.

Milmi (2008). “Misteri di balik tape”, Forum Sain, Kupang, available at: http://sylviadwirahayu. wordpress.com/category/sains/ (accessed October 21, 2014).

Mishra N & Chandra R. (2012). Development of functional biscuit from soy flour and rice bran. *International Journal of Agricultural and Food Science, 2*, 14-20.

Mohanadas, S. (2002). The palmyrah palm and the composition of palmyrah fruit pulp. In Hand book of Prof. S. Mageswaran memorial lecture. Sri Lanka: University of Jaffna

Mongeau, R. 2003. Dietary fibre. In R. Macrae, R. K. Robinson, & M. J. Sadler (Eds.), Encyclopaedia of food science and nutrition, p. 1362−1387. NewYork: Academic Press.

Moraes, T. De, Jablonski, A., Oliveira, A. De, Rech, R., & Hickmann, S. (2013). Dietary fi ber from orange byproducts as a potential fat replacer. *LWT - Food Science and Technology*, 53(1), 9–14.

Mukund P, Belur PD, and Saidutta MB (2014). Production of naringinase from a new soil isolate, *Bacillus methylotrophicus*: Isolation, optimization and scale-up studies. *Prep. Biochem. Biotechnol.*, 44: 146-163.

Muñiz, P., Ortega, N., & Busto, M. D. (2011). Effect of enzymatic debittering on antioxidant capacity and protective role against oxidative stress of grapefruit juice in comparison with adsorption on exchange resin. *Food Chemistry*, 125(1), 158–163.

Navarro-González, I., García-Valverde, V., García-Alonso, J., & Periago, M. J. (2011). Chemical profile, functional and antioxidant properties of tomato peel fiber. *Food Research International*, 44(5), 1528-1535.

Nesbitt, M. (2005).The Cultural history of plants. Taylor & George Francis. 173.

Ng, S. P., Tan, C. P., Lai, O. M., Long, K., & Mirhosseini, H. (2010). Extraction and characterization of dietary fiber from coconut residue, *Journal of Food, Agricultural and Environment,* 8 (2):172-177.

Ni, H., Chen, F., Cai, H., Xiao, A., You, Q., & Lu, Y. (2012). Characterization and preparation of *Aspergillus niger* naringinase for debittering citrus juice. J*ournal of Food Science,* 77(1), C1-C7.

Ni, H., Yang, Y. F., Chen, F., Ji, H. F., Yang, H., Ling, W., & Cai, H. N. (2014). Pectinase and naringinase help to improve juice production and quality from pummelo (*Citrus grandis*) fruit. *Food Science and Biotechnology*, 23(3), 739-746.

Nikawala J.K. (2000). Aspects of the chemistry and antimicrobial activity of flabelliferins of palmyrah fruit pulp. M.Phil. Thesis, University of Sri Jayewardenepura.

Nikawala J.K., Jansz E.R., Baeckstrom P., Wijeyaratna S.C. & Abeysekera A.M. (2000). The flabelliferins of naringinase debittered palmyrah fruit pulp. *Vidyodaya Journal of Science*, 9: 81-88

Nikawala J.K., Ariyasena D.D., Jansz E.R. & Abeysekera A.M. (2000). Separation techniques of flabelliferins from palmyrah (*Borassus flabellifer L*.) fruit pulp. *Journal of Science*, Eastern University of Sri Lanka, 1: 1-9.

Nikawala J.K. (2001). Consumer products using palmyrah fruit pulp. Proceedings of the Seminar on Palmyrah Research and Development, 17 Nov 2001. Published by IPICS Sri:O7 group, Department of Biochemistry, 'University of Sri Jayewardenepura. pp 16.

Niro GEA. (2005). GEA Niro Method No. A 10 A: Surface free fat of powder.

Nomanbhay, S. M., Hussain, R., Palanisamy, K., & Al, E. T. 2013. Microwave-assisted alkaline pretreatment and microwave assisted enzymatic saccharification of oil palm empty fruit bunch fiber for enhanced fermentable sugar yield, J*ournal of Sustainable Bioenergy System,* 3:7-17.

Nur Liyana Izyan, Z. (2014). Tensile and thermal properties of oil palm empty fruit bunch regenerated cellulose biocomposite films using ionic liquid (Doctoral dissertation, Universiti Malaysia Perlis (UniMAP)).

