UNIVERSITI PUTRA MALAYSIA

PHYSICOCHEMICAL CHARACTERISTICS, MICROBIAL SAFETY AND BIOLOGICAL ACTIVITIES OF FERMENTED BLACK SESAME (Sesamum indicum L.) SEEDS DREGS

NUR KAMARIAH BINTI ROSNI

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By

NUR KAMARIAH BINTI ROSNI

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

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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June 2020

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Faculty : Food Science and Technology

Utilization of dregs has been widely used, especially in Indonesia, such as peanut dregs into local Indonesian food known as “oncom”. Sesame seed dregs are derived from the process of making sesame oil. The seed dregs were then proceeded with spontaneous fermentation for 7 days at room temperature (23-27°C). During fermentation, physicochemical characteristics of the food product may undergo changes with microorganisms and bioactivities involvement in the process. The aims of this study were to analyse physicochemical characteristics and microbiological safety and quality of black sesame seed dregs during fermentation, to determine antimicrobial and antioxidant activity, and to identify bioactive compounds in raw black sesame seeds and fermented seed dregs extract. Physicochemical characteristics including internal temperature, pH value, total soluble solid (TSS), water activity (a_w), colour determination, proximate analysis and texture profile analysis of seed dregs during fermentation were analysed using Association of Analytical Communities (AOAC) methods for food analysis. The present of microorganisms including total plate count (TPC), *Escherichia coli*, *Salmonella* spp., *Pseudomonas aeruginosa*, *Bacillus cereus*, *Staphylococcus aureus*, lactic acid bacteria (LAB), coliform bacteria, mould and yeast in seed dregs during fermentation were isolated using microbial selective media. The collected samples for analysis were raw seeds and seed dregs at day 0, 1, 3, 5 and 7 of fermentation. Raw seeds and fermented seed dregs (day 7) were extracted using water and ethanol and the extracts were further determined for antimicrobial activity against foodborne pathogens using Clinical and Laboratory Standard Institute (CLSI) methods. The total phenolic content was determined using a Folin-Ciocalteu assay and antioxidant activity was determined using 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay. The bioactive compounds in ethanol extract of raw seeds and fermented seed dregs were determined using Gas Chromatography-Mass Spectrometry (GC-MS) and Liquid Chromatography-Mass Spectrometry (LC-MS). The results showed that internal temperature, pH and TSS showed no significant differences

while a_w shows the significant increased from 0.53 to 0.92% during fermentation. The colour determination of final product had the highest lightness and yellowness but had the lowest redness. Moisture was significantly increased while ash, crude protein and carbohydrate were decreased and crude fat and fibre were showed no significant differences during fermentation. A gradually increased in hardness and decreased in springiness, chewiness and resilience were observed while cohesiveness showed no significant differences. Microbial counts were reduced in number of *P. aeruginosa* and *B. cereus* while increased in number of TPC, *S. aureus*, lactic acid bacteria, coliform bacteria and mould and yeast. The extraction yield using ethanol showed higher yield than water. Diameter of inhibition zones of extracts against 16 pathogenic microorganisms were in the ranged from 6.50 to 11.00 mm. Minimum inhibitory concentrations (MICs) of water extract were in the range from 3.13 to >50.00 mg/mL, mostly effective against *B. cereus* ATCC33019. Meanwhile, MICs of ethanol extract were in the ranged from 6.25 to 50.00 mg/mL, mostly effective against *P. aeruginosa* ATCC9027, *B. megaterium* ATCC14581 and *C. albicans* ATCC10231. Minimum bactericidal/fungicidal concentrations of water and ethanol were spread from 6.25 to >50.00 mg/mL and 25.00 to >50.00 mg/mL, respectively. Time-kill curve study showed *S. aureus* ATCC29737, *E. coli* ATCC43895 and *B. cereus* ATCC33019 were completely killed when exposed to ethanol extract of raw seeds and fermented seed dregs in 0.5 h incubation at 4× MIC. One hour had been taken to completely killed *P. aeruginosa* ATCC9027 and *Candida albicans* ATCC10231 after exposing to raw seeds extract while two hours had been taken after exposing to fermented seed dregs extract at 4× MIC. The fermented seed dregs extract showed higher total phenolic contents rather than raw seeds and seed dregs extracts. IC_{50} of the fermented seed dregs extract showed lower concentration than raw seeds and seed dregs extracts. There were 19 bioactive compounds in raw seeds and 24 compounds in fermented seed dregs extract detected by GC-MS including sesamin and sesamolin. Six compounds were identified to be the first time reported in sesame seeds by LC-MS which were cyclo(L-leucyl-L-prolyl), docosahexaenoic acid (DHA), enoxolone, α-eleostearic acid, 16-hydroxyhexadecanoic acid and oleanolic acid. In conclusion, there were changes on physicochemical characteristics during fermentation and fermented seed dregs had low level of microbial counts, rich of lactic acid bacteria and detected bioactive compounds were potentially good for antimicrobial and antioxidant activities.

Keywords: antimicrobial activity, antioxidant activity, bioactive compounds, fermented black sesame seed dregs, microbial safety, physicochemical characteristics

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

CIRI-CIRI FISOKOKIMIA, KESELAMATAN MIKROB DAN AKTIVITI BIOLOGI HAMPAS BIJI BIJAN (*Sesamum indicum* L.) HITAM YANG DITAPAI

Oleh

NUR KAMARIAH ROSNI

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Penggunaan hampas telah digunakan secara meluas terutamanya di Indonesia, seperti hampas kacang tanah ke dalam makanan tempatan Indonesia yang dikenali sebagai “oncom”. Hampas biji bijan terhasil daripada proses pembuatan minyak bijan. Hampas biji kemudian akan melalui proses penampaian secara langsung selama 7 hari di suhu bilik (23-27°C). Semasa penampaian, ciri-ciri fisikokimia produk makanan akan mengalami perubahan dengan penglibatan mikroorganisma dan aktiviti bio dalam pemprosesan. Tujuan kajian ini adalah untuk menganalisis ciri-ciri fisikokimia serta keselamatan dan kualiti microbiologi terhadap hampas biji bijan hitam semasa penampaian, untuk mengkaji aktiviti antimikrob dan antioksida, dan untuk mengenalpasti sebatian bioaktif dalam ekstrak biji bijan hitam mentah dan ekstrak hampas biji yang ditapai. Ciri-ciri fisikokimia termasuk suhu dalaman, nilai pH, jumlah pepejal larut (TSS), aktiviti air (a_w), pengenalpastian warna, analisis proksima dan analisis profil tekstur ke atas hampas biji semasa penapaian telah dianalisis menggunakan kaedah Komuniti Persatuan Analitikal (AOAC) untuk analisis makanan. Kehadiran mikroorganisma termasuk plat kiraan keseluruhan (TPC), *Escherichia coli*, *Salmonella* spp., *Pseudomonas aeruginosa*, *Bacillus cereus*, *Staphylococcus aureus*, bakteria asid laktik (LAB), bakteria kolifom, kulat dan yis ke atas hampas biji yang ditapai semasa penampaian dianalisis menggunakan media selektif mikrob. Sampel yang di ambil untuk analisis adalah biji mentah dan hampas biji pada hari penampaian yang ke 0, 1, 3, 5 and 7. Biji mentah dan hampas biji yang ditapai (hari ke 7) diekstrak menggunakan air dan etanol, dan ekstrak berkenaan telah digunakan untuk mengenalpasti aktiviti mikrobial menentang patogen bawaan makanan menggunakan kaedah Institut Standard Klinikal dan Makmal (CLSI). Jumlah kandungan fenolik ditentukan menggunakan ujian Folin-Ciocalteu dan aktiviti antioksidan ditentukan menggunakan ujian memerangkap radikal 2,2-diphenyl-1-picrylhydrazyl (DPPH). Sebatian bioaktif dalam ektrak etanol biji mentah dan hampas biji yang ditapai ditentukan oleh Gas Kromatografi-Jisim Spektrometri (GC-MS) dan Cecair Kromatografi-Jisim

Spektrometri (LC-MS). Keputusan menunjukkan suhu dalaman, pH dan TSS menunjukkan tiada perbezaan signifikan manakala a_w menunjukkan peningkatan signifikan daripada 0.53 kepada 0.92% semasa penapaian. Penentuan warna bagi produk akhir mempunyai cahaya dan kekuningan yang tinggi tetapi kemerahan yang rendah. Kandungan kelembapan meningkat secara signifikan manakala kandungan abu, protin dan karbohidrat mengalami penurunan, dan kandungan lemak dan serat menunjukkan tiada perbezaan signifikan semasa penapaian. Peningkatan secara beransur-ansur dalam ciri kekerasan dan penurunan dalam kekenyalan, kelembutan dan daya tahan telah dikenalpasti manakala ciri kohesif menunjukkan tiada perbezaan signifikan. Kiraan mikrob menunjukkan penurunan pada *P. aeruginosa* dan *B. cereus* manakala peningkatan pada TPC, *S. aureus*, bakteria asid laktik, bacteria kolifom, dan kulat dan yis. Hasil ekstrak etanol lebih tinggi berbanding ekstrak air. Diameter zon penghambatan ekstrak menentang 16 jenis mikroorganisma patogenik menunjukkan julat perencatan di antara 6.50 sehingga 11.00 mm. Kepekatan Perencatan Minimum (MICs) ekstrak air bagi biji mentah dan hampas biji yang ditapai adalah di antara 3.13 sehingga >50.00 mg/mL, paling efektif menentang *B. cereus* ATCC33019. Manakala, MICs ekstrak etanol pula adalah di antara 6.25 sehingga 50.00 mg/mL, paling efektif menentang *P. aeruginosa* ATCC9027, *B. megaterium* ATCC14581 dan *C. albicans* ATCC10231. Kepekatan minimum bakterisida/fungisida untuk ekstrak air dan etanol adalah masing-masing di antara 6.25 sehingga >50.00 mg/mL dan 25.00 sehingga >50.00 mg/mL. Analisis keluk-masa pembunuhan menunjukkan *S. aureus* ATCC29737, *E. coli* ATCC43895 dan *B. cereus* dibunuh sepenuhnya apabila terdedah kepada ekstrak etanol bagi biji mentah dan hampas biji yang ditapai dalam pengeraman 0.5 h pada 4×MIC. Satu jam diambil untuk *P. aeruginosa* dan *Candida albicans* dibunuh sepenuhnya apabila terdedah kepada ekstrak biji mentah manakala dua jam diambil apabila terdedah kepada ekstrak hampas biji yang ditapai pada 4×MIC. Ekstrak hampas biji yang ditapai mempunyai kandungan jumlah fenolik lebih tinggi berbanding ekstrak biji mentah dan hampas. IC_{50} ekstrak hampas biji yang ditapai menunjukkan kepekatan lebih rendah berbanding ekstrak biji mentah dan hampas. Terdapat 19 sebatian bioaktif dalam ekstrak biji mentah dan 24 sebatian dalam ekstrak hampas biji yang ditapai dapat dikenalpasti oleh GC-MS termasuk sasamin dan sesamolin. Enam sebatian telah dikenalpasti pertama kali dilaporkan dalam biji bijan oleh LC-MS iaitu cyclo(L-leucyl-L-prolyl), docosahexaenoic acid (DHA), enoxolone, α-eleostearic acid, 16-hydroxyhexadecanoic acid dan oleanolic acid. Kesimpulannya, terdapat perubahan ciri-ciri fisikokimia semasa proses penapaian dan hampas biji yang ditapai mempunyai nilai kiraan mikrob yang rendah, kaya dengan bakteria asid laktik dan sebatian-sebatian bioaktif yang dikesan berpotensi baik untuk aktiviti antimikrob dan antioksida.

Kata kunci: aktiviti antimikrob, aktiviti antioksida, sebatian bioaktif, hampas biji bijan hitam yang ditapai, keselamatan mikrob, ciri-ciri fisikokimia.

