SHOOT MULTIPLICATION, ESSENTIAL OILS, ANTIOXIDANT CONTENT AND ANTIMICROBIAL ACTIVITIES OF Alpinia conchigera Griff.

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By

RAIHANA BINTI RIDZUAN

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

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DEDICATION

I dedicate this thesis to my mother Mrs. Hairunnishah binti Mat Jaffari for your patience, love and encouragement.

Also to my beloved Mr. Halim bin Ahmad for your support and love.

Thank you very much for everything

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

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Supervisor: Assoc. Prof. Faridah Qamaruz Zaman, PhD
Faculty: Institute of Bioscience

The research on medicinal value of *Alpinia conchigera* (Zingiberaceae) in Malaysia have been growing extensively for its antifungal properties. In order to meet the demand for commercial cultivation, the research on the *in vitro* propagation and the potential of rhizome and leaf oil of this species had been conducted. The whole plant of *Alpinia conchigera* Griff. (lengkuas padi) were collected from the Conservatory Park, Institute of Bioscience, Universiti Putra Malaysia. This research was divided into two experiment. Experiment 1 involved the establishment of the aseptic cultures of *A. conchigera* through *in vitro* propagation for shoot multiplication. The rhizome buds were cultured and directly regenerated in the Murashige and Skoog (MS) medium supplemented with 6-benzylaminopurine (BAP), Kinetin (Kin) at different concentrations (0, 1, 3, 5, 7 mg/L) and naphthalene acetic acid (NAA) at the concentrations of (0.5, 1.0, 1.5 mg/L). The optimum concentration for shoot initiation of *A. conchigera* was produced in MS medium supplemented with 0.5 mg/L NAA with 3.2 ± 0.9 shoots. Whereas, MS medium supplemented with 1.5 mg/L NAA was optimum for root initiation which gave 16.6 ± 1.4 roots. The effect of adenine on shoot multiplication was also investigated. The highest shoot number was produced in the medium containing 5 mg/L BAP and 0.5 mg/L NAA with the addition of 80 mg/L of adenine with 3.4 ± 0.5 shoot number. However, the medium supplemented with 80 mg/L adenine alone was observed to give good results for both shoots and roots, therefore was chosen for the rooting stage. Among all the sucrose concentrations, the sucrose supply of 60 g into the medium containing 80 mg/L adenine showed better response of plantlets. Healthy regenerated plantlets were selected for the hardening in a sterile mixture of husk and peat moss with the ratio 1:3. Experiment 2 was conducted to screen the constituents, antioxidant and antimicrobial properties of *A. conchigera* essential oils. The rhizomes and leaves were subjected to hydrodistillation using Clevenger-type apparatus. Then, the essential oils obtained from each part was analyzed for its volatile constituents by GC-MS analysis. Rhizome oil indicated 38 compounds with major compound detected was eucalyptol (60.58%) whereas the leaf oil produced 51 compounds with the most abundant compound was β-bisabolene (46.70%). The essential oils were then subjected to antioxidant tests namely

2,2-diphenyl-1-1-picrylhydrazyl (DPPH) free radical scavenging activity and β-carotene-linoleic acid assay followed by the total phenolic content (TPC) test. The rhizome oil indicated the highest antioxidant activities and the most abundant phenolic and polyphenolic compounds (IC_{50}=151.7 mg/µl, antioxidant activity=106.01% and TPC=203.3 GAE/100g) followed by leaf oil (IC_{50}=309.8 mg/µl, antioxidant activity=84.96% and TPC=94.1 GAE/100g) when comparing with the synthetic antioxidant, butylated hydroxytoluene (BHT). The antimicrobial assay namely disc diffusion assay and minimum inhibitory concentration (MIC) was conducted against selected microbes. The rhizome oil also showed inhibitory activity against all six bacteria and fungi. In contrast, the leaf oil only showed inhibition against two Gram positive bacteria. Overall, this study had provided the useful evidence on the shoot multiplication of tissue culture plantlets and the essential oils potential of *A. conchigera* for the its cultivation and commercialization.

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

PENGGANDAAN PUCUK, MINYAK PATI, KANDUNGAN ANTIOKSIDA DAN AKTIVITI ANTIMIKROB *Alpinia conchigera* Griff.

Oleh

RAIHANA RIDZUAN

Februari 2014

Penyelia: Prof. Madya Faridah Qamaruz Zaman, PhD
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Kajian mengenai nilai perubatan daripada pokok *Alpinia conchigera* (Zingiberaceae) di Malaysia telah berkembang dengan meluas oleh kerana ciri-ciri antikulatnya. Dalam usaha untuk memenuhi permintaan untuk penanaman komersial, penyelidikan ke atas pembiakan *in vitro* dan potensi minyak rizom dan daun spesis ini telah dijalankan. Keseloruhan pokok *Alpinia conchigera* Griff. (lengkuas padi) telah diambil dari Taman Konservatori, Institut Biosains, Universiti Putra Malaysia. Kajian ini dibahagikan kepada dua eksperimen. Eksperimen 1 melibatkan pembiakan tunas *A. conchigera* melalui kultur *in vitro* untuk pertumbuhan pucuk kultur. Tunas rizom dikulturkan secara langsung di dalam Murashige dan Skoog (MS) media yang ditambah dengan 6-benzylaminopurine (BAP), Kinetin (Kin) pada kepekatan (0, 1 , 3, 5, 7 mg /L) dan naftalena asetik asid (NAA) pada kepekatan (0.5 , 1.0 , 1.5 mg /L). Kepekatan optimum untuk pertumbuhan pucuk *A. conchigera* dihasilkan dalam media MS yang dibekalkan dengan 0.5 mg / L NAA dengan penghasilan sebanyak 3.2 ± 0.9 pucuk. Manakala, media MS yang dibekalkan dengan 1.5 mg / L NAA adalah optimum untuk pertumbuhan akar dengan penghasilan sebanyak 16.6 ± 1.4 akar. Penambahan hormon adenina dalam media dan kesannya pada penggandaan pucuk dikaji. Bilangan pucuk tertinggi dihasilkan dalam media yang mengandungi 5 mg/ L BAP dan 0.5 mg/L NAA dengan tambahan 80 mg/L adenina 3.4 ± 0.5 bilangan pucuk. Walau bagaimanapun, media yang hanya ditambah dengan 80 mg/ L adenina telah menunjukkan hasil yang baik untuk penggandaan pucuk dan akar, oleh itu kepekatan ini telah dipilih untuk dibekalkan di dalam media peringkat perakaran. Antara semua kepekatan sukrosa, bekalan sukrosa sebanyak 60 g di dalam media yang dibekalkan dengan 80 mg/L adenina menunjukkan penggandaan akar yang lebih baik. Anak pokok kultur yang sihat telah dipilih untuk peringkat pengerasan di dalam campuran media tanah sekam dan tanah gambut dengan nisbah 1:3. Eksperimen 2 telah dijalankan untuk menyaring sebatian kimia, anti-oksida dan anti-mikrob minyak pati pokok *A. conchigera*. Rizom dan daun pokok lengkuas padi telah menjalani proses penyulingan menggunakan alat Clevenger. Kemudian, minyak pati yang diperolehi daripada setiap bahagian telah dianalisa untuk menentukan sebatian kimia melalui analisis GC-MS. Minyak rizom

menunjukkan 38 sebatian dengan sebatian utama dikesan adalah eucalyptol (60.58 %) manakala minyak daun menghasilkan 51 sebatian dengan sebatian yang paling banyak adalah β-bisabolene (46.70%). Ujian antioksida iaitu 2,2-difenil-1-1-picrylhydrazyl (DPPH) aktiviti mengaut radikal bebas dan β-karotena-linoleik asid diikuti dengan ujian jumlah kandungan fenolik (TPC) telah dijalankan. Minyak rizom menunjukkan aktiviti antioksida tertinggi, fenolik dan sebatian polifenolik yang paling banyak (IC_{50}=151.7 mg/µl, aktiviti antioksida=106.01% dan TPC=203.3 GAE/100g) diikuti oleh minyak daun (IC_{50} = 309.8 mg/µl , aktiviti antioksida=84.96 % dan TPC=94.1 GAE/100g) apabila dibandingkan dengan antioksida sintetik, hydroxytoluene butylated (BHT). Ujian antimikrob kaedah cakera penyebaran dan kepekatan minimum perencatan (MIC) telah dijalankan terhadap mikrob terpilih. Minyak rizom juga menunjukkan aktiviti perencatan terhadap kesemua bakteria dan kulat. Sebaliknya, minyak daun hanya menunjukkan perencatan terhadap dua bakteria Gram positif . Secara keseluruhannya, kajian ini telah memberikan maklumat yang berguna mengenai pembiakan *A. conchigera* melalui kultur tisu dan potensi minyak patinya untuk penanaman dan pengkomersialan.