Obadoni, B. O., & Ochuko, P. O. 2001. Phytochemical studies and comparative efficacy of the crude extracts of some homeostatic plants in Edo and Delta States of Nigeria. *Global Journal of Pure and Applied Sciences,* 86: 2003-2008.

Obidoa O., Joshua P. E., & Eze N. J. 2010. Phytochemical analysis of *Cocos nucifera* L. *Journal of Pharmacy Research,* 3(2), 280–286.

Okareh, O. T., Adeolu, A. T., & Adepoju, O. T. (2015). Proximate and mineral composition of plantain (*Musa Paradisiaca)* wastes flour; a potential nutrients source in the formulation of animal feeds. *African Journal of Food Science and Technology*, 6(2), 53-57.

Oladiji, A. T. & Mih, F. O. 2005. Proximate composition, mineral and phytochemical constituents of *Eleusine coracana* (finger millet). *African Journal of Biotechnology,* 4 (12): 1440- 1441.

O'Shea N., Arendt E. K. & Gallagher E. (2012). Dietary fibre and phytochemical characteristics of fruit and vegetable by-products and their recent applications as novel ingredients in food products. *Innovative Food Science and Emerging Technologies*, 16, 1-10.

O'Shea, N., Ktenioudaki, A., Smyth, T.P., McLoughlin, P., Doran, L., Auty, M.A.E., Arendt, E., Gallagher, E. 2015. Physicochemical assessment of two fruit by-products as functional ingredients: Apple and orange pomace, *Journal of Food Engineering*, 153, 89-95.

Osundahunsi O. F., Fagbemi T. N., Kesselman E. & Shimoni E. (2003). Comparison of the physicochemical properties and pasting characteristics of flour and starch from red and white sweet potato cultivars. J*ournal of agricultural and food chemistry*, 51(8), 2232-2236.

Pavithra, M., Prasanna, D. B. & Saidutta, M. B. (2013). Production of naringinase by a new soil isolate of Serratia Sp.: Effect of different carbon and nitrogen sources. *Research Journal of Chemistry and Environment*, 6(17): 91-95.

Peerajit, P., Chiewchan, N., & Devahastin, S. (2012). Effects of pretreatment methods on health-related functional properties of high dietary fibre powder from lime residues. *Food Chemistry*, 132(4), 1891–1898.

Peng, X., Ma, J., Cheng, K. W., Jiang, Y., Chen, F., & Wang, M. (2010). The effects of grape seed extract fortification on the antioxidant activity and quality attributes of bread. *Food Chemistry*, 119(1), 49-53.

Perera, D. P. L., Kahandage, P. D. & Rambanda, M. 2015. Introducing a mechanical method for peeling the palmyrah fruits in oder to promote the

palmyrah juice based products. International Research Symposium Rajarata University of Sri Lanka. Colombo: Sri Lanka.

Peerajit, P., Chiewchan, N., & Devahastin, S. (2012). Effects of pretreatment methods on health-related functional properties of high dietary fibre powder from lime residues. *Food Chemistry*, 132(4), 1891–1898.

Ponnuswami, V., Kumar, A. R., Prabhu, M., Jagadeesan, R., Kavino, M., & Selvi, B. S. (2008). Correlation studies in palmyrah (*Borassus flabettifer L.*) genotypes. Asian *Journal of Horticulture*, 3(2), 234-237.

Potumarthi, R., Baadhe, R. R., & Bhattacharya, S. (2013). Fermentable sugars from lignocellulosic biomass: technical challenges. In *Biofuel Technologies* (pp. 3-27). Springer, Berlin, Heidelberg.

Prado, J. M., Forster-Carneiro, T., Rostagno, M. A., Follegatti-Romero, L. A., Maugeri Filho, F., & Meireles, M. A. A. 2014. Obtaining sugars from coconut husk, defatted grape seed, and pressed palm fiber by hydrolysis with subcritical water. *Journal of Supercritical Fluids,* 89:89–98.

Prakash, S., Singhal, R. S., & Kulkarni, P. R. (2002). Enzymic debittering of Indian grapefruit (*Citrus paradisi*) juice. J*ournal of the Science of Food and Agriculture*, 82(4), 394-397.

Puri, M., Seth, M., Marwaha, S. S., & Kothari, R. M. (2001). Debittering of kinnow mandarin juice by covalently bound naringinase on hen egg white. *Food Biotechnology*, 15(1), 13-23.