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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 Master of Science. The members of the Supervisory Committee were as follows:

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°C	Degree Celsius
%	Percentage
µL	Microlitre
*a**	Red/greenness
a_w	Water activity
ANOVA	Analysis of variance
ASE	Accelerated solvent extraction
AOAC	Association of Official Analytical Chemists
ATCC	American type culture collection
*b**	Yellow/blueness
$BaCl_2$	Barium chloride
BHA	Beta-hydroxy acid
BHT	Butylated hydroxytoluene
BSA	*Bacillus cereus* selective agar
CA	Coliform Agar
CFU	Colony forming unit
CHX	Chlorhexidine
CLSI	Clinical and Laboratory Standards Institute
cm	Centimetre
Da	Dalton
DMF	Dimethylformamide
DMSO	Dimethyl sulfoxide
DNA	Deoxyribonucleic acid
DPPH	2,2-diphenyl-1-picrylhydrazyl

EMB	Eosin methylene blue
Eth	Ethanol extract
EU	European Union
FFAs	Free fatty acids
FSD	Fermented seeds dregs
g	gram
GAE	Gallic acid equivalent
GRAS	Generally recognized as safe
GC-MS	Gas chromatography-mass spectrometry
h	Hour
H_2SO_4	Sulphuric acid
HPLC-MS	High-pressure liquid chromatography mass spectrometry
IBS	Institute of Bioscience
IC_{50}	Half-maximal inhibitory concentration
ICMSF	International Commission on Microbiological Specifications for Foods
kHz	Kilohertz
kPA	Kilopascal
*L**	Lightness
L	Litre
LAB	Lactic acid bacteria
LC-MS	Liquid chromatography-mass spectrometry
m/z	Mass-to-change ratio
MAE	Microwave assisted extraction
MBC	Minimum bactericidal concentration
MF	Molecular formula

MFC	Minimum fungicidal concentration
mg	Milligram
MHA	Mueller Hinton agar
MHB	Mueller Hinton broth
MIC	Minimum inhibitory concentration
min	Minute
mL	Millilitre
mm	Millimetre
MRS	Man, Rogosa and Sharpe
MSA	Mannitol salt agar
MW	Molecular weight
N	Normality
NaOH	Sodium hydroxide
Nm	Nanometre
PBS	Phosphate buffered saline
PCA	Plate count agar
PDA	Potato dextrose agar
ppm	Parts per million
psi	Pounds per square inch
PUFA	Polyunsaturated fatty acid
RI	Retention index
rpm	Revolutions per minute
RRI	Relative retention index
RS	Raw seeds
s	Second
SI	Similarity index

spp.	Species
t_R	Retention time
TPA	Texture profile analysis
TPC	Total plate count
TSS	Total soluble solid
UPM	Universiti Putra Malaysia
w/v	Weight per volume
WE	Water extract
XLD	Xylose lysine deoxylate

CHAPTER 1

INTRODUCTION

1.1 Background

Sesame seeds have beneficially on nutritional and medicinal that easily extract, good stability and high resistance in dry season (Sheahan, 2014). Black sesame seeds have been said more beneficial to human health; therefore, the price is higher than white sesame seeds. Wang et al. (2018) stated that the black sesame seeds can be classified as a healthy food as their identified compounds on the research were similar with specific characteristics in other studies. The use of sesame oil has become increasingly popular these days for food ingredient, pharmaceutical and cosmetic uses especially in Korea and Indonesia. Sesame oil is acknowledged rich in oleic and linoleic acids (essential unsaturated fatty acids) and have abundant of vitamin E (Hansen, 2011; Asghar et al., 2014). The extraction of sesame oil produced meaningful by-product that rich of protein which called as sesame oil meal or cake or dregs. This sesame dregs are beneficial source of protein for animal (Oplinger et al., 1990; Hansen, 2011). According to Suja et al. (2005), sesame dregs can be food grade (from dehulled sesame seeds), or used as a feed for livestock, especially ruminants and poultry (from undecorticated sesame seeds) or utilized as fertilizer regarding to the extracted methods used. In addition, Surono (2016) indicated that dregs of products such as coconut dregs, peanuts dregs and sesame seeds dregs can be used as food or functional food through fermentation process.

Interestingly, in West Java (Indonesia) the sesame seeds dregs are consumed after spontaneous fermentation namely *dage* while in Central Java (Indonesia) called *cabuk*. *Dage* and *cabuk* are defatted sesame seed-based fermented food. The difference between *dage* and *cabuk* is, *dage* is only spontaneous fermentation of sesame seeds dregs while *cabuk* is alkaline solid-state fermentation as it is produced by adding rice straw ash water with sesame seeds dregs (Sarkar and Nout, 2014). In Sierra Leone, Nigeria, fermented sesame seeds or called as Ogiri is one of their traditional foods that used as low-cost protein by Nigerian especially poor families to change the fish during rainy season as the price of fish is too expensive during that time (Jonsyn, 1990). Hence, the fermented sesame seeds that have longer shelf life can provide some protein during that season to replace fish.

Fermentation is one of the studies in food microbiology which is included in preservation technique. It is the process of freeing up water molecules and the complex compound will convert into simpler compounds. It will increase the area of raw materials and indirectly produced edible food products and removing anti-nutritional factors to ensure the safety of food (Steinkraus, 2018). The plant-based processing foods such as fermented food have improve in taste and flavour that indirectly surging the acceptability (Ejoh et al., 2007), however the

processing such as heating processes can give some effect on the chemistry of these foods. During the fermentation process, the microorganism might be present and can change physical characteristic and biological of the food product. The evaporation and metabolism of the microorganism cause the water activity, a_w might be varies (Tsao, 1999) while the pH value may drop along the with fermentation day. Based on previous studies, it is confirmed that fermentation process can enhance the nutritious content while increasing the food digestibility (Ray and Didier, 2014; Hasan et al., 2014; Tamang, 2016).

Fermented sesame seeds dregs usually made manually. Hence, a good hygiene practices should be emphasized during fermentation to lower or discards especially from microorganisms that dangerous for health. Previous studies had shown major microorganisms usually involved in this fermented food are bacilli family like *Bacillus subtilis* and *B. cereus* (Steinkraus, 2018). Besides, as studied by Gadaga et al. (2007) and Capozzi et al. (2017), *Bacillus cereus*, *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus* and *Aeromonas* are the most commonly encountered pathogens in African fermented foods. Steinkraus (2018) also stated that *tempe bongkrek,* which is also one of fermented dregs as it is produced from coconut dregs, has been reported to be contaminated by *Pseudomonas* species such as *Pseudomonas aeruginosa* and *P. cocovenenans* if no proper handling during process of fermentation. Fermented coconut dregs it not common fermented food, but well known as Indonesia cuisines other than tempeh and *oncom* which also food from fermentation process.

Natural antioxidants are one of the essential components found in plant have ability in scavenging free radical inside the biological system (Anjaneyulu et al., 2003). Moreover, extract of plants potentially has antimicrobial compounds against disease and food spoilage causing microorganisms. Sesame seeds have two lignans which are called sesamin and sesamolin that helps to prevent rancidity (Bennett et al., 1997; Hemalatha and Rao, 2004W; Moazzami et al., 2006; Asghar et al., 2014; Wu et al., 2016; Qadir et al., 2018). The sesamolin will converted into sesamol during roasting process. Sesamol have anti-oxidative effects that induce the growth arrests and apoptosis in cancer cells (Tunde-Akintunde et al., 2012). It also has phenolic and benzodioxide group that helps in antioxidant activity.

To the best of our knowledge, there are still no studies regarding to physicochemical characteristics and microbiological safety of black sesame seeds dregs during fermentation. Furthermore, there are also lacks of studies on determination of bioactivities and identification of bioactive compounds of black sesame seeds dregs and fermented seeds dregs extracts. Therefore, this research is aiming to analyse physicochemical characteristics and microbiological safety of black sesame seeds dregs during fermentation, to determine the antimicrobial and antioxidant activity and to identify the bioactive compounds using Liquid Chromatography Mass-Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS).

1.2 Problem Statements

During the fermentation process, physicochemical characteristics and biological of the food product may undergo changes (Steinkraus, 2002) with microorganisms' involvement in some of the process (Caplice and Fitzgerald, 1999). Spontaneous fermentation is an uncontrolled process, involving succession of different types of microorganism including pathogenic and non-pathogenic bacteria that results in variety of end product of fermented food. Mehta et al. (2012) stated that bioactivities on foods that involve chemical reactions during fermentation process could give effects on food properties and bioactive compounds (antioxidant and antimicrobial compounds) inside food product. Natural antioxidants are one of the essential components found in plant that have potential in scavenging of free radical inside the biological system (Anjaneyulu et al., 2003) and plant extract also potentially have antimicrobial compounds against disease and food spoilage causing microorganisms. There are a lot of studies are done on raw sesame seeds and fermented sesame seeds. However, no systematic study has been reported regarding fermented black sesame seeds dregs and its extracts. Thus, the physicochemical characteristics and microbiological safety of black sesame seeds dregs during fermentation need to be analysed and the antimicrobial and antioxidant of raw black sesame seeds, seeds dregs and fermented seeds dregs extract need to be determined. On the other hand, bioactive compounds that contributed in antimicrobial and antioxidant activity of raw black sesame seeds, seeds dregs and fermented seeds dregs extract also need to be identified.

1.3 Objectives

The objectives of this study are:

1. To analyse the physicochemical characteristics and microbiological safety of black sesame seeds dregs during fermentation.
2. To determine the antimicrobial and antioxidant activity of raw black sesame seeds and fermented seeds dregs extracts.
3. To identify the bioactive compounds in raw black sesame seeds and fermented seeds dregs extracts by Liquid Chromatography Mass-Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS).

REFERENCES

AOAC (Association Official Analytical Chemists). (2012). Official methods of analysis. (19th ed.). *Association Official Analytical Chemists*. Washington DC, USA.

Abdullah, A. Y., Obeidat, B. S., Muwalla, M. M., Matarneh, S. K. and Ishmais, M. A. A. (2011). Growth performance, carcass and meat characteristics of black goat kids fed sesame hulls and *Prosopis juliflora* pods. *Asian-Australasian Journal of Animal Sciences*, 24(9): 1217-1226.

Abdullah, E., Raus, R. A. and Jamal, P. (2012). Extraction and evaluation of antibacterial activity from selected flowering plants. *American Medical Journal*, 3(1): 27-32.

Abou-Gharbia, H. A., Shehata, A. A. Y. and Shahidi, F. (2000). Effect of processing on oxidative stability and lipid classes of sesame oil. *Food Research International*, 33(5): 331-340.

Abramovič, H., Grobin, B., Poklar Ulrih, N. and Cigić, B. (2018). Relevance and standardization of in vitro antioxidant assays: ABTS, DPPH, and folin–ciocalteu. *Journal of Chemistry*, 2018: 1-9.

Achi, O. K. (1992). Microorganisms associated with natural fermentation of *Prosopis africana* seeds for the production of okpiye. *Plant Foods for Human Nutrition*, 42: 297-304.

Addgene. (2014). Creating bacterial glycerol stocks for long-term storage of plasmids. Retrieved 28 May 2017 from https://www.addgene.org/plasmids-protocols/create-glycerol-stocks/.

Afoakwa, E. O., Quao, J., Takrama, J., Budu, A. S. and Saalia, F. K. (2013). Chemical composition and physical quality characteristics of Ghanaian cocoa beans as affected by pulp pre-conditioning and fermentation. *Journal of Food Science and Technology*, 50(6): 1097–105.

Agbangnan, P. C., Tachon, D. C., Dangou, J., Chrostowska, A., Fouquet, E. and Sohounhloue, D. C. K. (2012). Optimization of the extraction of sorghum's polyphenols for industrial production by membrane processes. *Research Journal of Recent Sciences*, 1(4): 1-8.

Agilent Technologies. (2001). Basics of LC/MS. Retrieved 16 October 2019 from www.agilent.com/chem.

Agnihotri, S., Dutt, D., Tyagi, C. H., Kumar, A. and Upadhyaya, J. S. (2010). Production and biochemical characterization of a novel cellulase-poor alkali-thermo-tolerant xylanase from *Coprinellus disseminatus* SW-1 NTCC 1165. *World Journal of Microbiology and Biotechnology,* 26(8): 1349-1359.

Akindumila, F. and Glatz, B. A. (1998). Growth and oil production of *Apiotrichum curvatum* in tomato juice. *Journal of Food Protection*, 61(11): 1515-1517.

Akinoso, R., Igbeka, J. C. and Olayanju, T. A. (2006). Process optimization of oil expression from sesame seed (*Sesamum indicum* Linn.). *Agricultural Engineering International: CIGR Journal*, 8: 1-7.

Akta Makanan dan Peraturan-Peraturan. (2012). Jadual kelima belas (Peraturan 39): Mikroorganisma dan toksinnya, daftar 1, standard mikrobiologi. *Akta Makanan dan Peraturan-Peraturan* (pp. 318-319). ISBN: 978-967-70-1409-9.

Altemimi, A., Lakhssassi, N., Baharlouei, A., Watson, D. G. and Lightfoot, D. A. (2017). Phytochemicals: Extraction, isolation, and identification of bioactive compounds from plant extracts. *Plants*, 6(4): 42.

Alwash, M. S., Ibrahim, N. and Ahmad, W. Y. (2013). Identification and mode of action of antibacterial components from *Melastoma malabathricum* Linn. leaves. *American Journal of Infectious Diseases*, 9(2): 46-58.

Amić, D., Davidović-Amić, D., Bešlo, D. and Trinajstić, N. (2003). Structure-radical scavenging activity relationships of flavonoids. *Croatica Chemica Acta*, 76(1): 55-61.

Amin, I., Jinap, S., Jamilah, B., Harikrisna, K. and Biehl, B. (2002). Oligopeptide patterns produced from *Theobroma cacao* L. of various genetic origins. *Journal of the Science of Food and Agriculture,* 82(7): 733-737.

Ancerewicz, J., Migliavacca, E., Carrupt, P. A., Testa, B., Brée, F., Zini, R., ... and Crevat, A. (1998). Structure–property relationships of trimetazidine derivatives and model compounds as potential antioxidants. *Free Radical Biology and Medicine*, 25(1): 113-120.