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I certify that a Thesis Examination Committee has met on 5 February 2014 to conduct the final examination of Raihana Ridzuan on her thesis entitled "Shoot Multiplication, Essential Oils, Antioxidant Content and Antimicrobial Activities of *Alpinia conchigera* Griff" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

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

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DECLARATION

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I hereby confirm that:

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LIST OF SYMBOLS AND ABBREVIATIONS

DPPH	2,2-diphenyl-1-1-picrylhydrazyl
BAP	6-Benzylaminopurine
And	Adenine
AD	After Death (of Christ)
AIDS	Acquired immune deficiency syndrome
ANOVA	Analysis of variance
BC	Before Christ
BHA	Butylated hydroxyanisole
BHT	Butylated hydroxytoluene
Cm	Centimeter
°C	Degree Celsius
DMRT	Duncan's New Multiple Range Test
et al.	*et alia*
FSTM	Faculty of Food Science and Technology
F-C	Folin-Ciocalteau
GAE	Gallic Acid Equivalence
G	Gram
g/L	Gram per liter
HPLC	High Performance Liquid Chromatography
H	Hour
IBA	Indole butylated acid
IBS	Institute of Bioscience
Kin	Kinetin

L	Liter
$HgCl_2$	Mercury chloride
µM	Micro molar
Mg	Milligram
mg/L	Milligram per liter
Mm	Millimeter
MIC	Minimum Inhibitory Concentration
Min	Minute
M	Molar
MHA	Mueller Hinton Agar
MHB	Mueller Hinton Broth
MS	Murashige and Skoog
MSO	Murashige and Skoog medium without supplemented hormone
NAA	Naphthalene acetic acid
NA	Nutrient Agar
NB	Nutrient Broth
%	Percentage
AA%	Percentage of antioxidant activity
OPC	Oropharyngeal candidosis
PGR	Plant Growth Regulator
±	Plus minus
pH	Potentiometric hydrogen ion concentration
ROS	Reactive Oxygen Species
NaOCl	Sodium hypochlorite

SE	Standard error
SPSS	Superior Performing Statistical Package
TPC	Total Phenolic Content
UPM	Universiti Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 Introduction

Malaysia is one of the mega-biodiversity countries of the world which is not only rich with its flora and fauna but also as a living heritage of various herbal species. The jungles which are believed to be 130 million years old consist of around 14,500 species of flowering plants and trees (Richmond, 2010).

Among all the monocots, Zingiberaceae (ginger family) has the highest number of plants used as herbs and spices. Zingiberaceae is the monocotyledonous plant family constitutes a vital group of rhizomatous medicinal and aromatic plants. This family is characterized by the presence of its volatile oils and oleoresins. Taxonomically, this family consist of 52 important genera which are distributed mostly in the tropical and subtropical countries such as India, China, Malaysia, Thailand, and Philippines (Habsah *et al*., 2005).

Holttum (1950) listed two subfamilies under Zingiberaceae which are Zingiberoideae (aromatic) and Costoideae (non-aromatic). Among 52 genera and 1400 of Zingiberaceae species distributed in the region of Asia (Kasarkar and Kulkarni, 2010), at least 20 genera and 300 species of this family are found in Malaysia (Habsah *et al*., 2005). Some of the important and common genus found in Malaysia are *Alpinia* Roxb.*, Curcuma* L.*, Zingiber* Mill.*, Geostachys* (Baker) Ridl, *Etlingera* Giseke, *Globba* L., and *Kaempferia* L.

Most of Zingiberaceae plants such as *Alpinia* Roxb. are obtained mainly from natural growing areas and the demand for these plants is very high as for its medicinal value. With these high demands, the plants are being overexploited and are threatening the survival of many rare species (Nalawade and Tsay, 2004).

As aromatic herbs*, A. conchigera* is rich in volatile oils or essential oils. Essential oils are highly concentrated and not the same as perfume or fragrance oils because it is derived directly from the true plants whereas in contrast, perfume oils are artificially created fragrances and may contain artificial substances (Nigam & Ahmed, 1991). The extract from this plant have been shown to contains natural phenolics, polyphenolics, terpenes and other phytochemical compounds which responsible for antimicrobial, anti inflammatory, anti tumor and antioxidant activities (Habsah *et al*., 2000; Lee *et al*., 2006; Awang *et al*., 2010; Sulaiman *et al*., 2010).

Over the last few years in Malaysia, the research on the medicinal values of *A. conchigera* have been growing extensively and the demand on this plant also became higher. Same as other *Alpinia* species, *A. conchigera* can be propagated through underground rhizomes, however this part is susceptible to the various diseases of fungal, bacterial, viral, and mycoplasmal origins such as rhizome rot, *Fusarium* yellow disease, leaf spot and bacteria wilt (Samsudeen *et al*., 2000). Whereas the major pests of Zingiberaceae spp. namely shoot borer *Conogethes punciferalis* and root-knot nematode, *Meliodogyne incognita* cause the considerable crop losses (Kavyashree, 2009).

The propagation of this plant through underground rhizomes is considered very slow (Devasahayam and Koya, 2007). This plant produces seeds, however it resulted in genetic variations which affect the consistency of their character. In order to overcome this production constraint, the biotechnological approaches was attempted for the production of disease-free plants. Thus, the micropropagation method provides an alternative way to produce healthy and disease-free plants in a short period of time continuously. To this date, no research had been conducted on the establishment of the micropropagation protocols of the *A. conchigera* in Malaysia.

In addition, most of the research papers only reported on the medicinal properties of the underground rhizome and lack of investigation specifically on the other plant parts such as leaf. The selection of the rhizome part is mainly due to its underground occurence which aid in the storage of plant nutrient. However, the report on the potential of the leaf needs to be explored since the mass production of this plants may contribute to the waste agriculture biomass. Although previous research have been conducted and the volatile components of the *A. conchigera* have been identified, however the relationship between the phenolic compounds and their bioactivity are not completely known. Moreover, the study on the essential oils, antioxidant and antimicrobial potential, and cultivation of *A. conchigera* are not as widely available as those of common Alpinia, *A. galanga.*

1.2 Research objectives

The aim of this study is to mass propagate the species for multiplication and commercialization and to determine the medicinal properties of essential oils from leaf and rhizome parts of *A. conchigera*.

The specific objectives of this study are:

1. To establish the micropropagation protocol of *A. conchigera.*
2. To identify the essential oils constituents extracted from the rhizomes and leaves of *A. conchigera*.
3. To determine the total phenolic content of the rhizome and leaf oil of *A. conchigera.*
4. To determine the antioxidant and antimicrobial properties of the essential oils of *A. conchigera*.

REFERENCES

Abdul-Baki, A.A. (1974). *Hypochlorite and tissue sterilization*.Berlin: Planta, 115, 373-376.

Abdoul-Latif, F., Edou, P., Eba, F., Mohamed, N., Djama, S., Obame, L-C., Bassolé, I., Ali, A. (2010). Antimicrobial and antioxidant activities of essential oils and methanol extract of *Jasminum sambac* from Djibouti. *African Journal of Plant Science,* 4(3), 38-43.

Ahmad, D., Wicaksana, N., Shimazaki, T., Kikuchi, A., Jatoi, S.A., Watanabe, K.N. (2011).Environmentally safe *in vitro* regeneration protocol for *Curcuma*, *Kaempferia* and *Zingiber*. *African Journal of Biotechnology*, 10(43), 8584-8592.

Ainsworth, G.C., Sparrow, F.K., Sussman, A.S. (1973). *The fungi: An advanced treatise*. Academic Press: London.

Ak, T., Gülçin, I. (2008). Antioxidant and radical scavenging properties of curcumin. *Chemico-biological Interactions,* 174(1), 27-37.

Alasalvar, C., Shahidi, F., Liyana-Pathirana, C., Ohshima, T., (2003). Turkish tombul hazelnut (*Corylus avellana* L.) composition characteristics. *Journal of Agricultural and Food Chemistry,* 51, 3790–3796.

Ali, H.F.M., El-Ella, F.M.A., Nasr, N.F. (2010). Sceening of chemical analysis, antioxidant, antimicrobial and antitumor activities of essential oils of Oleander (*Nerium oleander*) flower. *International Journal of Biological Chemistry*, 4(4), 190-202.

Aligiannis, N, Kalpoutzakis,E. Mitaku,S., Chinou, I.B. (2001). Composition and antimicrobial activity of the essential oils of two *Origanum* species. *Journal of Agricultural and Food Chemistry,* 49, 4168-4170.

Anesini, C., Ferraro, G. E., Filp, R. (2008). Total polyphenol content and antioxidant capacity of commercially available tea (*Camellia sinensis*) in Argentina. *Journal of Agricultural and Food Chemistry*, 56, 9225-9229.

Anisuzzaman, M., Sharmin, S.A., Sultana, R., Khalekuzzaman, M., Alam, M.F., (2008). *In vitro* microrhizome induction in *Curcuma zedoaria* (Christm.) Roscoe- A conservation prioritized medicinal plant, *Journal of Biological Sciences*, 1-5.