Puri, M., Banerjee, A., & Banerjee, U. C. (2005). Optimization of process parameters for the production of naringinase by *Aspergillus niger* MTCC 1344. *Process Biochemistry*, 40(1), 195-201.

Puri, M., Marwaha, S. S., Kothari, R. M. & Kennedy, J. S. (1996). Biochemical basis of bitterness in citrus fruit juices and biological approaches for debittering. *Critical Reviews in Biotechnology*, 16, 145- 155

Puwastien P., Siong, T. E., Kantasubrata, J., Craven, G., Feliciano, R. R, & Judprasong, K. (2011). ASEAN Manual of Food Analysis 2011. Thailand: Institute of Nutrition, Mahidol University.

Rabetafika, H. N., Bchir, B., Blecker, C., & Richel, A. (2014). Fractionation of apple by-products as source of new ingredients: Current situation and perspectives. *Trends in Food Science and Technology*, 40(1), 99–114.

Radhakrishnan, I., Sampath, S., & Kumar, S. (2013). Isolation and characterization of enzyme naringinase from *Aspergillus flavus*. I*nternational journal of advanced biotechnology and research*, 4(2), 208-212.

Radhakrisnan, I., Sampath, S. & Satishkumar, T. (2012). Optimization of medium composition for improving naringinase activity using response

surface metodoloy. *International Journal of Biotechnology and Research*, 2: 29-36.

Raghavendra, S. N., Swamy, S. R., Rastogi, N. K., Raghavarao, K. S. M. S., Kumar, S., & Tharanathan, R. N. (2006). Grinding characteristics and hydration properties of coconut residue: A source of dietary fiber. *Journal of Food Engineering*, 72(3), 281-286.

Rajiv, J., Soumya, C., Indrani, D., & Venkateswara Rao, G. (2011). Effect of replacement of wheat flour with finger millet flour (*Eleusine corcana*) on the batter microscopy, rheology and quality characteristics of muffins. *Journal of Texture Studies*, 42(6), 478–489.

Ramírez-Maganda, J., Blancas-Benítez, F. J., Zamora-Gasga, V. M., García-Magaña, M. de L., Bello-Pérez, L. A., Tovar, J., & Sáyago-Ayerdi, S. G. (2015). Nutritional properties and phenolic content of a bakery product substituted with a mango (*Mangifera indica*) "Ataulfo" processing by-product. *Food Research International*, 73, 117–123.

Ravi, K., Rajarajeshwari, N., & Swamy, V. B. N. (2012). Isolation and evaluation of *Borassus flabellifer* mucilage as a natural suspending agent. *International Journal of PharmTech Research*, 4(4), 1614-1630.

Rawson, A., Hossain, M. B., Patras, A., Tuohy, M., & Brunton, N. (2013). Effect of boiling and roasting on the polyacetylene and polyphenol content of fennel (*Foeniculum vulgare*) bulb. *Food Research International*, 50(2), 513-518.

Reddy, C. K., Suriya, M., Vidya, P. V., Vijina, K., & Haripriya, S. (2015). Effect of γ-irradiation on structure and physico-chemical properties of *Amorphophallus paeoniifolius* starch. *International journal of biological macromolecules*, 79, 309-315.

Robertson, J. A., de Monredon, F. D., Dysseler, P., Guillon, F., Amado` , R., & Thibault, J.-F. (2000). Hydration properties of dietary fibre and resistant starch: a European collaborative study. *Lebensmittel-Wis- senschaft und Technology*, 33, 72–79

Robinson, P. K. (2015). Enzymes: principles and biotechnological applications. *Essays in biochemistry*, 59, 1.

Rodiah, M. H., Nur Asma Fhadhila, Z., Kawasaki, N., Noor Asiah, H & Aziah, M. Y. (2018). Antioxidant activity of natural pigment from husk of coconut. *Journal of Tropical and Agricultural Science*, 4:441-452

Rupasena, L. P. and Chandrasiri, A. 1995. Marketing of palmyrah based product, Research Study No. 93. Sri Lanka: Hector Kobbekaduwa Agrarian Research and Training Institute.

Rupasinghe H. V, Wang L., Huber G. M & Pitts N. L. (2008). Effect of baking on dietary fibre and phenolics of muffins incorporated with apple skin powder. *Food Chemistry,* 107(3), 1217-1224.