Anjaneyulu, M., Tirkey, N. and Chopra, K. (2003). Attenuation of cyclosporine-induced renal dysfunction by catechin: possible antioxidant mechanism. *Renal Failure*, 25(5): 691-707.

Anna, M., Dara, K., Hickey, I., Mercedes, A. G. and Martin, W. (2013). Evaluation of antimicrobial activities of commercial herb and spice extracts against selected food-borne bacteria. *Journal of Food Research*, 2: 431-437.

Anokwuru, C. P., Anyasor, G. N., Ajibaye, O., Fakoya, O. and Okebugwu, P. (2011). Effect of extraction solvents on phenolic, flavonoid and antioxidant activities of three Nigerian medicinal plants. *Nature and Science,* 9(7): 53-61.

Antolovich, M., Prenzler, P. D., Patsalides, E., McDonald, S. and Robards, K. (2002). Methods for testing antioxidant activity. *Analyst*, 127(1): 183-198.

Ardhana, M. M. and Fleet, G. H. (2003). The microbial ecology of cocoa bean fermentations in Indonesia. *International Journal of Food Microbiology*, 86(1): 87-99.

Armstrong, W. P. (2016). Sesame: *Sesamum indicum* (Pedaliaceae). Retrieved 28 September 2019 from https://www2.palomar.edu/users/warmstrong/ecoph44.htm.

Asghar, A., Nauman, M. M. and Akhtar, M. N. (2014). A review on the utilization of sesame as functional food. *American Journal of Food and Nutrition*, 4(1): 21-34.

Azcarate-Peril, M. A. and Klaenhammer, T. R. (2010). Genomics of lactic acid bacteria: the post-genomics challenge–from sequence to function. *Biotecnology of Lactic Acid Bacteria: Novel Applications* (pp. 35-56). Wiley-Blackwell Publisher.

Azwanida, N. N. (2015). A review on the extraction methods use in medicinal plants, principle, strength and limitation. *Medical & Aromatic Plants*, 4(196): 2167-0412.

Bacteriological Analytical Manual (BAM). (1998). U. S. Food and Drug Administration. (8th ed.). Revision A.

Bamforth, C. W. (2005). *Food, Fermentation and Micro-organisms* (pp. 143-153). Oxford, UK: Blackwell Science.

Bayitse, R., Hou, X., Laryea, G. and Bjerre, A. B. (2015). Protein enrichment of cassava residue using *Trichoderma pseudokoningii* (ATCC 26801). *AMB Express*, 5(1):80.

Baylis, C., Uyttendaele, M., Joosten, H. and Davies, A. (2011). The *Enterobacteriaceae* and their significance to the food industry. *ILSI Europe Report Series* (pp. 52). Belgium: ILSI Europe.

Bedigian, D. (2003). Evolution of sesame revisited: Domestication, diversity and prospects. *Genetic Resources and Crop Evolution*, 50(7): 779-787.

Bennett, M. R., Imrie, B. C., Raymond, L., Wood, I. M. and Territory, N. (1997). Sesame growers guide. *Report of Department of Primary Industry and Fisheries* (pp. 24). Northern Territory Darwin, Australia.

Benozzi, E., Romano, A., Capozzi, V., Makhoul, S., Cappellin, L., Khomenko, I., Aprea, E., Scampicchio, M., Spano, G. and Märk, T. D. et al. (2015). Monitoring of lactic fermentation driven by different starter cultures via direct injection mass spectrometric analysis of flavour-related volatile compounds. *Food Research International*, 76: 682–688.

Bhargav, S., Panda, B. P., Ali, M. and Javed, S. (2008). Solid-state fermentation: An overview. *Chemical and Biochemical Engineering Quarterly*, 22(1): 49-70.

Biswas, D. and Roymon, M. G. (2013). LC/ TOF/ ESI/ MS based detection of bioactive compounds present in leaf and bark extract of *Acacia Arabica*. *Recent Research in Science and Technology,* 5(2): 37-40.

Blandino, A., Al-Aseeri, M. E., Pandiella, S. S., Cantero, D. and Webb, C. (2003). Cereal-based fermented foods and beverages. *Food Research International*, 36: 527–543.

Blatt, D. H., Leonard, S. W. and Traber, M. G. (2001). Vitamin E kinetics and the function of tocopherol regulatory proteins. *Nutrition*, 17(10): 799-805.

Bodoira, R. M., Penci, M. C., Ribotta, P. D. and Martínez, M. L. (2017). Chia (*Salvia hispanica* L.) oil stability: Study of the effect of natural antioxidants. *LWT-Food Science and Technology*, 75: 107-113.

Bolan, N. S., Curtin, D. and Adriano, D. C. (2005). *Encyclopedia of Soils in the Environment: Acidity* (Vol. 3) (pp. 11-17). Amsterdam: Elsevier.

Bopitiya, D. and Madhujith, T. (2013). Antioxidant activity and total phenolic content of sesame (*Sesamum indicum* L.) seed oil. *Tropical Agricultural Research,* 24(3): 302.

Borchani, C., Besbes, S., Blecker, C. H. and Attia, H. (2010). Chemical characteristics and oxidative stability of sesame seed, sesame paste, and olive oils. *Journal of Agriculture, Science and. Technology*, 12: 585-596.

Bove, P., Russo, P., Capozzi, V., Gallone, A., Spano, G. and Fiocco, D. (2013). *Lactobacillus plantarum* passage through an oro-gastro-intestinal tract simulator: Carrier matrix effect and transcriptional analysis of genes associated to stress and probiosis. *Microbiological Research*, 168: 351–359.

Brand-Williams, W., Cuvelier, M. E. and Berset, C. (1995). Use of a free radical method to evaluate antioxidant activity. *LWT- Food Science and Technology*, 28: 25-30.

Burt, S. (2004). Essential oils: Their antibacterial properties and potential applications in foods-a review. *International Journal of Food Microbiology*, 94(3): 223-253.

Burtner, C. R., Murakami, C. J., Kennedy, B. K. and Kaeberlein, M. (2009). A molecular mechanism of chronological aging in yeast. *Cell Cycle*, 8(8): 1256–1270.

Busta, F. F., Bernard, D. T., Gravani, R. B., Hall, P., Pierson, M. D., Prince, G. and Yiannas, F. (2003). Evaluation and definition of potentially hazardous

foods. *Comprehensive Reviews in Food Science and Food Safety*, 2: 1-109.

Byaruhanga, Y. B., Bester, B. H. and Watson, T. G. (1999). Growth and survival of *Bacillus cereus* in *mageu*, a sour maize beverage. *World Journal of Microbiology and Biotechnology,* 15(3): 329-333.

Camu, N., De Winter, T., Verbrugghe, K., Cleenwerck, I., Vandamme, P., Takrama, J. S., Vancanneyt, M. and De Vuyst, L. (2007). Dynamics and biodiversity of populations of lactic acid bacteria and acetic acid bacteria involved in spontaneous heap fermentation of cocoa beans in Ghana. *Applied and Environmental Microbiology*, 73(6): 1809-1824.

Caplice, E. and Fitzgerald, G. F. (1999). Food fermentations: Role of microorganisms in food production and preservation. *International Journal of Food Microbiology*, 50(1): 131-149.

Capozzi, V., Menga, V., Digesu, A. M., De Vita, P., van Sinderen, D., Cattivelli, L., Fares, C. and Spano, G. (2011). Biotechnological production of vitamin B2-enriched bread and pasta. *Journal of Agricultural and Food Chemistry,* 59: 8013–8020.

Capozzi, V., Fragasso, M., Romaniello, R., Russo, P. and Spano, G. (2017). Spontaneous food fermentations and potential risks for human health. *Fermentation*, 3(4): 49.

Centre for Food Safety. (2014). Microbiological guidelines for food (for ready-to-eat food in general and specific food items). Queensway: Food and Environmental Hygiene Department. *ICMSF Publications*, 1-38.

Chai, K. F., Adzahan, N. M., Karim, R., Rukayadi, Y. and Ghazali, H. M. (2018). Effects of fermentation time and turning intervals on the physicochemical properties of rambutan (*Nephelium lappaceum* L.) fruit sweatings. *Sains Malaysiana*, 47(10): 2311-2318.

Chaves-López, C., Rossi, C., Maggio, F., Paparella, A. and Serio, A. (2020). Changes occurring in spontaneous maize fermentation: An overview. *Fermentation*, 6(36): 1-25.

Chemonics, I. I. (Eds.). (2002). Overview of Nigerian sesame industry. Proceedings of the *International Conferences on Plants Developmental Biology*. The United State Agency for International Development (USAID), Nigeria.

Cheng, W. W., Liu, G. Q., Wang, L. Q. and Liu, Z. S. (2017). Glycidyl fatty acid esters in refined edible oils: a review on formation, occurrence, analysis, and elimination methods. *Comprehensive Reviews in Food Science and Food Safety*, 16(2): 263-281.

Chouhan, S., Sharma, K. and Guleria, S. (2017). Antimicrobial activity of some essential oils—present status and future perspectives. *Medicines*, 4(3): 58.

Chrun, R., Hosotani, Y., Kawasaki, S. and Inatsu, Y. (2017). Microbiological hazard contamination in fermented vegetables sold in local markets in Cambodia. *Biocontrol Science*, 22(3): 181-185.

CLSI (Clinical and Laboratory Standards Institute). (2012). Reference Method for Performance Standards for Antimicrobial Disk Susceptibility Tests; Approved Standard-Eleventh Edition, CLSI document M02-A11. USA: *CLSI*.

Copetti, M. V., Iamanaka, B. T., Pitt, J. I. and Taniwaki, M. H. (2014). Fungi and mycotoxins in cocoa: from farm to chocolate. *International Journal of Food Microbiology,* 178: 13–20.

Crafack, M., Keul, H., Eskildsen, C. E., Petersen, M. A., Saerens, S., Blennow, Skovmand-Larsena, M., Swiegersb, J. H., Petersend, G. B., Heimdald, H. and Nielsen, D. S. (2014). Impact of starter cultures and fermentation techniques on the volatile aroma and sensory profile of chocolate. *Food Research International*, 63: 306-316.

Csoma, H., Zakany, N., Capece, A., Romano, P. and Sipiczki, M. (2010). Biological diversity of *Saccharomyces* yeasts of spontaneously fermenting wines in four wine regions: comparative genotypic and phenotypic analysis. *International Journal of Food Microbiology,* 140(2-3): 239-248.

Cui, L. and Decker, E. A. (2016). Phospholipids in foods: prooxidants or antioxidants?. *Journal of the Science of Food and Agriculture*, 96(1): 18-31.

Cuvelier, M. E., Richard, H. and Berset, C. (1992). Comparison of the antioxidative activity of some acid-phenols: structure-activity relationship. *Bioscience, Biotechnology and Biochemistry*, 56(2): 324-325.

Dai, J. and Mumper, R. J. (2010). Plant phenolics: Extraction, analysis and their antioxidant and anticancer properties. *Molecules*, 15: 7313–7352.

Dar, A.A., Verma, N. K. and Arumugam, N. (2015). An updated method for isolation, purification and characterization of clinically important antioxidant lignans sesamin and sesamolin, from sesame oil. *Industrial Crops and Products*, 64, 201–208.

Dawlal, P., Brabet, C., Thantsha, M. S. and Buys, E. M. (2017). Potential of lactic acid bacteria for the reduction of fumonisin exposure in African fermented maize-based foods. *World Mycotoxin Journal*, 10: 309–318.

Deme, T., Haki, G., Retta, N., Woldegiorgis, A. and Geleta, M. (2017). mineral and anti-nutritional contents of niger seed (*Guizotia abyssinica* (Lf) Cass.,

linseed (*Linumusitatissimum* L.) and sesame (*Sesamum indicum* L.) Varieties grown in Ethiopia. *Foods*, 6(4): 27.

Devices, D. (2006). Fundamentals of water activity. *DECAGON*, Pullman.

Dhanani, T., Shah, S., Gajbhiye, N. A. and Kumar, S. (2017). Effect of extraction methods on yield, phytochemical constituents and antioxidant activity of *Withania somnifera*. *Arabian Journal of Chemistry*, 10: S1193-S1199.

Do, Q. D., Angkawijaya, A. E., Tran-Nguyen, P. L., Huynh, L. H., Soetaredjo, F. E., Ismadji, S., and Ju, Y. H. (2014). Effect of extraction solvent on total phenol content, total flavonoid content, and antioxidant activity of *Limnophila aromatica*. *Journal of Food and Drug Analysis,* 22(3): 296–302.

Dong, L., Zhou, H.-W., Sonego, L., Lers, A. and Lurie, S. (2001). Ripening of "Red Rosa" plums: effect of ethylene and 1-methylcyclopropene. *Australian Journal of Plant Physiology*, 8: 1039-1045.