Anita, H., Mustafa A.M., Halijah Ibrahim, (2000). Studies on essential oils of *Alpinia conchigera* Griff. from Malaysia. *Malaysian Journal of Science*, 19(1), 1-5.

Apfel, C.M., Enderle, T. (2004). Assays for high-throughput screening in drug discovery. In *Combinatorial Chemistry*, Second Edition, Weinheim, Germany:Edition Wiley-VCH, Vol. 26 pp 626-628.

Arambewela, L.S.R., Arawwawala, L.D.A.M, Athaudaka, N. (2010). Antioxidant and antifungal activities of essential oils of *Alpinia calcarata* Roscoe rhizomes. *Journal of Ayurveda and Integrative Medicine,* 1(3), 199-202.

Armando, C.C., Rahma, H.Y. (2009). Evaluation of the yield and the antimicrobial activity of the essential oils from: *Eucalyptus globulus, Cymbopogon citratus* and *Rosmarinus officinalis* in Mbarara district (Uganda). *Revista Colombiana de Cienca Animal,* 1, 240–249.

Arnason, J.T., Mata, R., Romeo, J.T. (1994). *Recent advances in phytochemistry: Phytochemistry of Medicinal plants*. New York: Plenum Press, pp 170-176.

Arques, J. L., Rodriguez, E., Nunez, M., Medina, M. (2008). Inactivation of gram negative pathogens in refrigerated milk by reuterin in combination with nisinor the lactoperoxidase system. *European Food Research and Technology,* 227(1), 77–82.

ASTA. (1968). Official analytical methods of the American Spice Trade Association. ASTA, Englewood Cliffs, N.J. p. 8-11.

Asthana, P., Jaiswal, V.S., Jaiswal, U. (2011). Micropropagation of *Sapindus trifoliatus* L. and assessment of genetic fidelity of micropropagated plants using RAPD analysis*. Acta Physiologiae Plantarum,* 33,1821–1829.

Athamaprasangsa, S., Buntrarongroj, U., Dampawan, P., Ongkavoranan, N. Rukachaisirikul, V., Sethuinda, S., Sornnarintra, M., Sriwub, P., Taylor, W. C. (1994). A 1, 7-Diarylheptanoid from *Alpinia conchigera. Phytochemistry,* 37(3), 871-873.

Awang, K., Ibrahim, H., Syamsir, D.R., Mohtar, M., Ali, R.M., Ali, N.A.M. (2011). Chemical constituents and antimicrobial activity of leaf and rhizome oils of *Alpinia pahangensis* Ridl., an endemic wild ginger from Peninsular Malaysia. *Chemistry and Biodiversity,* 8, 668-673.

Awang, K., Azmi, M.N., Aun, L.I.L., Aziz, A.N., Ibrahim, H., Nagoor, N.H. (2010). The apoptotic effect of 1'S-1'-scetoxychavicol acetate from *Alpinia conchigera* on human cancer cells*. Molecules,* 15, 8048–8059.

Aziz, A.N., Ibrahim, H., Syamsir, D.R., Mohtar, M., Vejayan, J., Awang K. (2013). Antimicrobial compounds from *Alpinia conchigera*. *Journal of Ethnopharmacology,*145, 798-802.

Azlim Almey, A.A., Ahmed Jalal Khan, C., Syed Zahir, I., Mustapha Suleman, K., 'Aisyah, M.R., Kamarul Rahim, K. (2010). Total phenolic content and primary antioxidant activity of methanolic and ethanolic extracts of aromatic plants' leaves. *International Food Research Journal,* 17, 1077-1084.

Baardseth, P. (1989). Effect of selected antioxidants on the stability of dehydrated mashed potatoes. *Food Additives and Contaminants*, 6, 201–207

Bakkali, F., Averbeck, S., Averbeck, D.,Idaomar, M.(2008). Biological effects of essential oils- A review. *Food and Chemical Toxicology,* 46(2), 446–75.

Battaglia, S., (2003). *The complete guide to aromatherapy*. Brisbane, Queensland, Australia: The International Centre of Aromatherapy.

Bauer, K., Garbe, D., Surburg, H. (2001). *Common fragrance and flavor materials: Preparation, properties and uses*, 2nd Edition, Weinheim, Germany: Wiley-VCH.

Bedi, S., Tanuja, Vyas, S.P. (2008). *A handbook of aromatic and essential oils plants: Cultivation, chemistry, processing and uses*, First Edition, India: Agrobios.

Becker, E.M., Nissen L.R., Skibsted L.H. (2004). Antioxidant evaluation protocols: Food quality or health effects. *European Food Research and Technology,* 219, 561-571.

Behera, K.K., Debashrita P., Santilata, S. (2010). Effect of plant growth regulator on *in vitro* multiplication of turmeric (*Curcuma longa* L. cv. Ranga). *International Journal of Biological Technology*, 1(1), 16-23.

Berg, D., Youdim, M.B., Riederer, P. (2004). Redox imbalance. *Cell and Tissue Research*, 318, 201–213.

Bera, T., Haque, R., Saha, S. (2009). Micropropagation of an important medicinal plant *Chlorophytum borivilianum*. *International Journal of Pharmaceutical Sciences,* 1(1), 153-163.

Bhatt, I.D., Dhar, U. (2000). Combined effect of cytokinins on multiple shoot production from cotyledonary node explants of *Bauhinia vahlii. Plant, Cell, Tissue, and Organ Culture,* 62,79–83.

Bhojwani, S.S., Razdan., M.K. (1986). *Plant tissue culture: Theory and practice*. New York, USA: Elsevier Publishers Company Inc, pp 16-24.

Bhuiyan, M.N.I., Chowdhury, J. U., Begum, J., Nandi, C. (2010). Essential oils analysis of the rhizomes of *Alpinia conchigera* Griff .and leaves of *Alpinia malaccensis* (Burm. f.) Roscoe from Bangladesh*, African Journal of Plant Science,* 4(6), 197–201.

Biavati, G.M., Wiederhecker, H.C., Colli, G.R. (2004): Diet of *Epipedobates flavopictus* (Anura: Dendrobatidae) in a Neotropical Savanna. *Journal of Herpetology,* 38, 510–518.

Biljana, D., Zika, L., Vladimir, Z., Aleksandar, T. (2005). Extraction of fennel *Foeniculum vulgare* Mill.) seeds with supercritical CO_2: Comparison with hydrodistillation. *Food Chemistry*, 92, 143–149.

Brands, D.A. (2006). *Salmonella*. United States of America: Chelsea House Publishers.

Burkill, I.H. (1966). A dictionary of the economic products of the Malay Peninsula (2nd ed.), Ministry of Agriculture and Cooperatives Vol. 1–2, Kuala Lumpur, Malaysia

Burt, S.A., Der Zee, R.V., Koets, A.P., De Graaff, A.M., Van Knapen, F., Gaastra, W. (2007). Carvacrol induces heat shock protein 60 and inhibits synthesis of flagellin in *Escherichia coli* O157:H7. *Applied and Environmental Microbiology,* 73, 4484–4490.

Burtt, P. B. L., Sm, R. M., Elzaawely, A. A., Xuan, T. D., Koyama, H., Tawata, S. (2007). Antioxidant activity and contents of essential oils and phenolic compounds in flowers and seeds *of Alpinia zerumbet. Food Chemistry,* 104, 1648–1653.

Caballero, B., Trugo, L. C., Finglas, P. M. (2003). *Encyclopedia of Food Sciences and Nutrition.* Amsterdam: Academic Press.

Campbell, N.A., Reece, J.B. (2008). *Biology* 8th ed. San Francisco (CA): Pearson/Benjamin Cummings.

Carlsen, M. H., Halvorsen, B. L., Holte, K., Bohn, S. K., Dragland, S., Sampson, L., Willey, C. (2010). The total antioxidant content of more than 3100 foods, beverages, spices, herbs and supplements used worldwide. *Nutrition Journal*, 9, 3.

Carson,C.F.,Hammer, K.A. (2011). *Chemistry and bioactivity of essential oils*. In: Thormar, H. (Ed.), Lipids and Essential oils as Antimicrobial Agents. Chichester: Wiley pp 204–238.

Chan, E. W. C., Lim, Y. Y., Wong, L. F., Lianto, F. S., Wong, S. K., Lim, K. K., Joe, C. E., (2008). Antioxidant and tyrosinase inhibition properties of leaves and rhizomes of ginger species. *Food Chemistry*, 109(3), 477–483.

Chandra, S., Bandopadhyay, R., Kumar, V., Chandra, R. (2010). Acclimatization of tissue cultured plantlets: from laboratory to land. *Biotechnology Letters*, 32, 1199-1205.

Chandra, S., Gonzalez de Mejia, E. (2004). Polyphenolic compounds, antioxidant capacity, and quinone reductase activity of an aqueous extract of ardisia compressa in comparisonto mate (*Ilex paraguariensis*) and green (*Camellia sinensis*) teas. *Journal of Agricultural and Food Chemistry*, 52, 3583-3589.