Sabiha-Hanim, S., Noor, M. A. M., & Rosma, A. 2011. Effect of autohydrolysis and enzymatic treatment on oil palm (*Elaeis guineensis Jacq*.) frond fibres for xylose and xylooligosaccharides production. *Bioresource Technology*, 102(2):1234–1239.

Sagar, B.K., & Singh, R.P. (2011). Genesis and development of DPPH method of antioxidant assay. *Journal of Food Science and Technology*, 48:412–422.

Salvador A. & Fiszman S. (2013). Performance of resistant starches in baking: a case study on fibre-rich and wholegrain muffins. *Fibre-rich and wholegrain foods: improving quality*, 236-255.

Šamec, D., Maretić, M., Lugarić, I., Mešić, A., Salopek-Sondi, B., & Duralija, B. (2016). Assessment of the differences in the physical, chemical and phytochemical properties of four strawberry cultivars using principal component analysis. *Food Chemistry,* 194, 828-834.

Sanz, T., Salvador, A., Baixauli, R. & Fiszman, S. M. (2009). Evaluation of four types of resistant starch in muffins. II. Effects in texture, colour and consumer response. *European Food Research and Technology*, 229(2), 197-204.

Saranya, P. & Vijayakumar, T. P. (2016). Preliminary phytochemical screening of raw and thermally processed palmyra palm (*Borassus flabellifer* linn.) fruit pulp. *Journal of Innovations in Pharmaceutical and Biological Science,* 3(1):186-193.

Saravanya, K., & Kavitha, D. S. (2017). Natural fibers, Palmyra tuber miracle plant. *International Journal of Current Research*, 9(7), 54299–54301.

Sathya, J. H., Franklin, N., Balaji, N., Selvaraj, S., & Seenuvasan, M. (2019). Utilizing *Borassus flabellifer* sprout peel sugars by Pseudomonas fluorescence for degradation of textile effluent. *Journal of Environmental Biology*, 40(4), 736-741.

Sato, S., & Kamei, M. (2005). Unpleasant taste-masked green tea extract compositions with good flavor, and foods and beverages containing them (p. 8). Japan: Morinaga and Co., Ltd.

Schutz, K., Persike, M., Carle, R., Schieber, A. (2006). Characterization and quantification of anthocyanins in selected artichoke (*Cynara scolymus L.*) cultivars by HPLC–DAD–ESI–MS. *Analytical and Bioanalytical Chemistry*, 384, 1511-1517.

Selani, M. M., Brazaca, S. G. C., dos Santos Dias, C. T., Ratnayake, W. S., Flores, R. A., & Bianchini, A. (2014). Characterisation and potential application of pineapple pomace in an extruded product for fibre enhancement. *Food chemistry*, 163, 23-30.

Sendra, E., & Navarro, C. (2012). Chemical, physico-chemical and functional properties of pomegranate (*Punica granatum L*.) bagasses powder co-product. *Journal of Food Engineering*, 110(2), 220–224.

Sharaniya, S., Navaratne, S. B. and Sangheetha, S. (2015). Development of high fibre biscuit from un-boiled palmyrah tuber flour. *Journal of Multidisciplinary Engineering Science Studies,* 1: 2912-1309.

Shirwaikar A.A., Prabu L.S., Mahalaxmi R., Rajendran K. (2007). Studies of disintegrant properties of seed mucilage of *Ocimum gratissimum*, *Ind. J. Pharm. Sci*., 753- 758.

Sindhuja, A., Sudha, M. L., & Rahim, A. (2005). Effect of incorporation of amaranth flour on the quality of cookies. *European Food Research and Technology*, 221(5), 597-601.

Singleton, V. L., Orthofer, R., & Lamuela-Raventos, R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods in Enzymology*, 299, 152–178.

Siti Rashima, R., Maizura, M., Kang, W. M., Fazilah, A., & Tan, L. X. (2017). Influence of sodium chloride treatment and polysaccharides as debittering agent on the physicochemical properties, antioxidant capacity and sensory characteristics of bitter gourd (*Momordica charantia*) juice. *Journal of Food Science and Technology,* 54(1), 228–235.

Soares, N. F. F., & Hotchkiss, J. H. (1998). Bitterness reduction in grapefruit juice through active packaging. Packaging Technology and Science: *An International Journal*, 11(1), 9-18.

Steiner, J. E., Glaser, D., Hawilo, M. E., & Berridge, K. C. (2001). Comparative expression of hedonic impact: Affective reactions to taste by human infants and other primates. *Neuroscience & Biobehavioral Reviews*, 25, 53-74.