Donot, F., Fontana, A., Baccou, J. C. and Schorr-Galindo, S. (2012). Microbial exopolysaccharides: Main examples of synthesis, excretion, genetics and extraction. *Carbohydrate Polymers*, 87: 951–962.

Dossa, K., Diouf, D., Wang, L., Wei, X., Zhang, Y., Niang, M., ... and Liao, B. (2017). The emerging oilseed crop *Sesamum indicum* enters the "Omics" era. *Frontiers in Plant Science*, 8: 1154.

Doughari, J. H. (2006). Antimicrobial activity of *Tamarindus indica* Linn. *Tropical Journal of Pharmaceutical Research,* 5(2): 597-603.

Echeverría, F., Valenzuela, R., Hernandez-Rodas, M. C. and Valenzuela, A. (2017). Docosahexaenoic acid (DHA), a fundamental fatty acid for the brain: New dietary sources. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 124: 1-10.

Ehiri, J. E., Azubuike, M. C., Ubbaonu, C. N., Anyanwu, E. C., Ibe, K. M. and Ogbonna, M. O. (2001). Critical control points of complementary food preparation and handling in eastern Nigeria. *Bulletin of the World Health Organization*, 79(5): 423-433.

Ejoh, R. A., Djuikwo, V. N., Gouado, I. and Mbofung, C. M. (2007). Effect of the method of processing and preservation on some quality parameters of three non-conventional leafy vegetables. *Pakistan Journal of Nutrition*, 6(2): 128-133.

Elias, M., Wieczorek, G., Rosenne, S. and Tawfik, D. S. (2014). The universality of enzymatic rate–temperature dependency. *Trends in Biochemical Sciences*, 39(1): 1-7.

Elliott, T., Casey, A., Lambert, P. A. and Sandoe, J. (2012). Lecture notes: *Medical Microbiology and Infection*. John Wiley & Sons.

El Khier, M. K. S., Ishag K.E.A. and Yagoub A. E.A. (2008). Chemical composition and oil characteristics of sesame seed cultivars grown in Sudan. *Research Journal of Agriculture and Biological Sciences*, 4(6): 761-766.

Embaby, H. E. S. (2010). Effect of heat treatments on certain antinutrients and in vitro protein digestibility of peanut and sesame seeds. *Food Science and Technology Research*, 17(1): 31-38.

Eze, S. O. and Ibe, O. J. (2005). Effect of fermentation on the nutritive value of *Brachystegia Eurycoma* "Achi". Chemical Society of Nigeria. *Journal of Chemical*, 30: 1-5.

Farkas, J. (2007). Physical methods of food preservation. In food microbiology: Fundamentals and frontiers, *American Society of Microbiology*, 3: 685-712.

Faostat, F. (2016). Agriculture Organization of the United Nations Statistics Division. *Economic and Social Development Department, Rome, Italy.* Retrieved 31 August 2019 from http://faostat3.fao.org/home/E.

Fatoki, O. A and Onifade, D. A. (2013). Use of plant antimicrobials for food preservation. *International Journal of Veterinary and Agricultural Engineering*, 7(12): 1110-1113.

Feil, B. (2001). Phytic acid. *Journal of New Seeds*, 3(3): 1-35.

Ferreira-Dias, S., Valente, D.G. and Abreu. J.M.F. (2003). Comparison between ethanol and hexane for oil extraction from *Quercus suber* L. fruits. *Grasas y Aceites*, 54(4): 378-383.

Foerster, S., Unemo, M., Hathway, L. J., Low, N and Althus, C. L (2016). Time-kill curve analysis and pharmacodynamics modelling for *in vitro* evaluation of antimicrobials against *Neisseria gonorrhoeae*. *BMC Microbiology*, 16(216): 1-11.

Food Standards Australia New Zealand (2001). Guidelines for the microbiological examination of ready-to-eat foods. Retrieved 23 June 2020 from http://www.foodstandards.gov.au/_srcfiles/Guidelines%20for%20Micro%20exam.pdf.

Frémont, L. (2000). Biological effects of resveratrol. *Life sciences*, 66(8): 663-673.

Gadaga, T. H., Nyanga, L. K. and Mutukumira, A. N. (2007). The occurrence, growth and control of pathogens in African fermented foods. *African Journal of Food, Agriculture Nutrition and Development*, 4.

Ganem-Quintanar, A., Quintanar-Guerrero, D. and Buri, P. (2000). Monoolein: A review of the pharmaceutical applications. *Drug Development and Industrial Pharmacy*, 26(8): 809-820.

Gangoué-Piéboji, J., Eze, N., Djintchui, A. N., Ngameni, B., Tsabang, N., Pegnyemb, D. E., Biyiti, L., Ngassam, P., Koulla-Shiro, S. and Galleni, M. (2009). The in vitro antimicrobial activity of some traditionally used medicinal plants against beta-lactam-resistant bacteria. *The Journal of Infection in Developing Countries*, 3(9): 671-680.

Gargaud, M. (2011). *Encyclopedia of Astrobiology*. Berlin, Heidelberg: Springer Science & Business Media.

Gebremedhin, B., Hirpa, A. and Berhe, K. (2009). Feed marketing in Ethiopia: Results of rapid market appraisal. Improving productivity and market success (IPMS) of Ethiopian farmers project working paper 15. *ILRI (International Livestock Research Institute)*, Nairobi, Kenya.

Gharby, S., Harhar, H., Bouzoubaa, Z., Asdadi, A., El Yadini, A. and Charrouf, Z. (2017). Chemical characterization and oxidative stability of seeds and oil of sesame grown in Morocco. *Journal of the Saudi Society of Agricultural Sciences*, 16(2): 105-111.

Ghosh, J. S. (2015). Solid state fermentation and food processing: A short review. *Journal of Nutrition and Food Science*, 6(1): 1-7.

Giraffa, G. (2004). Studying the dynamics of microbial populations during food fermentation. *FEMS Microbiology Reviews*, 28(2): 251-260.

Górniak, I., Bartoszewski, R. and Króliczewski, J. (2019). Comprehensive review of antimicrobial activities of plant flavonoids. *Phytochemistry Reviews*, 18(1): 241-272.

Gomez, F. (2011). Aerobe. In Gargaud, M. (Ed.), *Encyclopedia of Astrobiology* (pp. 21-21). Berlin, Heidelberg: Springer Science & Business Media.

Gong, W., Shi, R., Chen, M., Qin, J. and Liu, X. (2019). Quantification and monitoring the heat-induced formation of trans fatty acids in edible oils by Raman Spectroscopy. *Journal of Food Measurement and Characterization*, 1-8.

Gote, M., Umalkar, H., Khan, I. and Khire, J. (2004). Thermostable α-galactosidase from *Bacillus stearothermophilus* (NCIM 5146) and its application in the removal of flatulence causing factors from soymilk. *Process Biochemistry*, 39(11): 1723-1729.

Greppi, A., Rantisou, K., Padonou, W., Hounhouigan, J., Jespersen, L., Jakobsen, M. and Cocolin, L. (2013). Yeast dynamics during spontaneous fermentation of *mawè* and *tchoukoutou*, two traditional products from Benin. *International Journal of Food Microbiology*, 165(2): 200-207.

Gul, W. (2014). Menadione: Role in cancer prevention and methods of analysis. *World Journal of Pharmacy and Pharmaceutical Sciences*, 2: 1390-1394.

Haines, T. D., Adlaf, K. J., Pierceall, R. M., Lee, I., Venkitasubramanian, P. and Collison, M. W. (2011). Direct determination of MCPD fatty acid esters and glycidyl fatty acid esters in vegetable oils by LC–TOFMS. *Journal of the American Oil Chemists' Society*, 88(1): 1-14.

Halm, M., Lillie, A., Sørensen, A. K. and Jakobsen, M. (1993). Microbiological and aromatic characteristics of fermented maize doughs for *kenkey* production in Ghana. *International Journal of Food Microbiology,* 19(2): 135-143.

Haltrich, D., Nidetzky, B., Kulbe, K. D., Steiner, W. and Župančič, S. (1996). Production of fungal xylanases. *Bioresource Technology*, 58(2): 137-161.

Handa, S. S., Khanuja, S. P. S., Longo, G. and Rakesh, D. D. (2008). Extraction technologies for medicinal and aromatic plants. (No. 66) (1st ed.). Italy: *United Nations Industrial Development Organization and the International Centre for Science and High Technology*.

Hansen, R. (2011). Sesame. *AgMRC (Agricultural Marketing Resource Center), Iowa State University, USA*.

Hasan, M. N., Sultan, M. Z. and Mar-E-Um, M. (2014). Significance of fermented food in nutrition and food science. *Journal of Scientific Research*, 6(2): 373-386.

Hawashi, M., Widjaja, T. and Gunawan, S. (2019). Solid-state fermentation of cassava products for degradation of anti-nutritional value and enrichment of nutritional value. In *New Advances on Fermentation Processes* (pp. 1-18). IntechOpen.

Hayama, R. and Coupland, G. (2004). The molecular basis of diversity in the photoperiodic flowering responses of Arabidopsis and rice. *Plant Physiology*, 135(2): 677-684.

Hayek, S. A. and Ibrahim, S. A. (2013). Current limitations and challenges with lactic acid bacteria: a review. *Food and Nutrition Sciences*, 4(11): 73-87.

He, F. F. (1994). Karyotype of sesame (*Sesamum* L.) as related to its phylogenesis. *Journal of Southwest Agriculture University (Sichuan),* 16: 573–6.

Hegde, D. M. (2012). Sesame. In *Handbook of Herbs and Spices* (pp. 449-486). Woodhead Publishing.

Hemalatha, S. and Rao, M. V. V. (2004). Sesame lignans enhance antioxidant activity of vitamin E in lipid peroxidation systems. *Molecular and Cellular Biochemistry*, 262(1-2): 195-202.

Hernández, F., Noguera-Artiaga, L., Burló, F., Wojdyło, A., Carbonell-Barrachina, Á. A. and Legua, P. (2016). Physico-chemical, nutritional, and volatile composition and sensory profile of Spanish jujube (*Ziziphus jujuba* Mill.) fruits*. Journal of the Science of Food and Agriculture*, 96(8): 2682-2691.

Heuzé, V., Tran, G., Bastianelli, D. and Lebas, F. (2016). Sesame (Sesamum indicum) seeds and oil meal. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. Retrieved 12 September 2019 from https://feedipedia.org/node/26. Last updated on June 22, 2017, 16:08.

Ho, V. T. T., Zhao, J., Srzednicki, G. and Fleet, G. (Eds.). (2013). Proceeding from AFHW '13: *International Symposium on Agri-Foods for Health and Wealth*. Bangkok, Thailand.

Ho, V. T. T., Zhao, J. and Fleet, G. (2014). Yeasts are essential for cocoa bean fermentation. *International Journal of Food Microbiology*, 174: 72–87.

Hosein, H. K. M. and Zinab, D. (2007). Phenolic compounds and antioxidant activity of henna leaves extracts (*Lawsonia inermis*). *World Journal of Dairy & Food Sciences*, 2(1): 38-41.

Hu, Q., Xu, J., Chen, S. and Yang, F. (2004). Antioxidant activity of extracts of black sesame seed (*Sesamum indicum* L.) by supercritical carbon dioxide extraction. *Journal of Agricultural and Food Chemistry*, 52(4): 943-947.

Huang, S. L., Wu, L. C., Liang, H. K., Pan, K. T., Horng, J. T. and Ko, M. T. (2004). PGTdb: A database providing growth temperatures of prokaryotes. *Bioinformatics*, 20(2): 276–278.

Huda-Faujan, N., Rahim, Z. A., Rehan, M. M. and Ahmad, B. H. A. (2015). Comparative analysis of phenolic content and antioxidative activities of eight Malaysian traditional vegetables. *Malaysian Journal of Analytical Sciences*, 19(3): 611– 62.

Hudzicki, J. (2009). Kirby-Bauer disk diffusion susceptibility test protocol. *American Society for Microbiology*, 2016: 1-23.

Hussain, S. Z. and Maqbool, K. (2014). GC-MS: Principle, technique and its application in food science. *International Journal of Current Science,* 13: 116-126.

Ibukun, E. O. (2012). Fermentation attenuates the free radical scavenging and antioxidant activities of sesame seed (*Sesanum indicum*). *International Journal of Pharmaceutical Application*, 3(2): 324-331.

Ichiro, H. (2018). Fundamental guide to liquid chromatography mass spectrometry (LCMS). Retrieve 16 October 2019 from www.shimadzu.com/an.

ICMSF (International Commission on Microbiological Specifications for Foods). (1996). *Microorganisms in food 5: Microbiological specifications of food pathogens*. London: Blackie Academic and Professional.

ICMSF (International Commission on Microbiological Specifications for Foods). (1998). *Microorganisms in food 6: Cereals and cereal products. Springer, Boston*, MA. 392-439. ISBN: 978-1-4613-7422-0.

ICMSF (International Commission on Microbiological Specifications for Foods) (2005). *2nd Edition. Microbial ecology of foods. Volume 2, Factors affecting life and death of microorganisms. Orlando.* Orlondo : Academic Press, Vol. 2. ISBN: 0-306-48675-X.