Charles, D.J., Simon, J.E. (1990). Comparison of extraction methods for the rapid determination of essential oils content and composition of basil. *Journal of the American Society for Horticultural Science*, 115(3), 458–462.

Chaurasia, S.C., Vyas, K.K. (1977). *In vitro* effect of some volatile oil against *Phytophthora parasitica* var *piperina*. *Journal of Research in Indian Medicine, Yoga and Homoeopathy,* 24-26.

Chinou, I. (2008). Primary and secondary metabolites and their biological activity. In *Thin Layer Chromatography in Phytochemistry*, London, New York: CRC Press, Vol. 99.

Choi, C. W. Kim, S. C., Hwang, S. S. (2002). Antioxidant activity and free radical scavenging capacity between Korean medicinal plants and flavonoids by assay-guided comparison, *Plant Science*, 163(6), 1161–1168.

Cloutier, S., Landry, B.S. (1994). Molecular markers applied to plant tissue culture. *In Vitro Cellular Development Biology*, 30, 32-39.

Colgecen, H., Koca, U., Toker, G. (2011). Influence of different sterilization methods on callus initiation and production of pigmented callus in *Arnebia densiflora* Ledeb. *Turkish Journal of Biology*, 35, 513-520.

Combs, Jr. G.F. (1998). *The Vitamins:* Fundamental Aspects in Nutrition and Health. San Diego: Academic Press.

Conforti, F., Statti, G., Uzunov, D., Menichini, F. (2006). Comparative chemical composition and antioxidant activities of wild and cultivated *Laurus nobilis* L. leaves and *Foeniculum vulgare* subsp. Piperitum (Ucria) coutinho seeds. *Biological and Pharmaceutical Bulletin,* 29 (10), 2056-2064.

Cseke, L.J., Kirakosyan, A., Kaufman, P.B., Warber, S.L., Duke, J.A., Brielmann, H.L. (2006). *Natural products from plants* Second Edition. United States: CRC Press, pp 2.

Das, A.B. (2012). *Plant tissue culture techniques for global food production*. Science Horizon. 9th Issue, India: Odisha, pp 35-41.

Davies, P. J. (2010). The plant hormones: their nature, occurrence, and functions. In *Plant hormones*., Netherlands: Springer, pp. 1-15.

Devasagayam, T. P. A., Tilak, J. C., Boloor, K. K., Sane, K. S. (2004). *Free radicals and antioxidants in human health*: Current status and future prospects research, (October).

Devasahayam, S. and Koya, K. M. A. (2007). *Insect pests of Turmeric*. In: Ravindran, P. N., Babu, K. N. and Sivaraman, K. (Eds.), Turmeric: The genus Curcuma. Medicinal and Aromatic Plants-Industrial Profiles. CRC Press, Taylor & Francis Group, Boca Raton, London, p. 169-193.

Dewick, P.M. (2002). *Medicinal Natural Products*: A biosynthetic Approach, 2nd Edition. Chichester: Wiley.

Dhande, G.A., Patil, V.M., Raut, R.V., Rajput, J.C., Ingle, A.G. (2012). Regeneration of okra (*Abelmoschus esculentus* L.) via apical shoot culture system. *African Journal of Biotechnology*, 11(86), 15226-15230.

Di Pasqua, R., Hoskins, N., Betts, G., Mauriello, G. (2006). Changes in membrane fatty acids composition of microbial cells induced by addiction of thymol, carvacrol, limonene, cinnamaldehyde, and eugenol in the growing media. *Journal of Agricultural and Food Chemistry,* 54, 2745–2749.

Diplock, A.T. (1991). Antioxidant nutrients and disease prevention- An overview. *American Journal of Clinical Nutrition,* 53, 189-193.

Dorman, H.J.D., Deans, S.G., Noble, R.C., Surai, P. (1995). Evaluation *in vitro* of plant essential oils as natural antioxidants. *Journal of Essential oils Research* 7: 645-651.

Duh, P.D. (1998). Antioxidant activity of Budrock (*Arctium lappa* Linn): Its scavenging effect on free radical and active oxygen. *Journal of the American Oil Chemists' Society,* 75, 455-461.

Earl, A.M., Losick, R., Kolter, R. (2008). Ecology and genomics of *Bacillus subtilis*. *Trends in microbiology,* 16(6), 269–75.

Elder, R.O., Keen, J.E., Siragusa, G.R., Barkocy-Gallagher, G. Koohmaraie, M. Laegreid, W.W. (2000). Correlation of enterohemorrhagic *Escherichia coli* O157 prevalence in feces, hides, and carcasses of beef cattle during processing. *Proceedings of the National Academy of Sciences of the United States of America* 97(7), 2999-3003.

Elkins, R., M.H., Tenney, L. (1988). *Candida albicans: A nutritional approach*. Australia: Woodland Publishing, pp 5-6

El-Ghorab, A., El-Massry, K.F., Shibamoto, T. (2007). Chemical composition of the volatile extract and antioxidant activities of the volatile and nonvolatile extracts of Egyptian corn silk (*Zea mays* l.). *Journal of Agricultural and Food Chemistry,* 55(22), 9124 -9127.

Elzaawely, A.A., Xuan, T.D., Tawata, S (2007). Essential oils, kava pyrones and phenolic compounds from leaves and rhizomess of *Alpinia zerumbet* and their antioxidant activity. *Food Chemistry,* 103, 486-494.

Evans, C.A.R., Miller, N.J., Paganga, G. (1997). Antioxidant properties of phenolic compounds. *Trends in Plant Science*, 2(4), 152-159.

Evans, W.C. (2002). *Trease and Evans' Pharmacognosy*, 15th Edition, London: Saunders.

Everette, J. D., Bryant, Q. M., Green, A. M., Abbey, Y. A., Wangila, G. W., Walker, R. B. (2010). Thorough study of reactivity of various compound classes toward the Folin-Ciocalteu reagent. *Journal of Agricultural and Food Chemistry*, 58, 8139-8144.

FAO. (2009). *Socio-economic impact of non-transgenic biotechnologies in developing countries. The case of plant micropropagation in Africa*, by Sonnino, A., Dhlamini, Z., Santucci, F.M., Warren, P., Eds. Rome.

Faridah, Q.Z., Abdelmageed, A.H.A., Nor Hazirah, A.N., Muhamad Yaacob (2010). Comparative study of essential oils composition of leaves and rhizomes of *Alpinia conchigera* Griff. at different post-harvest drying period. *Journal of Medicinal Plants Research,* 4(24), 2700-2705.

Faridah, H., Nurulhuda, H. (1999). The use of medicinal plant species by the Temuan tribe of Ayer Hitam Forest, Selangor, Peninsular Malaysia. *Pertanika Journal of Tropical Agricultural Sciences,* 22(2), 85 – 94.

Ficker, C.E., Smith, M.L., Susiarti, S., Leaman, D.J., Irawati, C., Arnason, J.T. (2003). Inhibition of human pathogenic fungi by members of Zingiberaceae used by the Kenyah (Indonesian Borneo). *Journal of Ethnopharmacology* 85, 289-293.

Figueiredo, S.F.L., Albarello, N., Viana, V.R.C.(2001). Micropropagation of *Rollinia mucosa* (Jacq.) Baill. *In Vitro Cellular and Developmental Biology-Plant,* 37, 471-475.

Filho, J.L.S.C., Blank, A.F., Alves, P.B., Ehlert, P.A.D., Melo, A.S., Cavalcanti, S.C.H., Arrigoni-Blank, M.F., Silva-Mann, R. (2006). Influence of the harvesting time, temperature and drying period on basil (*Ocimum basilicum* L.) essential oils. *Brazilian Journal of Pharmacognosy,* 16(1), 24-30.

Folin O., Ciocalteu V. (1927). Tyrosine and tryptophan determination on proteins. *Journal of Biological Chemistry,* 73(2), 627-649.

Fragakis, A.S., Thomson, C. (2007). *The Health Professional's Guide: Popular Dietary Supplements* Third Edition. USA: American Dietettic Association, pp 518-520.

Fu, L., Xu, B. T., Xu, X. R., Gan, R. Y., Zhang, Y., Xia, E, Q., and Li, H.B. (2011). Antioxidant capacities and total phenolic contents of 62 fruits. *Food Chemistry*, 129, 345-350.

Fujita, N., Yu, S., Yuta, N., Tomohiro, I., Hitoshi, M., Masatoshi, E., Tateaki, O. (2012). Folin-Chiocalteu colorimetric analysis using a scanner for rapid

determination of total polyphenol content in many test samples. *Studies in Science and Technology*, 1(2), 139–144.

Fukuda, T., Ito, H., Yoshida, T., (2003). Antioxidant polyphenols from walnuts (*Juglans regia* L.). *Phytochemistry,* 63, 795-801.