Struck, S., Gundel, L., Zahn, S., & Rohm, H. (2016). Fiber enriched reduced sugar muffins made from iso-viscous batters. *LWT-Food Science and Technology*, 65 (1), 32-38

Stewart, D. (2008). Lignin as a base material for materials applications: Chemistry, application and economics. *Industrial crops and products,* 27(2), 202-207.

Szymańska-Chargot, M., Chylińska, M., Gdula, K., Kozioł, A., & Zdunek, A. (2017). Isolation and characterization of cellulose from different fruit and vegetable pomaces. *Polymers,* 9(10), 495.

Talens, C., Álvarez-Sabatel, S., Rios, Y., & Rodríguez, R. (2017). Effect of a new microwave-dried orange fibre ingredient vs. a commercial citrus fibre on texture and sensory properties of gluten-free muffins. *Innovative Food Science and Emerging Technologies*, 44, 83–88.

Tejada-Ortigoza, V., Garcia-Amezquita, L. E., Serna-Saldívar, S. O., & Welti-Chanes, J. (2016). Advances in the functional characterization and extraction processes of dietary fiber. *Food Engineering Reviews*, 8(3), 251-271.

Tess M., Bhaduri S., Ghatak R. & Navder K. P. (2015). Physical, textural and sensory characteristics of gluten free muffins prepared with teff flour (Eragrostistef (ZUCC) trotter). *Journal of Food Processing and Technology*, 6(9).

Thabrew, M. I. & Jansz, E. R. (2004). Nutritive importance of palmyrah products. *Recent Research Development. Environmental Biology*. 1: 43-60.

Thanusan, S., Tharmaratnam, G., & Priyantha, K. D. P. (2018). Physicochemical Evaluation in the Development of Palmyrah and Pineapple Mixed Fruit Toffee. *Annals. Food Science and Technology*, 19 (2). 244-249

Thivya, P., Durgadevi, M., & Jaganmohan, R. (2018). Effect of debittering on the physical and chemical properties of palmyrah young shoots flour. International *Journal of Agriculture, Environment and Biotechnology*, 11(4), 609-614.

Thivya, P., Durgadevi, M., Rawson, A., Vadakkepulppara Ramachandran Nair, S., & Rangarajan, J. (2020). Exploring the feasibility of bitterness reduction in palmyrah young shoot for its effective utilization. *Journal of Food Process Engineering*, 43(3), e13315.

Tikkanen, I. 2007. Maslow's hierarchy and food tourism in Finland: five cases. British Food Journal, 109(9):721–734.

Trease G.E. and Evans W.C. (2008). Pharmacognosy, Saunders, 15th ed., 206.

Tungland B. C. & Meyer D. (2002). Nondigestible oligo-and polysaccharides (dietary fibre): their physiology and role in human health and food. Comprehensive Reviews in Food Science and Food Safety, 1(3), 90-109

Ugartondo, V. Mitjans, M. Vinardell, M. P. 2008. Comparative antioxidant and cytotoxic effects of lignins from different sources. *Bioresourses Technology*, 99: 6683–6687.

Uluwaduge, D. I & Thillainathan, K. (2019). Palmyrah research in Sri Lanka: a way forward, ed. E.R. Jansz, pp. 11-51. Sri Lanka: University of Jaffna

Varela, P., Beltrán, J., Fiszman, S. (2014). An alternative way to uncover drivers of coffee liking: Preference mapping based on consumers' preference ranking and open comments. *Food Qual. Prefer.*, 32, 152–159.

Vasantha Rupasinghe, H. P., Wang, L., Pitts, N. L., & Astatkie, T. (2009). Baking and sensory characteristics of muffins incorporated with apple skin powder. *Journal of Food Quality*, 32(6), 685–694.

Vági, E., Simándi, B., Vásárhelyiné, K.P., Daood, H., Kéry, A., Doleschall, F., Nagya, B. (2007). Supercritical carbon dioxide extraction of carotenoids, tocopherols and sitosterols from industrial tomato by-products. *Journal of Supercritical Fluid*, 40, 218–226.

Variyar, P. S., Limaye, A., & Sharma, A. (2004). Radiation-induced enhancement of antioxidant contents of soybean (Glycine max Merrill). *Journal of Agricultural and Food Chemistry*, 52, 3385–3388.