Ide, T., Lim, J. S., Odbayar, T. O. and Nakashima, Y. (2009). Comparative study of sesame lignans (sesamin, episesamin and sesamolin) affecting gene expression profile and fatty acid oxidation in rat liver. *Journal of Nutritional Science and Vitaminology*, 55(1): 31-43.

Igbabul, B. D., Bello, F. A. and Ani, E. C. (2014). Effect of fermentation on the proximate composition and functional properties of defatted coconut (*Cocos nucifera* L.) flour. *Sky Journal of Food Science*, 3(5): 034-040.

Jabeen, G., Farooq, R., Khan, A. U. and Khan, A. A. (2015). Acetyl-coa pathway for biosynthesis of organics. *Asian Journal of Chemistry*, 27(1): 1–8.

Jakab, A., Nagy, K., Héberger, K., Vékey, K. and Forgacs, E. (2002). Differentiation of vegetable oils by mass spectrometry combined with statistical analysis. *Rapid Communications in Mass Spectrometry*, 16(24): 2291-2297.

Jackson, L. S., Knize, M. G. and Morgan, J. N. (Eds.). (2012). *Impact of Processing on Food Safety* (Vol. 459). Springer Science & Business Media.

Jakubowski, W. and Bartosz, G. (1997). Estimation of oxidative stress in *Saccharomyces cerevisae* with fluorescent probes. *The International Journal of Biochemistry & Cell Biology,* 29(11): 1297-1301.

Jay, J. M., Loessner, M. J. and Golden, D. A. (2008). *Modern food microbiology*. Springer Science & Business Media.

Jeng, K. C. G. and Hou, R. C. W. (2005). Sesamin and sesamolin: nature's therapeutic lignans. *Current Enzyme Inhibition*, 1(1): 11-20.

Jennesen, J., Neilsen, K. F., Houbraken, J., Lyhne. L., Schnurer, J., Frisad, J. C. and Samson, R. A. (2005). Secondary metabolite and mycotixin production by *Rhizopus* microspores group. *Journal of Agricultural and Food Chemistry*, 53: 1833-1840.

Jeon, J. S., Park, C. L., Syed, A. S., Kim, Y. M., Cho, I. J. and Kim, C. Y. (2016). Preparative separation of sesamin and sesamolin from defatted sesame meal via centrifugal partition chromatography with consecutive sample injection. *Journal of Chromatography B*, 1011: 108-113.

Ji, X., Xu, J., Wang, X., Qi, P., Wei, W., Chen, X., ... and Zhou, Y. (2015). Citrinin determination in red fermented rice products by optimized extraction method coupled to liquid chromatography tandem mass spectrometry (LC-MS/MS). *Journal of Food Science*, 80(6): T1438-T1444.

Jobim, M. L., Santos, R. C. V., Alves, C. F. D. S., Oliveira, R. M., Mostardeiro, C. P., Sagrillo, M. R., Filho, O. C. S., Garcia, L. F. M., Manica-Cattani, M. F., Ribeiro, E. E. and Manica da Cruz, I. B. (2014). Antimicrobial activity of amazon *Astrocaryum aculeatum* extracts and its association to oxidative metabolism. *Microbiological Research*, 169: 314–323.

Jones, P. J. (2002). GC-MS analysis of ethanol extract of *Wattakaka Volubilis*. *Canadian Medical Association Journal*, 166: 1555-1563.

Jonsyn, F. E. (1990). Mycological contamination of *Ogiri* (Fermented sesame seeds) during production in Sierra Leone. *Mycopathologia*, 110(2): 113-117.

Kamal-Eldin, A., Yousif, G., Iskander, G. M. and Appelqvist, L. Å. (1992). Seed lipids of *Sesamum indicum* L. and related wild species in Sudan I: Fatty acids and triacylglycerols. *Lipid/Fett*, 94(7): 254-259.

Kamal-Eldin, A. and Appelqvist, L. Å. (1994). Variation in fatty acid composition of the different acyl lipids in seed oils from four Sesamum species. *Journal of the American Oil Chemists' Society*, 71(2): 135-139.

Kamal-Eldin, A., Moazzami, A. and Washi, S. (2011). Sesame seed lignans: Potent physiological modulators and possible ingredients in functional foods & nutraceuticals. *Recent Patents on Food, Nutrition & Agriculture*, 3(1), 17-29.

Kamao, M., Hirota, Y., Suhara, Y., Tsugawa, N., Nakagawa, K., Okano, T. and Hasegawa, H. (2017). Determination of menadione by liquid chromatography–tandem mass spectrometry using pseudo multiple reaction monitoring. *Analytical Sciences*, 33(7): 863-867.

Kamatou, G. P. and Viljoen, A. M. (2010). A review of the application and pharmacological properties of α-bisabolol and α-bisabolol-rich oils. *Journal of the American Oil Chemists' Society*, 87(1): 1-7.

Kanu, P. J. (2011). Biochemical analysis of black and white sesame seeds from China. *American Journal of Biochemistry and Molecular Biology*, 1(2): 145-157.

Kapilan, R. (2015). Determination of antibacterial of activity of some important spices. *International Journal of Research Granthaalayah*, 3(10), 1-8.

Kaufmann, B. and Christen, P. (2002). Recent extraction techniques for natural products: microwave-assisted extraction and pressurised solvent extraction. Phytochemical Analysis: *An International Journal of Plant Chemical and Biochemical Techniques*, 13(2): 105-113.

Kayser, F. H., Bienz, K. A., Eckert, J., and Zingernagel, R. M. (2001). *Medical Microbiology* (10th ed.). Stuttgart, Germany: Georg Thieme Verlag.

Khoddami, A., Wilkes, M. A. and Roberts, T. H. (2013). Techniques for analysis of plant phenolic compounds. *Molecules*, 18(2): 2328-2375.

Khushboo, P. S., Jadhav, V. M., Kadam, V. J. and Sathe, N. S. (2010). *Psoralea corylifolia* Linn. "Kushtanashini". *Pharmacognosy Reviews*, 4(7): 69.

Kimpe, K., Jacobs, P. A. and Waelkens, M. (2001). Analysis of oil used in late Roman oil lamps with different mass spectrometric techniques revealed the presence of predominantly olive oil together with traces of animal fat. *Journal of Chromatography A*, 937(1-2): 87-95.

Klein, D. W., Lansing M. and Harley, J. (2006). *Microbiology* (6th ed.). New York: McGraw-Hill. ISBN 978-0-07-255678-0.

Koffi, E., Sea, T., Dodehe, Y. and 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.

Konings, W. N., Albers, S. V., Koning, S. and Driessen, A. J. (2002). The cell membrane plays a crucial role in survival of bacteria and archaea in extreme environments. *Antonie Van Leeuwenhoek*, 81(1-4): 61-72.

Korfmacher, W. A. (2005). Foundation review: principles and applications of LC-MS in new drug discovery. *Drug Discovery Today*, 10(20): 1357-1367.

Kothe, E. and Köhler, J. M. (2015). Changing growth behavior of heavy-metal tolerant bacteria: media optimization using droplet-based microfluidics. *Engineering in Life Sciences*, 15(3): 327–332.

Kotzekidou, P., Giannakidis, P. and Boulamatsis, A. (2008). Antimicrobial activity of some plant extracts and essential oils against foodborne pathogens *in*

vitro and on the fate of inoculated pathogens in chocolate. *Food Science and Technology*, 41(1): 119-127.

Kula, J. (2016). Synthesis and bioactivity of (R)-ricinoleic acid derivatives: A review. *Current Medicinal Chemistry*, *23*(35): 4037-4056.

Kumar, K. J. and Vijayan, V. (2014). An overview of liquid chromatography-mass spectroscopy instrumentation. *Pharmaceutical Methods*, 5(2): 47-55.

Kumar, C. M. and Singh, S. A. (2015). Bioactive lignans from sesame (*Sesamum indicum* L.): Evaluation of their antioxidant and antibacterial effects for food applications. *Journal of Food Science and Technology*, 52(5): 2934-2941.

Laetitia, M. M., Joseph, H. D., Joseph, D. and Christian, M. (2005). Physical, chemical and microbiological changes during natural fermentation of *Gowé*, a sprouted or non-sprouted sorghum beverage from West-Africa. *African Journal of Biotechnology*, 4(6): 487-496.

Lazos, E. S., Aggelousis, G. and Bratakos, M. (1993): The fermentation of *Trahanas*: a milk-wheat flour combination. *Plant Foods for Human Nutrition*, 44: 45-62.

Lederberg, J. (2000). *Pseudomonas*. *In Encyclopedia of Microbiology* 2(3) (pp. 876-891). San Diego, Califonia. Academic Press.

Lee, H. M. and Lee, Y. (2008). A differential medium for lactic acid-producing bacteria in a mixed culture. *Letters in applied microbiology*, 46(6): 676-681.

Lee, W. J., Su, N. W., Lee, M. H. and Lin, J. T. (2013). Assessment of authenticity of sesame oil by modified Villavecchia Test and HPLC-ELSD analysis of triacylglycerol profile. *Food Research International*, 53(1): 195-202.

Leistner, L. (1990). Mould-fermented foods: Recent developments. (In `Proceedings of the International Conference on Biotechnology & Food' [see FSTA (1991) 23 4B18].). *Food Biotechnology,* 4: 433-441.

Lemmer, A. (2012). Mineral substances and macronutrients in the anaerobic conversion of biomass: An impact evaluation. *Engineering in Life Sciences*, 12(3): 287-294.

Leus, J., Venter, P., Westhuizen, J. and Westhuizen, H. (2003). Enumeration of potential microbial hazards in milk from a marginal urban settlement in Central South Africa. *Food Microbiology*, 20: 321-326.

Lim, C. K. and Lord, G. (2002). Current developments in LC-MS for pharmaceutical analysis. *Biological and Pharmaceutical Bulletin*, 25(5): 547-557.

Lima, E. S. and Abdalla, D. S. P. (2002). High-performance liquid chromatography of fatty acids in biological samples. *Analytica Chimica Acta*, 465(1-2): 81-91.

Lima, L. J., Almeida, M. H., Nout, M. R. and Zwietering, M. H. (2011). *Theobroma cacao* L., "The food of the Gods": Quality determinants of commercial cocoa beans, with particular reference to the impact of fermentation. *Critical Reviews in Food Science and Nutrition*, 51(8): 731-761.

Lis-Balchin, M. and Deans, S. G. (1997). Bioactivity of selected plant essential oils against *Listeria monocytogenes*. *Journal of Applied Microbiology.* 82: 759-762.

Liu, C. G., Li, K., Wen, Y., Geng, B. Y., Liu, Q. and Lin, Y. H. (2019). Biotechnol: New opportunities for an ancient product. In *Advances in Bioenergy*, 4: 1-34. Elsevier.

Liu, J. (1995). Pharmacology of oleanolic acid and ursolic acid. *Journal of Ethnopharmacology*, 49(2): 57-68.

Liu, R. and Xu, B. (2013). Optimization of extraction conditions of citrinin from red yeast rice by orthogonal design and quantification of citrinin by high-performance liquid chromatography. *Food Analytical Methods*, 6(2): 677-682.

Liu, X., Jia, B., Sun, X., Ai, J., Wang, L., Wang, C., Zhao, F., Zhan, J. and Huang, W. (2015). Effect of initial pH on growth characteristics and fermentation properties of *Saccharomyces cerevisiae. Journal of Food Science*, 80(4): 800-808.

Lu, N., Shimura, M., Kinukawa, Y., Yoshida, M. and Tamai, M. (1999). Quantitative analysis of leukocyte dynamics in retinal microcirculation of rats with short-term ischemia-reperfusion injury. *Current Eye Research*, 19(5): 403-410.

Luedemann, A., Strassburg, K., Erban, A. and Kopka, J. (2008). TagFinder for the quantitative analysis of gas chromatography-mass spectrometry (GC-MS)-based metabolite profiling experiments. *Bioinformatics*, 24(5): 732-737.

Mahmoud, K. Z. Obeidat, B. S. and Ishmais, M. A. (2015). Roasted sesame hulls improve broiler performance without affecting carcass characteristics. *Italian Journal of Animal Science*, 14 (3): 495-501.

Makinde, F. M., Akinoso, R. and Adepoju, A. O. (2013). Effect of fermentation containers on the chemical composition of fermented sesame (*Sesamum indicum* L) seeds. *African Journal of Food, Agriculture, Nutrition and Development,* 13(1): 7122-7137.

Makinde, F. M. and Akinoso, R. (2014). Comparison between the nutritional quality of flour obtained from raw, roasted and fermented sesame (*Sesamum indicum* L.) seed grown in Nigeria. *Acta Scientiarum Polonorum Technologia Alimentaria*, 13(3): 309-319.

Malini, T. and G. Vanithakumari. (1993). Effect of β-sitosterol in male albino rats. *Journal of Ethnopharmacology*, 35: 149-153.