Gao, Y., M.J. van Belkum, M.E. Stiles. (1999). The outer membrane of gram-negative bacteria inhibits antibacterial activity of brochocin-C. *Applied and Environmental Microbiology,* 65, 4329-4333.

Garcia-Gonzales, R., Quiroz, K., Carrasco, B., Caligari, P. (2010). Plant tissue culture: Current status, opportunities and challenges. *Ciencia e Investigatcion Agraria*, 37(3), 5-30.

George, S., Brat, P., Alter, P., Amiot, M. J. (2005). Rapid determination of polyphenols and vitamin C in plant-derived products. *Journal of Agricultural and Food Chemistry*, 53, 1370-1373.

Ghafar, M.F.A., Prasad, K.N., Kong, K.W., Ismail, A. (2010). Flavonoid, hesperidine, total phenolic contents and antioxidant activities from *Citrus* species. *African Journal of Biotechnology,* 9(3), 326-330.

Gholivand, M.B., Rahimi-Nasrabadi, M. Batooli, H., Ebrahimabadi, A.H. (2010). Chemical composition and antioxidant activities of the essential oils and methanol extracts of *Psammogeton canescens. Food and Chemical Toxicology,* 48, 24-28.

Gilbert, R.J., Turnbull, P.C.B., Parry, J.M., Kramer, J.M. (1981). *Bacillus cereus and other Bacillus species: Their part in food poisoning and other clinical infections*. In: Berkeley, R.C.W., Goodfellow, M. (eds). The aerobic endospore-forming bacteria; classification and identification. Academic Press, London.

Gilly, C., Rohr, R., Chamel. A. (1997). Ultrastructure and radio labelling of leaf cuticles from ivy (*Hedera helix* L.) plants *in vitro* and during *ex vitro* acclimatization. *Annals of Botany,* 80, 139-145.

Gleason, F.K., Chollet, R. (2012). *Plant Biochemistry,* First Edition. United States: Jones & Bartlett Learning, pp 104-113.

Gomes, F., Simoes, M., Lopes, M.L., Canhoto, M. (2010). Effect of plant growth regulators and genotype on the micropropagation of adult trees of *Arbutus unedo* L. (strawberry tree). *New Biotechnology*, 27(6), 882-892.

Guildford, J. P. (1973). *Fundamental statistics in psychology and education,* Fifth edition New York: McGraw-Hill.

Gulluce, M. Sokmen, D. Daferera, G. Agar, H. Ozkan, N. Kartal, M. Polissiou, A. Sokmen, F. Sahin (2003). *In vitro* antibacterial, antifungal and antioxidant activities of the essential oils and methanol extracts of herbal parts and

callus cultures of *Satureja hortensis* L. *Journal of Agricultural and Food Chemistry,* 51 (14), 3958–3965.

Guo, D.J., Cheng, H.L., Chan, S.W., Yu, P.H.F. (2008). Antioxidative activities and the total phenolic contents of tonic Chinese medicinal herbs. *Inflammopharmacology* 16, 201-207.

Gutierrez, J., Barry-Ryan, C., Bourke, P. (2009). Antimicrobial activity of plant essential oils using food model media: Efficacy, synergistic potential and interactions with food components. *Food Microbiology,* 26, 142-150.

Habsah, M., Amran, M., Mackeen, M.M., Lajis, N.H., Kikuzaki, H., Nakatani, N., Rahman, A.A., Ghafar, A., Ali, A.M. (2000). Screening of Zingiberaceae extracts for antimicrobial and antioxidant activities. *Journal of Ethnopharmacology,* 72(3), 403-410.

Habsah, M., Ali, A.M., Lajis, N.H., Sukari, M.A., Yap, Y.H., Kikuzaki, H., Nakatani, N. (2005). Antitumor promoting and cytotoxic constituents of *Etlingera elatior*. *Malaysian Journal Medical Science,* 12, 6-12.

Halliwell, B. (1996). Antioxidants in human health and disease. *Annual Review of Nutrition,*16, 33–50.

Hamrouni-Sellami, I., Bettaieb Rebey, I., Sriti, J. Zohra Rahali, F., Limam, F., Marzouk, B. (2012). Drying sage (*Salvia officinalis* L.) plants and its effects on content, chemical composition and radical scavenging activity of the essential oils. *Food Bioprocess Technology,* 5, 2978-2989.

Harwood, C.R. (1989). *Bacillus*. New York: Plenum Press

Helms, M., Vastrup, P., Gerner-Smidt, P., Molbak, K. (2002). Excess mortality associated with antimicrobial drug-resistant *Salmonella typhimurium*. *Emerging Infectious Diseases*, 8(5), 490-495.

Hesar, A.A., Kaviani, B., Tarang, A., Zanjani, S.B. (2011). Effect of different concentrations of kinetin on regeneration of ten weeks (*Matthiola incana*). *Plant Omics Journal,* 4(5), 236-238.

Hillig, K.W. (2004). A chemotaxonomic analysis of terpenoid variations in Cannabis. *Biochemical and Systematics and Ecology* 32, 875.

Hoet, S., Stevigny, C., Herent, M.F., Quetin-Leclercq, J., (2006). Antitrypanosomal compounds from leaf essential oils of *Strychnos spinosa*. *Planta Medica*, 72, 480-482.

Hoffman, E. de., Stroobant, V. (2007). *Mass Spectrophotometry: Principles and Applications*, Third edition. England:John Wiley and Sons, pp 4-5 & pp 219-221.

Holttum, R.E. (1950). The Zingiberaceae of the Malay Peninsula. *Gardens Bulletin, Singapore* 13, 1-249.

Houdret, J. (2009). *The Practical Illustrated Home Herbal Doctor*. London: Annes Publishing, pp 10-13.

Howlett, J. (2008). *Functional foods - from science to health claims*. ILSI Europe Concise Monograph Series. Brussels: ILSI Europe.

Hussain, Q. (2010). Chemistry and biochemistry of some vegetable flavors. In: *Handbook of Fruit and Vegetable Flavors*. New Jersey, Canada: John Wiley & Sons, 32, 575-592.

Hyldgaard, M., Mygind, T., Meyer, R. L., Debabov, D. (2012). Essential oils in food preservation: Mode of action, synergies, and interactions with food matrix components. *Front Microbiology, 3*(1), 1–24.

Ibrahim, H., Aziz, A.N., Syamsir, D.R., Ali, N.A.M., Mohtar, M., Ali, R.M., Awang, K. (2009). Essential oils of *Alpinia conchigera* Griff.and their antimicrobial activities. *Food Chemistry,* 113, 575-577.

Ibrahim, H., Chooi, O.H., Hassan, R. (2000). Ethnobotanical survey of the ginger family in selected Malay villages in Peninsular Malaysia. *Malaysian Journal of Science,* 19, 93–99.

Indrayan, A.K., Tyagi, P.K., Agrawal, N.K. (2010). Chemical composition and antimicrobial activity of the essential oils of *Alpinia speciosa* K. Schum. rhizome from India. *Journal of Essential oils Research,* 22, 179–182.

Iuresca, S., Marconi, A. M., Tofani, D., Gambacorta, A. Paterno, A., Devirgilis, C., Van der Werf, M. J., Zennaro, E. (1999). Identification and sequencing of β-myrcene catabolism genes from *Pseudomonas* sp. Strain M1. *Applied and Environmental Microbiology,* 65 (7), 2871-2876.

Islam, K., Howlader, M. A., Kundu, G.C., Bulbul, I.J., Ahsan, M.R. (2010). Free radical scavenging activity of chloroform and ethyl acetate extracts of leaves of *Piper betle* Linn. *Libyan Agriculture Research Center Journal International*, (6), 384-387.

Jafari, N., Othman R.Y. and Khalid, N. (2011). Effect of benzylaminopurine (BAP) pulsing on *in vitro* shoot proliferation of *Musa acuminate* (banana) cv Berangan. *African Journal of Biotechnology*, 10(13), 2446-2450.

Jain, V.K. (2009). *Biotechnology and Plant Pathology*: Current trends. Jaipur, India: Oxford Book Company, pp 2-5

Jamshidi, R., Afzali, Z., Afzali, D. (2009). Chemical composition of hydrodistillation essential oils of Rosemary in different origins in Iran and comparison with other countries 5(1), 78–81.

Jantan, I.B., Yassin, M.S.M., Chin, C.B., Chen, L.L., Sim, N.L., (2003). Antifungal activity of the essential oils of nine Zingiberaceae species. *Pharmaceutical Biology* 41, 392–397.

Jayaprakasha, G.K., Singh, R.P., Sakariah, K.K. (2001). Antioxidant activity of grape seed (*Vitis vinifera*) extracts on peroxidation models *in vitro. Food Chemistry,* 73, 285-290.

Janses, B.J.M., A. de Groot, (2004). Occurance, biological activity and synthesis of drimane sesquiterpenoids, *Natural Product Reports*. 21:449-477.