Vengaiah, P. C, Vijaya Trease a, B, Murthy, G. N., and Prasad, K. R. 2015. Physico-chemical properties of palmyrah fruit pulp (*Borassus flabellifer* L). *Journal of Nutrition and Food Science*, 5:391.

Vignolles, M. L., Jeantet, R., Lopez, C., & Schuck, P. (2007). Free fat, surface fat and dairy powders: interactions between process and product. *A review. Le Lait,* 87(3), 187-236.

Vijaya kumara B, V. P., & Prasad KR, M. G. (2015). Physico-Chemical Properties of Palmyrah fruit Pulp (*Borassus flabellifer L*). *Journal of Nutrition & Food Sciences*, 05(05).

Viuda-Martos, M., López-Marcos, M.C., Fernández-López, J., Sendra, E., López- Vargas, J.H., Pérez-Alvarez, J.A. 2010. Role of fibre in cardiovascular diseases: a review. *Comprehensive Reviews in Food Science and Food Safety*, 9:240–258.

Viuda-martos, M., Barber, X., Pérez-álvarez, J. A., & Fernández-lópez, J. 2015. Assessment of chemical, physico-chemical, techno-functional and antioxidant properties of fig (Ficus carica L.) powder co-products. *Industrial Crops and Product*, 69:472–479.

Walker R., Tseng A., Cavender G., Ross A. & Zhao Y. (2014). Physicochemical, nutritional, and sensory qualities of wine grape pomace fortified baked goods. *Journal of Food Science,* 79, 1811–1822

Wickramasekara, N. T., & Jansz, E. R. (2003). The range of steroidal saponins of palmyrah flour: could they contribute to toxic effect on consumers. *Journal of Science EUSL,* 3(1), 11-18.

Widiyanti, N. L. P. M., Mulyadiharja, S., Sukarta, I. N., & Pradnyandari, N. W. I. (2018). The effect of addition sucrose concentrations toward weight of Nata DE Lontar (*Borassus flabellifer*) Linn. In Journal of Physics: Conference Series (Vol. 1040, No. 1, p. 012006). IOP Publishing.

Wijewardana R.M.N.A, Nawarathne, S.B, Wickramasinghe, I, Gunawardane, C.R, Wasala, W.M.C.B, & Thilakarathne, B.M.K.S. 2016. Retention of physicochemical and antioxidant properties of dehydrated bael (*Aegle marmelos*) and palmyra (*Borassus flabellifer*) fruit powders. *Procedia Food Science,* 6:170 – 175

Wong, P. Y. Y., & Kitts, D. D. (2003). A comparison of the buttermilk solids functional properties to nonfat dried milk, soy protein isolate, dried egg white, and egg yolk powders. *Journal of Dairy Science,* 86(3), 746-754.

Yadav V., Yadav, P. K., Yadav, S., Yadav, K. D. S. (2010) Rhamnosidase: a review. *Process Biochem*, 45:1226–1235

Yalim S, Ozdemir, Y., Ibrahim Ekiz, H .(2004). Naringin in Turkish Orange Juices and Its Reduction by Naringinase. *Journal of Food and Drug Analysis*, 12: 273–276.

Yoshikawa, M., Xu, F., Morikawa, T., Pongpiriyadacha, Y., Nakamura, S., Asao, Y. & Matsuda, H. (2007). Medicinal flowers. XII. 1) New spirostane-type steroid saponins with antidiabetogenic activity from *Borassus flabellifer*. *Chemical and Pharmaceutical bulletin*, 55(2), 308-316.

Zambrano, F., Despinoy, P., Ormenese, R. C. S. C., & Faria, E. V. (2004). The use of guar and xanthan gums in the production of 'light'low fat cakes. *International Journal of Food Science & Technology,* 39(9), 959-966.

Zhou, X. L., Qian, Y. F., Zhou, Y. M., & Zhang, R. (2012). Effect of enzymatic extraction treatment on physicochemical properties, microstructure and nutrient composition of tartary buckwheat bran: A new source of antioxidant dietary fiber. In *Advanced Materials Research* (Vol. 396, pp. 2052-2059). Trans Tech Publications Ltd.

Zhu, Y., Dong, Y., Qian, X., Cui, F., Guo, Q., Zhou, X., & Xiong, Z. (2012). Effect of superfine grinding on antidiabetic activity of bitter melon powder. *International Journal of Molecular Sciences*, 13(11), 14203-14218.