Mamman, P. H., Mshelia, W. P., Susbatrus, S. C. and Sambo. K. (2013). Antibacterial effects of crude extract of *Azadirachta indica* against *Escherichia coli*, *Salmonella* spp. and *Staphylococcus aureus*. *International Journal of Medicine and Medical Sciences*, 5: 14-18.

Marco, M. L., Heeney, D., Binda, S., Cifelli, C. J., Cotter, P. D., Foligné, B., Gänzle, M., Kort, R., Pasin, G. and Pihlanto, A. et al. (2017). Health benefits of fermented foods: Microbiota and beyond. *Current Opinion in Biotechnology*, 44: 94–102.

Marriott, R. J. (2010). Greener chemistry preparation of traditional flavour extracts and molecules. *Agro Food Industry Hi-Tech*, 21(2): 46-48.

McDonnell, G. and Russell, A.D. (1999). Antiseptics and disinfectants: activity, action and resistance. *Clinical Microbiology Reviews.* 12(1): 147-79.

McGovern, P. E., Zhang, J., Tang, J., Zhang, Z., Hall, G. R., Moreau, R. A., ... and Cheng, G. (2004). Fermented beverages of pre-and proto-historic China. *Proceedings of the National Academy of Sciences of the United States of America*, 101(51): 17593-17598.

Mehta, B. M., Kamal-Eldin, A. and Iwanski, R. Z. (2012). *Fermentation: Effects on Food Properties*. CRC Press. ISBN 9781138199460 - CAT# K31478.

Mienda, B. S., Idi, A. and Umar, A. (2011). Microbiological features of solid-state fermentation and its applications - an overview. *Research in Biotechnology*, 2: 21- 26.

Mira, N. P., Teixeira, M. C. and S´a-Correia, I. (2010). Adaptive response and tolerance to weak acids in *Saccharomyces cerevisiae*: A genome-wide view. *Omics,* 14(5): 525–40.

Mishima, K., Tanaka, T., Pu, F., Egashira, N., Iwasaki, K., Hidaka, R., ... and Fujiwara, M. (2003). Vitamin E isoforms α-tocotrienol and γ-tocopherol prevent cerebral infarction in mice. *Neuroscience Letters*, 337(1): 56-60.

Moazzami, A. A. (2006). Sesame seed lignans diversity, Human metabolism and bioactivities. *Acta Universitatis Agriculturae Sueciae*. ISSN 1652-6880, ISBN 91-576-7147-8.

Moazzami, A. A., Andersson, R. E. and Kamal-Eldin, A. (2006). HPLC analysis of sesaminol glucosides in sesame seeds. *Journal of Agricultural and Food Chemistry*, 54(3): 633-638.

Mohamed, M. A., Hamed, A. N. E. S., Abd, A. N., Kotb, E. and Kamel, M. S. (2017). GC/MS analyses of avocado and sesame fixed oils. *Journal of Pharmacognosy and Phytochemistry*, 6(4): 721-725.

Mokoena, M. P., Mutanda, T. and Olaniran, A. O. (2016). Perspectives on the probiotic potential of lactic acid bacteria from African traditional fermented foods and beverages. *Food and Nutrition Research,* 60: 29630.

Mokrani, A. and Madani, K. (2016). Effect of solvent, time and temperature on the extraction of phenolic compounds and antioxidant capacity of peach (*Prunus persica* L.) fruit. *Separation and Purification Technology*: Elsevier B.V.

Mornar, A., Sertić, M. and Nigović, B. (2013). Development of a rapid LC/DAD/FLD/MS n method for the simultaneous determination of monacolins and citrinin in red fermented rice products. *Journal of Agricultural and Food Chemistry*, 61(5): 1072-1080.

Monteiro, É., Chibli, L., Yamamoto, C., Pereira, M., Vilela, F., Rodarte, M., ... and da Luz André de Araújo, A. (2014). Antinociceptive and anti-inflammatory activities of the sesame oil and sesamin. *Nutrients*, 6(5): 1931-1944.

Morris, J. B. (2002). Food, industrial, nutraceutical, and pharmaceutical uses of sesame genetic resources. In: J. Janick and A. Whipkey, eds., Trends in new crops and new uses. *ASHS Press* (pp. 153– 156). Arlington, VA.

Moturi, W. K. N. (2008). Factors likely to enhance mycotoxin introduction into the human diet through maize in Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 8(3): 265-277.

Mueller, M., Pena, A. and Derendorf, H. (2004). Issues in pharmacokinetics and pharmacodynamics of anti-infective agents: Kill curves versus MIC. Antimicrobial *Agents and Chemotherapy*, 48(2): 369-377.

Muzdalifah, D., Athaillah, Z. A., Devi, A. F. and Udin, L. Z. (2018). Cytotoxicity of ethanol overripe tempeh extract against MCF-7 breast cancer cell and its antioxidant activity. In *AIP Conference Proceedings*, 2024(1): 020037. AIP Publishing.

Myers, R. L. (2004). Sesame: A high value oilseed. *Small Farm Today*, 21(3): 24-27.

NAERLS (2010). Beniseed production and utilisation in Nigeria. Extension Bulletin No 154, Horticulture Series No 5. 17/07/11. Available at www.naerls.gov.ng/extmat/bulletins/Beniseed.pdf

Namiki, M. (1995). The chemistry and physiological functions of sesame. *Food Reviews International*, 11(2): 281-329.

Narendranath, N. V. and Power, R. (2005). Relationship between pH and medium dissolved solids in terms of growth and metabolism of *Lactobacilli* and *Saccharomyces cerevisiae* during ethanol production. *Applied and Environmental Microbiology*, 71(5): 2239–43.

Negi, P. S. (2012). Plant extracts for the control of bacterial growth: Efficacy, stability and safety issues for food application. *International Journal of Food Microbiology*, 156(1): 7-17.

Nigeria's Harvest (2009). *Small seed provides large income*. Volume 5, October 21, 2009. Available at http://www.nigeriamarkets.org/files/Nigeria%27s_Harvest_Vol_5_Exporting_Nigerian_Sesame.pdf

Nielsen, S. S. (2010). United States government regulations and international standards related to food analysis. In *Food Analysis*, 15-33. Springer, Boston, MA.

Nigović, B., Sertić, M. and Mornar, A. (2013). Simultaneous determination of lovastatin and citrinin in red yeast rice supplements by micellar electrokinetic capillary chromatography. *Food Chemistry*, 138(1): 531-538.

Nikaido, H. (1996). Outer membrane. In: Neidhardt F C, et al., editors. Escherichia coli and Salmonella: cellular and molecular biology. Washington, D.C.: *American Society for Microbiology*, 1(2): 29–47.

Nimse, S. B. and Pal, D. (2015). Free radicals, natural antioxidants, and their reaction mechanisms. *Royal Society of Chemistry Advances*, 5(35): 27986-28006.

Normén, L., Ellegård, L., Brants, H., Dutta, P. and Andersson, H. (2007). A phytosterol database: Fatty foods consumed in Sweden and the Netherlands. *Journal of Food Composition and Analysis*, 20(3-4): 193-201.

Nout, M. J. R. and Rombouts, F. M. (1990). Recent developments in *tempe* research. *Journal of Applied Bacteriology,* 69(5): 609-633.

Nout, M. J. R. (1994). Fermented foods and food safety. *Food Research International*, 27(3): 291-298.

Nout, M. J. R., and Kiers, J. L. (2005). Tempe fermentation, innovation and functionality: Update into the third millenium. *Journal of Applied Microbiology*, 98(4): 789-805.

NSW Food Authority. (2009). Microbiological quality guide for ready-to-eat foods: A guide to interpreting microbiological results. Retrieved 23 June 2020 from www.foodauthority.nsw.gov.au.

Nwodo, U. U., Obiiyeke, G. E., Chigor, V. N. and Okoh, A. I. (2011). Assessment of *Tamarindus indica* extracts for antibacterial activity. *International Journal of Molecular Sciences*, 12(10): 6385-6396.

Oboh, G. and Akindahunsi, A. A. (2003). Biochemical changes in cassava products (flour & gari) subjected to *Saccharomyces cerevisae* solid media fermentation. *Food Chemistry*, 82(4):599-602.

Ogunlesi, M., Okiei, W. and Osibote, E. A. (2010). Analysis of the essential oil from the leaves of Sesamum radiatum, a potential medication for male infertility factor, by gas chromatography-mass spectrometry. *African Journal of Biotechnology*, 9(7): 1060-1067.

Ogunmoyole, T., Rocha, J. B. T., Okoronkwo, A. E. and Kade, I. J. (2009). Altered pH homeostasis modulates the glutathione peroxidase mimics and other antioxidant properties of diphenyl diselenide. *Chemico-Biological Interactions*, 182(2-3): 106-111.

Olaleye, O. O., Eke, M. O. and Aondo, T. O. (2018). Extraction, Physicochemical and phytochemical characterization of oil from sesame seed. *Asian Food Science Journal*, 1-12.

Oliveira, M. D. S., Feddern, V., Kupski, L., Cipolatti, E. P., Badiale-Furlong, E. and de Souza-Soares, L. A. (2010). Physico-chemical characterization of fermented rice bran biomass Caracterización fisico-química de la biomasa del salvado de arroz fermentado. *CyTA–Journal of Food*, 8(3): 229-236.

Olude, O., George, F. and Alegbeleye, W. (2016). Utilization of autoclaved and fermented sesame (*Sesamum indicum* L.) seed meal in diets for Til-aqua natural male tilapia. *Animal Nutrition*, 2(4): 339-344.

Oplinger, E. S., Oelke, E. A., Doll, J. D., Bundy, L. G. and Schuler, R. T. (1997). Sesame. In: Alternative Field Crops Manual, University of Wisconsin-Exension, *Cooperative Extension*.

Oren, A. (2012). Diversity of Anaerobic Prokaryotes and Eukaryotes: Breaking Long Established Dogmas. In *Altenbach, A., Bernhard, J. M. and Seckbach, J. (Eds.), Anoxia: Evidence for Eukaryote Survival and Paleontological Strategies* (pp. 39-47). Netherlands: Springer.

Orij, R., Brul, S. and Smits, G. J. (2011). Intracellular pH is a tightly controlled signal in yeast. *Biochimica et Biophysica Acta (BBA)-General Subjects*, 1810(10): 933-944.

Othman, M., Wiart, H. S., Khoo, C., Lim, T. J. and Ting, K. N. (2011). Optimal methods for evaluating antimicrobial activities from plant extracts. *Journal of Microbiological Methods*, 84: 161-166.

Othman, A., Mukhtar, N. J., Ismail, N. S. and Chang, S. K. (2014). Phenolics, flavonoids content and antioxidant activities of 4 Malaysian herbal plants. *International Food Research Journal*, 21(2): 759.

Ouattara, D. H., Ouattara, H. G., Goualie, B. G., Kouame, L. M. and Niamke, S. L. (2014). Biochemical and functional properties of lactic acid bacteria isolated from *Ivorian* cocoa fermenting beans. *Journal of Applied Biosciences*, **77**: 6489-6499.

Ouattara, H. G., Koffi, B. L., Karou, G. T., Sangaré, A., Niamke, S. L. and Diopoh, J. K. (2008). Implication of *Bacillus* sp. in the production of pectinolytic enzymes during cocoa fermentation. *World Journal of Microbiology and Biotechnology*, 24(9): 1753-1760.

Papalexandratou, Z., Vrancken, G., De Bruyne, K., Vandamme, P. and De Vuyst, L. (2011). Spontaneous organic cocoa bean box fermentations in Brazil are characterized by a restricted species diversity of lactic acid bacteria and acetic acid bacteria. *Food Microbiology*, 28(7): 1326–38.

Parekh, J., Jadeja, D. and Chanda, S. (2005). Efficacy of aqueous and methanol extracts of some medicinal plants for potential antibacterial activity. *Turkish Journal of Biology*, 29: 203-210.

Pepe, O., Blaiotta, G., Bucci, F., Anastasio, M., Aponte, M. and Villani, F. (2006). *Staphylococcus aureus* and *Staphylococcal enterotoxin* A in breaded chicken products: detection and behavior during the cooking process. *Applied and Environmental Microbiology*, 72(11), 7057-7062.

Pitt, J. I., and Hocking, A. D. (1997). *Fungi and Food Spoilage*, 2nd ed, Gaithersburg, MD. Aspen Publishers. 10: 978-1.

Prakash, V., Martín-Belloso, O., Keener, L., Astley, S. B., Braun, S., McMahon, H., and Lelieveld, H. (Eds.). (2015). *Regulating safety of traditional and ethnic foods*. Academic Press.

Prieto, J. M. (2012). Procedure: Preparation of DPPH Radical, and antioxidant scavenging assay. *DPPH Microplate Protocol*, 7-9.

Prior, R. L., Wu, X. and Schaich, K. (2005). Standardized methods for the determination of antioxidant capacity and phenolics in foods and dietary supplements. *Journal of Agricultural and Food Chemistry*, 53: 4290-4302.