Janssen, A.M., Scheffer, J.J., Svendsen, A.B. (1987). Antimicrobial activity of essential oils: A 1976-1986 Literature review. Aspects of the test methods. *Planta medica* 53(5): 395–98.

Juneja V.K., Dwivedi, H.P., Yan, X. (2012). Novel natural food antimicrobials. *Annual Review of Food Science and Technology,* 3, 381-403.

Kahkonen, M.P., Hopia, A.I., Heikki, J.V., Rauha, J-P, Pihlaja, K., Kujala, T.S. (1999). Antioxidant activity of plant extracts containing phenolic compounds. *Journal of Agricultural and Food Chemistry,* 47, 3954-3962.

Kalemba, D., Kunicka, A. (2003). Antibacterial and antifungal properties of essential oils. *Current Medicinal Chemistry,* 10, 813–829.

Kasarkar, A.R., Kulkarni D.K. (2010). Phyto-chemical studies in the genus *Alpinia* (Zingiberaceae). *Journal of Pharmacy Research,* 3(10), 2521-2522

Kaviani, B., Hesar, A.A., Kharabian-Masouleh, A. (2011). *In vitro* propagation of *Matthiola incana* (Brassicaceae)- an ornamental plant. *Plant Omics Journal*, 4(7), 435-440.

Kavyashree, R. (2009). An efficient *in vitro* protocol for clonal multiplication of ginger-var Varada. *Indian Journal Biotechnology,* 8, 328-331.

Khopde, S.M., Priyadarsini, K.I., Venkatesan, P., Rao M.N.A. (1999). Free radical scavenging ability and antioxidant efficiency of curcumin and its substituted analogue. *Biophysical Chemistry,* 80(2), 85-91

Khorshidi, J., Rahmat, M., Mohammad, F. T., Himan, N. (2009). Influence of drying methods, extraction time, and organ type on essential oils content of Rosemary (*Rosmarinus officinalis* L.). *Nature and Science,* 7(11), 42-44

Kitchen, V.S., Savage, M., Harris, J.R.W. (1991). *Candida albicans* resistance in AIDS. *Journal of Infection*, 22, 204-205.

Kochuthressia, K. P., Britto, S. J., Raj, L. J. M., Jaseentha, M. O., Senthilkumar, S. R. (2010). Efficient regeneration of *Alpinia purpurata* (Vieill.) K. Schum. plantlets from rhizome bud explants, (August), 43–47.

Kozai, T. and Kubota, C. (2001). Developing a photoautotrophic micropropagation systems for woody plants. *Journal of Plant Research* 114: 525-537

Kress, W.J. Liu, A-Z., Newman, M., Li, Q-J. (2005).The molecular phylogeny of *Alpinia* (Zingiberaceae): A complex and polyphyletic genus of gingers. *American Journal of Botany,* 92(1), 167-178.

Kumar, S.R.S., Krishna, V., Pradeepa, K., Kumar, K.G., Gnanesh, A.U. (2012). Direct and indirect method of plant regeneration from root explants of *Caesalpinia bonduc* (L.) Roxb. A threatened medicinal plant of Western Ghats*. Indian Journal of Experimental Biology*, 50, 910-917.

Kunisaki, J., Araki, A. and Sagawa, Y. (2003). *Micropropagation of 'Awa (Kava, Piper methysticum)*. Biotechnology. University of Hawaii, Manoa: College of Tropical Agriculture and Human Resources.

Lai, H. Y, Lim,Y.Y. (2011). Evaluation of antioxidant activities of the methanolic extracts of selected ferns in Malaysia. *International Journal of Environmental Science and Development* 2(6), 2–7.

Lalitha, M.K. (2005). Manual on antimicrobial susceptibility testing. *Indian Association of Medical Microbiologist*, pp 6-16

Larsen, K., Lock, J. M., Maas, H., Maas, P.J.M. (1998). *Zingiberaceae*. In K. Kubitzki [ed.], The families and genera of vascular plants, Berlin, Germany: Springer-Verlag, 4, 474–495.

Le, H.T., Phan, M.G., Phan, T.S., (2007). Futher study on chemical constituents and biological activities of *Alpinia conchigera* Griff.(Zingiberaceae). *Journal of Chemistry,* 45(2), 260-264.

Lee, J., Haeng, S.J., Phan, M.G., Xuejun, J., Lee, S., Phan, T.S., Lee, D., Hong, Y., Lee, K., Jung, J.L. (2006). Blockade of nuclear factor-kB signaling pathway and anti-inflammatory activity of cardamomin, a chalcone analog from *Alpinia conchigera. Journal of Pharmacology and Experimental Therapeutics*, 316(1), 271-278.

Li, J-E., Nie, S-p., Qiu, Z-h., Che, M-J., Li, C., Xie, M-y (2010). Antimicrobial and antioxidant activities of the essential oils from *Herba moslae*. *Journal of the Science of Food and Agriculture,* 90, 1347-1352.

Li, H., Wang, X., Li, Y., Li, P., Wang, H. (2009). Polyphenolic compounds and antioxidant properties of selected China wines. *Food Chemistry,* 112, 454-460.

Li, W. Y., Chan, S. W., Yu, P. H. F. (2007). Correlation between antioxidative power and anticancer activity in herbs from traditional Chinese medicine formulae with anticancer therapeutic effect. *Pharmaceutical Biology,* 45, 541-546.

Liu, R.H. (2004) Potential synergy of phytochemicals in cancer prevention: mechanism of action. *Journal of Nutrition*, 134(12), 3479-3485.

Lo-apirukkul, S.,Jenjittikul, T., Saralamp, P., Prathanturarug, S. (2012). Micropropagation of a Thai medicinal plant for women's health, *Curcuma comosa* Roxb., via shoot and microrhizome inductions. *Journal of Natural Medicines*, 66, 265-270.

Lowy, F.D. (1998). *Staphylococcus aureus* infection.*The New England Journal of Medicine*, 339, 520-532.

Lu, M., Yuan, B., Zeng, M., Chen, J. (2011). Antioxidant capacity and major phenolic compounds of spices commonly consumed in China. *Food Research International,* 44, 530-536.

Ma, X., David, R.G. (2006). Metabolic profiling of *in vitro* micropropagated and conventionally greenhouse grown ginger (*Zingiber officinale*). *Phytochemistry*, 67, 2239-2255.

Maisuthisakul, P., Suttajit, M., Pongsawatmanit, R. (2005). Assessment of phenolic content and free radical-scavenging capacity of some Thai indigenous plants. *Food Chemistry* 100, 1409– 1418.

Maizura, M., Aminah, A., Wan Aida, W.M. (2011). Total phenolic content and antioxidant activity of kesum (*Polygonum minus*), ginger (*Zingiber officinale*) and turmeric (*Curcuma longa*) extract. *International Food Research Journal,* 18, 529-534.

Malek, S.N.A., Phang, C.W., Ibrahim, H., Wahab, N.A., Sim, K.S. (2011). Phytochemical and cytotoxic investigations of *Alpinia mutica* rhizomes. *Molecules,*16, 583-589.

Maretta, D., Efendi, D., Aziz, S.A., Sastra, D.R. (2011). *In vitro* microrhizome formation of temulawak (*Curcuma xanthorrhiza* Roxb.). Proceedings of the Second International Symposium on Temulawak, Indonesia, 11-15.

Maridass, M., Victor, B., Manikam, V.S., Ghanthikumar, S. Arockium, A. (2008). The ethnobotanical uses of the aromatic oils from two Indian endemic plant species of the family Lamiaceae, Pogostemon travancoricus Bedd., and Orrthosiphon comosus Wight ex Benth. *Ethnobotanical Leaflets*, 12, 191-194.

Mathur, A., Mathur, A.K., Verma, P. (2008). Biological hardening and genetic fidelity testing of micro-cloned progeny of *Chlorophytum borivilianum. African Journal of Biotechnology,*7, 1046–1053.

Mastelic, J., Jerkovic, I., Blazevic, I., Poljak-Blazi, M., Borovic, S., Ivancic-Bace, I., Smrecki, V., Zarkovic, N.,Brcic-Kostic, K., Vikic-Topic, D., Muller, N. (2008). Comparative study on the antioxidant and biologicalactivities of carvacrol, thymol, and eugenolderivatives.*Journal of Agricultural and Food Chemistry,* 56, 3989–3996.

Mayachiew, P. and Devahastin, S. (2008). Antimicrobial and antioxidant activities of Indian gooseberry and galangal extracts. *LWT-Food Science and Technology*, 41, 1153-1159.

McCullough, M.J,. Ross, B.C,Reade, P.C. (1996). *Candida albicans*: A review of its history, taxonomy, epidemiology, virulence attributes, and methods of strain differentiation. *International Journal of Oral and Maxillofacial Surgery,* 25(2), 136-144.