Zhu, Yunping, Jia, H., Xi, M., Li, J., Yang, L., & Li, X. (2017). Characterization of a naringinase from *Aspergillus oryzae* 11250 and its application in the debitterization of orange juice. *Process Biochemistry*, 62, 114–121.

BIODATA OF STUDENT

Rodiah was born in Butterworth, Pulau Pinang in 1981. When she finished her SPM, she furthered her studies in Diploma of Forestry at Universiti Putra Malaysia. After one year of studies, she made a big decision to change her course to Science Biotechnology. Therefore, she applied for promotion from diploma to degree using her excellent result through promotion program. After 3 years, she graduated her Bachelor Degrees in Science Biotechnology in 2003. Later, she continued her studies as a Master student in the field of Food Technology at Universiti Sains Malaysia and graduated in 2008. After sixth years, she enrolled her study for PhD program at the Department of Food Technology, Faculty of Science and Food Technology, Universiti Putra Malaysia.

She is currently working as a lecturer at Universiti Selangor in Biotechnology field. Prior to joining Universiti Selangor, Rodiah worked as a Research Assistant at School of Industrial Technology, Universiti Sains Malaysia from 2006 to 2008. She is now married to Amzari Abu Bakar and blessed with three children, two girls and one boy. Rodiah has always been very dedicated and hardworking when trying to achieve her goals. Even though, she only gets part time study leave from her organization but she is very determined in completing her PhD journey. She has facing problem in managing her time within her career, family and studies but she does not let any obstacles get in her way; she preserves and keeps working towards her dreams.

LIST OF PUBLICATIONS

Publication in Indexed Journal:

Rodiah MH, Jamilah B, Sharifah Kharidah SM and Russly AR. (2019). Physico-chemical and Antioxidant Properties of Mesocarp and Exocarp from *Borassus flabellifer*, International Food Research Journal 26(5): 1469-1476.

Rodiah Mohd Hassan, Jamilah Bakar, Russly Abdul Rahman and Kharidah Muhamad. (2019). Flabelliferin removal by sodium salts and sodium hydroxide: Pretreatment in *Borassus flabellifer* mesocarp, *Malaysian Journal of Fundamental and Applied Sciences Special Issue on International Conference on Agriculture, Animal Sciences and Food Technology (ICAFT 2018),* 313-318.

Rodiah M. H., Jamilah B., Norhayati, H., and Kharidah M. Functional Properties of *Borassus flabellifer* Mesocarp Powder and Its Effect on Muffin Properties, *Food Chemistry*, Under Review (Manuscript ID:FOODCHEM-D-20-07545)

Publication in Indexed Proceeding:

Rodiah M. H. Jamilah B., Kharidah. M., Russly A. R. (2019). The Effects of Enzymatic Treatment on The Phytochemical Content and Antioxidant Properties of Mesocarp of *Borassus flabellifer*. eProceeding 2nd International Postgraduate Symposium in Biotechnology (IPSB) 2019 (Noor Azwani et al., eds), pp 23-26, Institute of Bioproduct Development, Universiti Teknologi Malaysia
ISBN (eISBN-978-983-99322-6-3).

Rodiah M. H., Jamilah B., Russly A. R., and Sharifah Kharidah S. M. (2017). Chemical Composition of Mesocarp and Exocarp from *Borassus flabellifer, Proceedings of the International Food Research Conference 2017*, pp 371-375, Faculty of Food Science and Technology, Universiti Putra Malaysia.
ISBN: 978-967-960-421-4

Publication in Non-Indexed Proceeding:

Rodiah M. H., Jamilah B., Sharifah Kharidah and Russly A. R., S. M. (2017). The removal of flabelliferin by sodium salts and sodium hydroxide in *Borassus flabellifer* mesocarp*, Proceedings of the International Conference on Agriculture, Animal Sciences and Food Technology 2018*, pp 301-309, Faculty of Bioresources and Food Industry (FBIM), Universiti Sultan Zainal Abidin (UniSZA).

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30-31 October 2018

2nd International Postgraduate Symposium in Biotechnology 2019 (IPSB 2019),
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24th – 25th September 2019

Award and Product Innovation

Award: Silver
Product's name: Flabelli-Fiber
Event/Competition: Intelectual Research and Innovation Showcase (IRIS2019), Universiti Selangor.

Media Appearances

TV programme: Misteri Nadir: Kelapa Laut (Episode 4)
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