Proestos, C., Lytoudi, K., Mavromelanidou, O., Zoumpoulakis, P. and Sinanoglou, V. (2013). Antioxidant capacity of selected plant extracts and their essential oils. *Antioxidants*, 2(1): 11-22.

Pumphrey, B. and Julien, C. (1996). An introduction to fermentation. *Fermentation Basics, New Brunswick Scientific* (pp. 1-24). UK and The Netherlands.

Qadir, A., Ali, A., Arif, M., Al-Rohaimi, A. H., Singh, S. P., Ahmad, U., ... and Kumar, A. (2018). Solvent extraction and GC-MS analysis of sesame seeds for determination of bioactive antioxidant fatty acid/fatty oil components. *Drug Research*, 68(06): 344-348.

Quinto, E. J., Jiménez, P., Caro, I., Tejero, J., Mateo, J. and Girbés, T. (2014). Probiotic lactic acid bacteria: A review. 18, s.l.: *Food and Nutrition Sciences*, 5: 1765.

Ramli, S., Radu, S., Shaari, K. and Rukayadi, Y. (2017). Antibacterial activity of ethanolic extract of *Syzygium polyanthum* L. (Salam) leaves against foodborne pathogens and application as food sanitizer. *Biomed Research International*, 2017.

Ray, R. C. and Didier, M. (Eds.). (2014). *Microorganisms and Fermentation of Traditional Foods*. CRC Press.

Reverchon, E. and De Marco, I. (2006). Supercritical fluid extraction and fractionation of natural matter. *The Journal of Supercritical Fluids*, 38(2): 146-166.

Rezac, S., Kok, C. R., Heermann, M. and Hutkins, R. (2018). Fermented foods as a dietary source of live organism. *Frontiers in Microbiology*, 9: 1785.

Rittner, H. (1992). Extraction of vegetable oils with ethyl alcohol. *Oleagineux*, 47: 29-42.

Rizki, H., Kzaiber, F., Elharfi, M., Latrache, H., Zahir, H. and Hanine, H. (2014). Physicochemical characterization and in vitro antioxidant capacity of 35 cultivars of sesame (*Sesamum indicum* L.) from different areas in Morocco. *International Journal of Science and Research*, 3: 2306-2311.

Rockland, L. B. and Stewart, G. F. (Eds.). (2013). Water activity: influences on food quality: a treatise on the influence of bound and free water on the quality and stability of foods and other natural products. Academic Press.

Ruga, R. (2017). *Antibacterial agents from Dracaena cochinchinensis (Lour.) SC Chen and Eleutherine americana (Aubl.) Merr. Ex K. Heyne* (Unpublished doctoral dissertion). Chulalongkorn University, Thailand.

Rukayadi, Y. and Hwang, J. K. (2006). *In vitro* activity of xanthorrhizol against *Streptococcus mutans* biofilms. *Letters in Applied Microbiology,* 42: 400-404.

Rukayadi, Y., Shim, J. S. and Hwang, J. K. (2008). Screening of Thai medicinal plants for anticandidal activity. *Mycoses*, 51: 308-312.

Rukayadi, Y., Lau, K.Y., Zainin, N. S., Zakaria, M. and Abas, F. (2013). Screening of antimicrobial activity of tropical edible medicinal plant extracts against five standard microorganisms for natural food preservatives. *International Food Research Journal*, 20(5): 2905-2910.

Russo, P., Capozzi, V., Spano, G., Corbo, M. R., Sinigaglia, M. and Bevilacqua, A. (2016). Metabolites of microbial origin with an impact on health: Ochratoxin A and biogenic amines. *Frontier in Microbiology*, 7.

Sabir, A. (2005). Aktivitas antibakteri flavonoid propolis *Trigona* sp. terhadap bakteri *Streptococcus mutans* (in vitro) (*In vitro* antibacterial activity of flavonoids *Trigona* sp. propolis against *Streptococcus mutans*). *Dental Journal*, 135-141.

Sabu, A., Sarita, S., Pandey, A., Bogar, B., Szakacs, G. and Soccol, C. R. (2002). Solid-state fermentation for production of phytase by *Rhizopus oligosporus*. *Applied Biochemistry and Biotechnology,* 102(1-6): 251-260.

Sahil, K., Prashant, B., Akanksha, M., Premjeet, S. and Devashish, R. (2011). Gas chromatography-mass spectrometry: Applications. *International Journal of Pharmaceutical and Biological Archives,* 2(6): 1544-1560.

Şahin, S., Bilgin, M., Sayım, E. and Güvenilir, B. (2017). Effects of natural antioxidants in the improvement of corn oil quality: Olive leaf vs. lemon balm. *International Journal of Food Science & Technology*, 52(2): 374-380.

Şahin, S. and Elhussein, E. A. A. (2018). Assessment of sesame (*Sesamum indicum* L.) cake as a source of high-added value substances: From waste to health. *Phytochemistry Reviews*, 17(4): 691-700.

Sahlin, P. and Nair, B. M. (2012). Production of organic acids, titratable acidity and pH-development during fermentation of cereal flours. *International Journal of Fermented Foods*, 1(1): 15-32.

Salari, M. H., Sohrabi, N., Kadkhoda, Z. and Khalili, M. B. (2003). Antibacterial effects of enoxolone on periodontopathogenic and capnophilic bacteria isolated from specimens of periodontitis patients. *Iranian Biomedical Journal*, 7(1): 39-42.

Salehan, N. M., Meon, S. and Ismail, I. S. (2013). Antifugal activity of *Cosmos caudatus* extracts against seven economically important plant pathogens. *International Journal of Agriculture and Biology*, 15: 864-870.

Samet-Bali, O., Felfoul, I., Lajnaf, R., Attia, H. and Ayadi, M. A. (2017). Enumeration and identification of microflora in “Leben”, a traditional Tunisian dairy beverage. *International Food Research Journal*, 24(3): 927-932.

Samy, R. P. and Gopalakrishnakone, P. (2010). Therapeutic potential of plants as anti-microbials for drug discovery. *Evidence-Based Complementary and Alternative Medicine*, 7(3): 283-294.

Sánchez-Moreno, C., Larrauri, J. A. and Saura-Calixto, F. (1998) A procedure to measure the anti-radical efficiency of polyphenols*. Journal of the Science of Food and Agriculture*, 76(2): 270-276.

Santos-Sánchez, N. F., Salas-Coronado, R., Villanueva-Cañongo, C. and Hernández-Carlos, B. (2019). Antioxidant Compounds and Their Antioxidant Mechanism. In *Antioxidants*. IntechOpen.

Sapers, G. and Annous, B. (2004). Browning inhibitor and processing aid contamination. In *Annual Meeting of Institute of Food Technologists*, 89: 4.

Sarkar, P. K. and Nout, M. R. (Eds.). (2014). *Handbook of Indigenous Foods Involving Alkaline Fermentation*. CRC Press.

Sarker, S. D. and Nahar, L. (2012). Natural products isolation: methods in molecular biology. *Springer Science and Business Media*, 864: 33-34.

Sarkis, J. R., Michel, I., Tessaro, I. C. and Marczak, L. D. F. (2014). Optimization of phenolics extraction from sesame seed cake. *Separation and Purification Technology*, 122: 506–514.

Schmitz, R. A., Daniel, R., Deppenmeier, U. and Gottschalk, G. (2013). The Anaerobic Way of Life. *The Prokaryotes: Prokaryotic Communities and Ecophysiology*, 259-273.

Schönheit, P., Buckel, W. and Martin, W. F. (2016). On the origin of heterotrophy. *Trends in Microbiology,* 24(1): 12–25.

Schwan, R. F. and Wheals, A. E. (2004). The microbiology of cocoa fermentation and its role in chocolate quality. *Critical Reviews in Food Science and Nutrition*, 44(4): 205-221.

Shahidi, F. and Zhong, Y. (2010). Novel antioxidants in food quality preservation and health promotion. *European Journal of Lipid Science and Technology*, 112(9): 930-940.

Shapton, D. A. and Shapton, N. F. (1993). Principles and Practices for the Safe Processing of Foods. Chapter 8. A volume in Woodhead Publishing Series in *Food Science, Technology and Nutrition* (pp. 220-253). Copyright©1993 Woodhead Publishing Limited. All rights reserved. Woodhead Publishing.

Sheahan, C. M. (2014). Plant guide for sesame (Sesamum orientale). *USDA-Natural Resources Conservation Service, Cape May Plant Materials Center.* Cape May, NJ.

Shetty, P. H. and Jespersen, L. (2006). Saccharomyces cerevisiae and lactic acid bacteria as potential mycotoxin decontaminating agents. *Trends in Food Science & Technology*, 17(2): 48-55.

Shurtleff, W. and Aoyagi, A. (2013). History of *tofu* and *tofu* products (965 CE to 2013). Soyinfo Center.

Shyu, Y. S. and Hwang, L. S. (2002). Antioxidative activity of the crude extract of lignan glycosides from unroasted Burma black sesame meal. *Food Research International*, 35(4): 357-365.

Simirgiotis, M.J. and Schmeda-Hirschmann, G. (2010). Determination of phenolic composition and antioxidant activity in fruits, rhizomes and leaves of the white strawberry (*Fragaria chiloensis* spp. chiloensis form chiloensis) using HPLC-DAD–ESI-MS and free radical quenching techniques. *Journal of Food Composition and Analysis,* 23: 545–553.

Skoog, D. A., West, D. M., Holler, F. J. and Crouch, S. R. (2013). Fundamentals of Analytical Chemistry. *Nelson Education*.

Skoog, D. A., Holler, F.J. and Crouch, S. R. (2017). Principles of Instrumental Analysis (6th ed.). *Brooks/Cole Cengage Learning*, Chapters 11, 20, 26, 27.

Smid, E. J. and Gorris, L. G. M. (1999). Natural antimicrobials for food preservation. *Handbook of Food Preservation* (pp. 285-308). Marcel Dekker, New York.

Soobrattee, M. A., Neergheen, V. S., Luximon-Ramma, A., Aruoma, O. I. and Bahorun, T. (2005). Phenolics as potential antioxidant therapeutic agents: Mechanism and actions. *Mutation Research/Fundamental and Molecular Mechanisms of Mutagenesis*, 579(1): 200-213.

Spigno, G., Tramelli, L. and De Faveri, D. M. (2007). Effects of extraction time, temperature and solvent on concentration and antioxidant activity of grape marc phenolics. *Journal of Food Engineering*, 81(1): 200-208.

Steinkraus, K. H. (1993). Comparison of fermented foods of the East and West. In Fish Fermentation Technology. Edited by Lee, C. H. and Steinkraus, K. H. *United Nations University Press* (pp. 1–12). Reilly PJ: Tokyo.

Steinkraus, K. H. (2002). Fermentations in world food processing. *Comprehensive Reviews in Food Science and Food Safety,* 1(1): 23-32.

Steinkraus, K. H. (2018). Handbook of Indigenous Fermented Foods, revised and expanded. CRC Press. *Food Science and Technology (USA)*, 73: 76–79.

Stockinger Lab. (2001). Glycerol stocks. Retrieved 5 January 2016 from www.oardc.ohio-state/stockingerlab/.

Suffredini, I. B., Sader, H. S., Gonçalves, A. G., Reis, A. O., Gales, A. C., Varella, A. D. and Younes, R. N. (2004). Screening of antibacterial extracts from plants native to the Brazilian Amazon rain forest and Atlantic forest. *Brazilian Journal of Medical and Biological Research*, 37(3): 379-384.

Sugano, A., T. Inoue, K. Kobe, K. Yoshida, N. Hirose and Y. Akimoto. (1990). Influence of sesame lignans on various lipid parameters in rats. *Agricultural and Biological Chemistry*, 54: 2669-2673.

Sui, X. (2016). *Impact of Food Processing on Anthocyanins.* (Doctoral thesis accepted). National University of Singapore, Singapore. Springer. doi:10.1007/978-981-10-2612-6.

Suja, K. P., Jayalekshmy, A. and Arumughan, C. (2005). Food chemistry antioxidant activity of sesame cake extract*. Food Chemistry*, 91: 213–219.

Sulaiman, S. F., Sajak, A. A. B., Ooi, K. L. and Seow, E. M. (2011). Effect of solvents in extracting polyphenols and antioxidants of selected raw vegetables. *Journal of Food Composition and Analysis,* 24(4-5): 506-515.

Sultana, B., Anwar, F. and Ashraf, M. (2009). Effect of extraction solvent/technique on the antioxidant activity of selected medicinal plant extracts. *Molecules*, 14(6): 2167-2180.

Sumono, A. and Wulan, S. D. A. (2008). The use of bay leaf (*Eugenia polyantha* Wight) in dentistry. *Dental Journal (Majalah Kedokteran Gigi)*, 41(3): 147-150.

Sun, H. L. (2005). Sesame oil. In: Fereidoon Shahidi (Ed.), Bailey's Industrial Oil and Fat Products. (Vol. 6) (6th ed). John Wiley & Sons.