Mehta, J., Sain, M., Mathuriya, B.L. Naruka, R., Kavia, A., Sharma, D.R. (2012). Rapid micropropagation and callus induction of *Terminalia bellerica* Roxb.- An endangered plant. *Asian Journal of Plant Science and Research,* 2(3), 364-368.

Mohanty, S., Panda, M.K., Sahoo, S., Nayak, S. (2011). Micropropagation of *Zingiber rubens* and assessment of genetic stability through RAPD and ISSR markers. *Biologia Plantarum*, 55(1): 16-20.

Mok, D.W., Mok, M.C. (2001). Cytokinin metabolism and action. Annual Review. *Plant Physiology and Plant Molecular Biology,* 52, 89–118.

Moon, J.K., Shibamoto, T. (2009). Antioxidant assays for plant and food components. *Journal of Agricultural and Food Chemistry,* 57(5), 1655-1666.

Moreira, M.R., Ponce, A.G.Valle, C.E., Roura, S.I. (2005). Inhibitory parameters of essential oils to reduce a foodborne pathogen, *Swiss Society of Food Science and Technology* 38, 565–70.

Motterlini, R., Foresti, R., Bassi, R., Green, C.J. (2000). Curcumin, an antioxidant and anti-inflammatory agent, induces heme oxygenase-1 and protects endothelial cells against oxidative stress. *Free Radical Biology and Medicine,* 28(8), 1303-1312.

Murray, P.R., Baron, E.J., Jorgensen, J.H., Pfaller, M.A., Yolken, R. H. (2003). *Manual of Clinical Microbiology*, 8th edn. Washington, DC: American Society for Microbiology.

Murashige, T. Skoog, F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiology Plant,* 15, 473-497.

Nahak, G., Sahu, R. K. (2010). *In vitro* antioxidative activity of *Azadirachta indica* and *Melia azedarach* leaves by DPPH scavenging assay. *Journal of American Sciences,* 6(6),123-128.

Naidu, A.S. (2003). Antimicrobials from animals. In: *Natural antimicrobials for the minimal processing of foods*. England: Woodhead, pp. 133-149.

Nataro, J.P., Kaper. J.B. (1998). Diarrheagenic *Escherichia coli*. *Clinical microbiology reviews,* 11(1): 142–201.

NCCLS. (2001). *Development of in vitro susceptibility testing and quality control parameters*. Approved guideline, 2nd ed. NCCLS document M23-A2. NCCLS, Wayne, Pa, 21(7), 8-15

Newall, C.A., Anderson, L.A., Phillipson, J.D. (1996). *Herbal medicines*: A guide for health-care professionals. London: Pharmaceutical Press:ix, 296.

Niessen, W.M.A. (2012). *Liquid chromatography-mass spectrometry*, Third Edition, New York: CRC Press Taylor and Francis, Volume 37

Nigam, M. C., Ahmed, A. (1991). *Curcuma longa*- Terpenoid composition of its essential oils. *Indian Perfumer*, 3, 201–205

Normanly, J., Solvin, J.P., Cohen, J.D. (2010). Auxin biosynthesis and metabolism. *Plant Hormones,* 36-62.

Norshazila, S., Syed Zahir, I., Mustapha Suleiman, K., Aisyah, M.R., Kamarul Rahim, K. (2010). Antioxidant levels and activities of selected seeds of Malaysian tropical fruits. *Malaysian Journal of Nutrition* 16(1), 149–59.

Nychas, G.J.E., Skandamis, P.N. (2003). *Antimicrobials from herbs and spices*. In S.m. Roller (Ed.) New York: CRC Press, Woodhead Publishers pp 177–200

Ohloff, G. (1994). *Scent and Fragrances*. The fascination of odors and their chemical perspectives. Berlin: Springer Verlag.

Oliveira, I., Sousa, A., Morais, J. S., Ferreira, I. C. F. R., Bento, A., Estevinho, L., Pereira, J. A. (2008). Chemical composition, and antioxidant and antimicrobial activities of three hazelnut (*Corylus avellana* L.) cultivars. *Food and chemical toxicology : An international journal published for the British Industrial Biological Research Association*, 46(5), 1801–1807.

Oonmetta-aree, J., Tomoko, S., Piyawan, G., Griangsak, E. (2006). Antimicrobial properties and action of Galangal (*Alpinia galanga* Linn.) on *Staphylococcus aureus. LWT Food Science and Technology*, 39, 1214-1220.

Oyedeji, A.O. and A.J. Afolayan.(2006). Chemical composition and antibacterial activity of the essential oils isolated from South African *Mentha longifolia*

(L.) L. subsp.*capensis* (Thunb.)Briq. *Journal of Essential oils Research,* 18, 57-59.

Oyedemi S.O., Okoh, A.I., Mabinya, L.V., Pirochenva, G., Afolayan, A.J. (2009) The proposed mechanism of bactericidal action of eugenol, γ-terpineol and γ-terpinene against *Listeria* monocytogenes, *Streptococcus pyogenes, Proteus vulgaris* and *Escherichia coli*. *African Journal of Biotechnology,* 8, 1280-1286.

Ozer, H., Sokmen, M., Gulluce, M., Adiguzel, A., Sahin, F., Sokmen, A., Kilic, H., Baris, O. (2007). Chemical composition and antimicrobial and antioxidant activities of the essential oils and methanol extract of *Hippomarathrum microcarpum* (Bieb.) from Turkey. *Journal of Agricultural and Food Chemistry,* 55(3), 937-942.

Parveen, M., Hasan, M.K., Takahashi, J., Murata, Y., Kitagawa, E., Kodama, O., Iwahashi, H. (2004). Response of *Saccharomyces cerevisiae* to a monoterpene: An evaluation of antifungal potential by DNA microarray analysis. *Journal of Antimicrobial Chemotherapy,* 54, 46–55.

Parthasarathy, V.A., Bhageerathy, C., Zachariah, T.J. (2008). *Chemistry of spices.* London: CAB International, pp 17-18.

Patel, P.N., Patel, K.M., Chaudhary, D.S., Parmar, K.G., Patel, H.A., Kansagra, C.D., Sen, D.J. (2011). Extraction of herbal aroma oils from solid surface. *International Journal of Comprehensive Pharmacy,* 9(2), 1-10.

Pender, H. (2007). *Agriculturaltechnology choices for poor farmers in less favored area of south and east Asia*. IFPRI Discussion Paper 709.Washington, DC, IFPRI.

Pereira, J.A., Pereira, A.P.G., Ferreira, I.C.F.R., Valentao, P., Andrade, P.B., Seabra, R., Estevinho, L., Bento, A., (2006). Table olives from Portugal: Phenolic compounds, antioxidant potential and antimicrobial activity. *Journal of Agricultural and Food Chemistry,* 54, 8425–8431.

Phang, C., Nurestri, S., Malek, A., Ibrahim, H., Wahab, N. A. (2011). Antioxidant properties of crude and fractionated extracts of *Alpinia mutica* rhizomes and their total phenolic content. *African Journal of Pharmacy and Phamacology,* 5(7), 842–852.

Pirbalouti, A.G., Oraie, M., Pouriamehr, M., Babadi, E.S. (2013). Effects of drying methods on qualitative and quantitative of the essential oils of Bakhtiari savory (*Satureja bachtiarica* Bunge.). *Industrial Crops and Products,* 46, 324-327.

Pongpiriyadacha, Y., Nuansrithong, P., Chumbuajan, O., Sirintharawech, N., Chamtip, D. (2008). Gastroprotective effects of the extracts from *Alpinia*

conchigera Griff. in rats and the possible mechanism. *King's Mongkut Institute of Technology Ladkrabang (KMITL) Science Journal,* 8(2).

Proestos, C., Boziaris, I., Kapsokefalou, S.M., Komaitis, M. (2008). Natural antioxidant constituents from selected aromatic plants and their antimicrobial activity against selected pathogenic microorganisms*. Food Technology and Biotechnology,* 46, 151–156.

Proestos, C., Boziaris, I.S., Nychas, G.J.E., Komaitis, M. (2006). Analysis of flavonoids and phenolic acids in Greek aromatic plants: Investigation of their antioxidant capacity and antimicrobial activity. *Food Chemistry,* 95(4), 664-671.

Proestos, C., Chorianopoulos, N., Nychas, G.J.E., Komaitis, M. (2005). RP-HPLC analysis of the phenolic compounds of plant extracts. Investigation of their antioxidant capacity and antimicrobial activity. *Journal of Agricultural Food Chemistry,* 53, 1190–1195.

Purkayastha, J., Sugla, T., Paul, A., Solleti, S.K., Mazumdar, P., Basu, A. Mohammad, A., Ahmed, Z., Sahoo, L. (2010). Efficient *in vitro* plant regeneration from shoot apices and gene transfer by particle bombardment in *Jatropha curcas. Biologica Plantarum*, 54(1), 13-20.