Sun, X., Jin, Q. and Li, X. (2016). Physical quality changes of pre-cooked shrimps during frozen storage. *Advances in Engineering Research*, 63: 76-81.

Surono, I. S. (2016). Ethnic fermented foods and beverages of Indonesia. In *Ethnic Fermented Foods and Alcoholic Beverages of Asia* (pp. 341-382). Springer, New Delhi.

Swamy, T. A., Obey, J. and Mutuku, N. C. (2013). Phytochemical analysis of *Vernonia adoensis* leaves and roots used as a traditional medicinal plant in Kenya. *International Journal of Pharmaceutical and Biological*, 3: 46-52.

Svanberg, U., Sjögren, E., Lorri, W., Svennerholm, A. M. and Kaijser, B. (1992). Inhibited growth of common enteropathogenic bacteria in lactic-fermented

cereal gruels. *World Journal of Microbiology and Biotechnology*, 8(6): 601-606.

Szliszka, E., Skaba, D., Czuba, Z. P. and Krol, W. (2011). Inhibition of inflammatory mediators by neobavaisoflavone in activated RAW264. 7 macrophages. *Molecules*, 16(5): 3701-3712.

Tahmouzi, S. (2014). Optimization of polysaccharides from Zagros oak leaf using RSM: antioxidant and antimicrobial activities. *Carbohydrate Polymers*, 106: 238-246.

Tamang, J. P. (2015). Health benefits of fermented foods and beverages. New York: CRC Press, Taylor & Francis Group. ISBN 978-1-4665-88097. 636

Tamang, J. P. (Ed.). (2016). *Ethnic fermented foods and alcoholic beverages of Asia* (pp. 4-5). Delhi, India: Springer.

Tamang, J. P., Watanabe, K. and Holzapfel, W. H. (2016). Review: Diversity of microorganisms in global fermented foods and beverages. *Frontiers in Microbiology*, 7.

Tamang, J. P. and Kailasapathy, K. (2010). *Fermented Foods and Beverages of The World*. Florida: CRC Press.

Thommes, K. and Strezov, V. (2015). Fermentation of Biomass. In Strezov, V. and Evan, T. J. (Eds.), *Biomass Processing Technologies* (pp. 257-268). Boca, Raton: CRC Press.

Thompson, S. S., Miller, K. B., Lopez, A. and Camu, N. (2013). Cocoa and coffee, In: Doyle, M.P., Buchanan, R.L. (Eds.), Food Microbiology: Fundamentals and Frontiers (4th ed) (pp. 881-889). ASM Press,Washington, DC.

Tille, P. M. (2015). *Bailey & Scott's Diagnostic Microbiology 13* (pp. 88). Elsevier Publication.

Tirloni, E., Ghelardi, E., Celandroni, F., Bernardi, C. and Stella, S. (2017). Effect of dairy product environment on the growth of Bacillus cereus. *Journal of Dairy Science*, 100(9): 7026-7034.

Tortora, G. J., Funke B. R. and Case C. L. (2007). *Microbiology: An Introduction*. San Francisco: Pearson Benjamin Cummings.

Trusheva, B., Trunkova, D. and Bankova, V. (2007). Different extraction methods of biologically active components from propolis: a preliminary study. *Chemistry Central Journal*, 1(1): 13.

Tsao, G. T. (1999). *Recent Progress in Bioconversion of Lignocellulosics 75* (pp. 78). Germany: Springer Science & Business Media.

Tsuzuki, T., Tokuyama, Y., Igarashi, M. and Miyazawa, T. (2004). Tumor growth suppression by α-eleostearic acid, a linolenic acid isomer with a conjugated triene system, via lipid peroxidation. *Carcinogenesis*, 25(8): 1417-1425.

Tunde-Akintunde, T. Y., Oke, M. O. and Akintunde, B. O. (2012). Sesame seed. In *Oilseeds*. InTech. ISBN: 978-953-51-0665-4.

Tyagi, R. and Sharma, V. (2014). A comparison of volatile compounds in different genotypes of Sesamum indicum L. by GC-MS. *International Journal of Pharmaceutical Sciences and Research*, 5(1): 249.

UC Davis Integrative Medicine. (2016). Retrieved 10 September 2019 from https://ucdintegrativemedicine.com/2016/01/magic-seeds/black-sesame-seeds-isolated-on-white-background/#gs.2c9gqn.

Uzun, B., Arslan, Ç. and Furat, Ş. (2008). Variation in fatty acid compositions, oil content and oil yield in a germplasm collection of sesame (*Sesamum indicum* L.). *Journal of the American Oil Chemists' Society*, 85(12): 1135-1142.

Van Bogaert, I. N., Groeneboer, S., Saerens, K. and Soetaert, W. (2011). The role of cytochrome P450 monooxygenases in microbial fatty acid metabolism. *The FEBS Journal*, 278(2), 206-221.

Van Rensburg, S. J., Daniels, W. M. U., Van Zyl, J. M. and Taljaard, J. J. F. (2000). A Comparative study of the effects of cholesterol, beta-sitosterol, beta-sitosterol glucoside, dehydro-epiandrosterone sulphate and melatonin on in vitro lipid peroxidation. *Metabolic Brain Disease*, 15(4): 257-265.

Van Zyl, R. L., Seatlholo, S. T., Van Vuuren, S. F. and Viljoen, A. M. (2006). The biological activities of 20 nature identical essential oil constituents. *Journal of Essential Oil Research*, 18: 129-133.

Vongsak, B., Sithisarn, P., Mangmool, S., Thongpraditchote, S., Wongkrajang, Y. and Gritsanapan, W. (2013). Maximizing total phenolics, total flavonoids contents and antioxidant activity of *Moringa oleifera* leaf extract by the appropriate extraction method. *Industrial Crops and Products*, 44: 566-571.

Waalkens-Berendsen, D. H., Wolterbeek, A. P. M., Wijnands, M. V. W., Richold, M. and Hepburn, P. A. (1999). Safety evaluation of phytosterol esters. Part 3. Two-generation reproduction study in rats with phytosterol esters—a novel functional food. *Food and Chemical Toxicology*, 37(7): 683-696.

Wacher, C., Canas, A., Cook, P. E., Barzana, E. and Owens, J. D. (1993). Sources of microorganisms in pozol, a traditional Mexican fermented maize dough. *World Journal of Microbiology and Biotechnology*, 9, 269–274.

Wang, D., Zhang, L., Huang, X., Wang, X., Yang, R., Mao, J., Wang, X., Wang, X., Zhang, Q. and Li, P. (2018). Identification of nutritional components in black sesame determined by widely targeted metabolomics and traditional Chinese medicines. *Molecules*, 23(5): 1180.

Warra, A. A. (2011). Sesame (*Sesamum indicum* L.) seed oil methods of extraction and its prospects in cosmetic industry: a review. *Bayero Journal of Pure and Applied Sciences*, 4(2): 164-168.

Wasko, B. M., Carr, D. T., Tung, H., Doan, H., Schurman, N., Neault, J. R., Feng, J., Lee, J., Zipkin, B., Mouser, J., Oudanonh, E., Nguyen, T., Stetina, T., Shemmory, A., Lemma, M. and Kaeberlein, M. (2013). Buffering the pH of the culture medium does not extend yeast replicative lifespan. *F1000Research*, 2.

Weiss, E. A. (2000). Oilseed Crops Blackwell Science. *Inc., Malden, MA*.

Welch, R. A. (2006). The genus *Escherichia*. Proteobacteria: Gamma Subclass. *The Prokaryotes*, 6: 60-71.

Wettasinghe, M., Shahidi, F. and Amarowicz, R. (2002). Identification and quantification of low molecular weight phenolic antioxidants in seeds of evening primrose (*Oenothera biennis* L.). *Journal of Agricultural and Food Chemistry*, 50(5): 1267-1271.

Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. (2008). *Prescott, Harley and Klein's Microbiology* (pp. 134-135). New York: McGraw Hill Inc.

Witkowska, A. M., Hickey, D. K., Alonso-Gomez, M. and Wilkinson, M. (2013). Antimicrobial activity of commercial herb and spices extracts against selected foodborne bacteria. *Journal of Food Research*, 2(4): 37-54.

Wong, P. Y. and Kitts, D. D. (2006). Studies on the dual antioxidant and antibacterial properties of parsley (*Petroselinum crispum*) and cilantro (*Coriandrum sativum*) extracts. *Food Chemistry*, 97(3): 505-515.

Wu, R., Ma, F., Zhang, L., Li, P., Li, G., Zhang, Q., ... and Wang, X. (2016). Simultaneous determination of phenolic compounds in sesame oil using LC–MS/MS combined with magnetic carboxylated multi-walled carbon nanotubes. *Food Chemistry*, 204: 334-342.

Yasothai, R. (2014). Chemical composition of sesame oil cake–review. *International Journal of Science, Environmental and Technology*, 3(3): 827-835.

Yi, J., Zhang, Q., Li, X., Wang, X., Li, B. and Zhu, W. (2019). Steam explosion technology based for oil extraction from sesame (*Sesamum indicum* L.) seed. *Journal of the Saudi Society of Agricultural Sciences*, 18(1): 1-6.

Yoshida, H., Shigezaki, J., Takagi, S. and Kajimoto, G. (1995). Variations in the composition of various acyl lipids, tocopherols and lignans in sesame seed oils roasted in a microwave oven. *Journal of the Science of Food and Agriculture*, 68(4): 407-415.

Young, I. S. and Woodside, J. V. (2001). Antioxidants in health and disease. *Journal of Clinical Pathology*, 54(3): 176-186.

Yusoff, N. A. H., Noor, N. F. and Rukayadi, Y. (2015). Effects of *Cosmos caudatus* Kunth. (*Ulam raja*) extract on microflora in raw chicken meat. *International Journal of Current Microbiology and Applied Sciences,* 4(2): 426-435.

Zainin, N. S., Lau, K. Y., Zakaria, M., Son, R., Abdull Razis, A. F. and Rukayadi, Y. (2013). Antibacterial activity of *Boesenbergia rotunda* (L.) Mansf. A. extract against *Escherichia coli. International Food Research Journal*, 20(6): 3319-3323.

Zhan, Y. X., Cheng, M., Wu, A. Z. and Zhou, X. C. (1990). Cytogenetic studies in sesame (Sesamum indicum L.). III. A new taxonomic system. *Acta Agriculturae Universitatis Pekinensis*, 16(1): 11-18.

Zhang, Q., Zhang, J., Shen, J., Silva, A., Dennis, D. A. and Barrow, C. J. (2006). A simple 96-well microplate method for estimation of total polyphenol content in seaweeds. *Journal of Applied Phycology*, 18(3-5): 445-450.

Zhao, C. C., Shao, J. H., Li, X., Xu, J. and Zhang, P. (2005). Antimicrobial constituents from fruits of *Ailanthus altissima* SWINGLE. *Archives of Pharmacal Research*, 28(10): 1147-1151.

Zhao, X., Lin, C. W., Wang, J. and Oh, D. H. (2014). Advances in rapid detection methods for foodborne pathogens. *Journal of Microbiology and Biotechnology*, 24(3): 297-312.

Zhou, L., Lin, X., Abbasi, A. M. and Zheng, B. (2016). Phytochemical contents and antioxidant and antiproliferative activities of selected black and white sesame seeds. *BioMed Research International*, 2016: 1-9.

Zhu, E. and Sambath, S. (Eds.). (2012). *Information Technology and Agricultural Engineering* (pp. 134). Springer Science & Business Media.

Zinder, S. H. and Dworkin, M. (2013). Morphological and Physiological Diversity. In Rosenberg, E. (Ed.). *The Prokaryotes*, 89-122. Berlin, Heidelberg: Springer.

Zgurskaya, H. I., Lopez, C. A. and Gnanakaran, S. (2015). Permeability barrier of Gram-negative cell envelopes and approaches to bypass it. *ACS Infectious Diseases*, 1(11), 512-522.

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LIST OF PUBLICATIONS

Manucript

Rosni, N. K., Sanny, M., Bahranor, N. S. A. and Rukayadi, Y. (2020). Physicochemical characteristics, microbiological safety and sensory acceptability of coconut dregs during fermentation using *Rhizopus oligosporus*. *Food Research*, 4(5): 1402-1411. (Published)

Rosni, N. K., Sanny, M., Mustaffer, N. H. and Rukayadi, Y. Antimicrobial and antioxidant activities of ethanolic extract of fermented black sesame (*Sesamum indicum* L.) seed dregs. LWT – Food Science and Technology. (Submitted)

Rosni, N. K., Yusof@Daud, N. A. M. and Rukayadi, Y. Effect of *Nigella sativa* L. seed extract on foodborne pathogens and microflora in raw chicken wing. Journal of Food Safety. (Submitted)

Oral presentation

Rosni, N. K. Physicochemical characteristics, microbiological safety and sensory acceptability of coconut dregs during fermentation using *Rhizopus oligosporus*. Monash Science Symposium 2018. Monash University Malaysia, Subang Jaya, Selangor. 21st - 23rd November 2018.

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