Raina, V. K., Srivastava, S. K., Syamasunder, K. V. (2002). The essential oils of `greater galangal' (*Alpinia galanga* (L.) Willd) from the lower Himalayan region of India. *Flavour and Fragrance Journal*, 17(5), 358–360.

Rakkimuthu, R., Jacob, J., Aravinthan, K. M. (2011). *In vitro* micropropagation of *Alpinia zerumbet* Variegate: An important medicinal plant, through rhizome bud explants. *Research in Biotechnology,* 2(1), 7–10.

Rao, K., Chodisetti, B., Gandi, S., Mangamoori, L.N., Giri, A. (2011). Direct and indirect organogenesis of *Alpinia galanga* and the phytochemical analysis. *Applied Biochemistry and Biotechnology*, 165, 1366-1378.

Ricca, E., Henriques, A.O., Cutting, S.M. (2004). *Bacterial spore formers: Probiotics and emerging applications*. Norfolk, United Kingdom: Horizon Scientific Press

Richmond, S. (2010).*Environment: Malaysia, Singapore and Brunei.* Lonely Planet, Malaysia pp 74.

Ridnour, L. A., Thomas, D. D., Mancardi, D., Espey, M. G., Miranda, K. M., Paolocci, N., Feelish, M., Fukuta, J., Wink, D.A. (2004). The chemistry of nitrosative stress induced by nitric oxide and reactive nitrogen oxide species. Putting perspective on stressful biological situations. *Biological Chemistry,* 385, 1–10.

Rietjens, I.M., Boersma, M.G., De Haan, L., Spen, K.B., Awad, H.M., Cnubben, N.H.P., Van Zan Den J.J., Van Der Woude H., Alink G.M., Koeman J.H. (2002). The pro-oxidant chemistry of the natural antioxidants vitamin c, vitamin E, carotenoids and flavonoids. *Environmental Toxicology and Pharmacology,*11, 321.

Riley, P.A.(1994). Free radicals in biology: oxidative stress and effects of ionizing radiation*. International Journal of Radiation Biology*. 65, 27–33.

Robbins, R.J. (2003). Phenilic acids in foods: An overview of analytical methodology. *Journal of Agricultural and Food Chemistry,* 51, 2866-2887.

Rout, G.R., Das, P. (1997). *In vitro* organogenesis in Ginger (Zingiber officinale Rosc.). *Journal of Herbs, Spices and Medicinal Plants*, 4(4): 41-51.

Rout, G., Mohapatra, A., and Mohan, J.S. (2006). Tissue culture of ornamental pot plant. A critical review on present scenario and future prospects. *Biotechnology Advances,* 24, 531–560.

Ruberto, G., Baratta, M. (2000). Antioxidant activity of selected essential oils components in two lipid model systems. *Food Chemistry,* 69, 167–174.

Saad, N.Y., Muller, C.D., Lobstein, A. (2013). Major bioactivities and mechanism of action of essential oils and their components. *Flavor and Fragrance Journal,* doi: 10.1002/ffj.3165.

Saggiorato, A.G., Gaio, I., Treichel, H., De Oliveira, D., Cichoski, A.J., Cansian, R.L. (2012). Antifungal activity of basil essential oils (*Ocimum basilicum* L.): Evaluation *in vitro* and on an Italian-type sausage surface*. Food and Bioprocess Technology,* 5, 378-384.

Sailas, B., Preethi, T. P., Shinija, K., Rakhi, K. P., Sabu, M. (2009). Micropropagation and chemical profiling of *Alpinia malaccensis* and *Hedychium coccineum. Journal of Tropical Medicinal Plants,* 10(1), 95-99.

Salvi, N.D., George, L., Eapen, S. (2002). Micropropagation and field evaluation of micropropagated plants of turmeric. *Plant, Cell, Tissue, Organ Culture* 68, 143-151.

Samsudeen, K., Babu, K.N., Divakaran, M. and Ravindran, P.N. (2000). Plant Regeneration from Anther Derived Callus Cultures of Ginger (*Zingiber officinale* Rosc.). *Journal of Horticultural Science and Biotechnology,* 75(4), 447-450.

Sarikurkcu, C., Feryat, E., Mustafa, C., Bektas, T., Ahmet, C., Ebru, M. (2012). Screening of the antioxidant activity of the essential oils and methanol extract of *Mentha pulegium* L. From Turkey. *Spectroscopy Letters* 45(5), 352–358.

Sarmento, L.A.V., Machado, R.A.F., Bolzan, A., Spricigo, C.B., Petrus, J.C.C. (2004). Use of revrse osmosis membranes for the separation of lemongrass essential oils and supercritical CO_2. *Brazilian Journal of Chemical Engineering,* 21(2): 285-291.

Sawa, T., Nakao, M., Akaike.T., Ono, K. Maeda, H., (1999). Alkylperoxyl radical scavenging activity of various flavonoids and other phenolic compounds: Implications for the antitumor promoter effect of vegetables. *Journal of Agricultural and Food Chemistry,* 47, 397–402.

Schnaubelt, K. (2011). *The Healing Intelligence of Essential oils*, The science of advanced aromatheraphy. Toronto, Canada: Healing Arts Press, pp 10-11.

Schnaubelt, K. (1999). *Medical aromatherapy*: Healing with essential oils. Berkeley, CA: Frog, Ltd.

Schuenzel, K. M., Harrison, M. A. (2002). Microbial antagonists of foodborne pathogens on fresh minimally processed vegetables. *Journal of Food Protection,* 65(12), 1909–1915.

Schuster, E., Dunn-Coleman, N.Frisvad, J.C.,van Dijck, P.W.M. (2002). On the safety of *Aspergillus niger*- A review. *Applied microbiology and biotechnology* 59, 426-435.

Seabra, R.M., Andrade, P.B., Valentao, P., Fernandes, E., Carvalho, F., Bastos, M.L., (2006). Anti-*oxidant compounds extracted from several plant materials.* In: Fingerman, M., Nagabhushanam, R. (Eds.), Biomaterials from aquatic and terrestrial Organisms. Enfield (New Hampshire): Science Publishers, pp 115–174.

Selvakkumar, C., Balakrishnan A., Lakshmi, S.B. (2007). Rapid *in vitro* micropropagation of *Alpinia officinarum* Hance, an important medicinal plant, through rhizome bud explants, *Asian Journal of Plant Science,* 6(8), 1251-1255.

Sharafi, S.M., Rasooli, I., Owlia, P., Taghizadeh, M., Astaneh, S.D. (2010). Protective effects of bioactive phytochemicals from *Mentha piperita* withmultiple healthpotentials. *Pharmacognosy Magazine*, 6, 147-153.

Sharma, A., Saxena, S., Zibbu, G., Sardana, J., Batra, A. (2010). Crucial role of poor seed viability and superiority of *in vivo* explant than *in vitro* derived explant in tissue culture of *Jatropha curcas* L. *Libyan Agriculture Research Center Journal International,* 1(5), 274-278.

Sharma, P.D. (2005). *Fungi and allied organisms*. Oxford, Unites Kingdom: Alpha Science International Ltd. pp 192-198.

Sharma, T.R., Singh, B.M. (1997). High frequency *in vitro* multiplication of disease free *Zingiber officinale* Rocs. *Plant Cell Reports*, 17, 68-72

Sharp, W. R., Sondhal, M. R., Caldar, R. S., Maraffa, S. B. (1986). The physiology of *in vitro* asexual embryogenesis. *Horticultural Reviews,* 2, 268–310.

Shiyab, S., Shatnawi, M., Shibli, R., Al-Zweiri, M. Akash, M., Aburijai, T. (2012). Influence of developmental stage on yield and composition of *Origanum syriacum* L. oil by multivariate analysis. *Journal of Medicinal Plants Research,* 6(15), 2985-2994.

Sies, H. (1985). Introductory remarks. In: Sies H. (eds) *Oxidative stress*. Orlando, FL: Academic Press, 1-7.

Silva,F.G., Oliveira, C.B.A., Pinto, J.E.B.P., Nascimento, V.E., Santos, S.C., Seraphin, J.C. (2007). Seasonal variability in the essential oils of wild and cultivated *Baccharis trimera. Journal of Brazilian Chemical Society,* 18, 990–997.

Sirat, H.M., Nordin AB (1995). Chemical composition of the rhizome oil of *Alpinia conchigera* Griff from Malaysia. *Journal of Essential oils Research,* 7(2), 195-197.

Sirat, H.M., Rahman, A.A., Itokawa, H., Morita, H. (1996). Constituents of the rhizomes of two *Alpinia* species of Malaysia. *Planta Medica,* 62, 188-189.

Siti Nadia, R. (2010). Effect of harvesting materials and extraction methods on essential oils of *Cinnamomum verum.* BSc. Thesis, Dept. of Biology, Faculty of Science, Universiti Putra Malaysia, Malaysia pp 44-45.

Sivarajan, V.V., Balachandran, I. (1994). *Ayurvedic drugs and their Plant Sources*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 570p

Smale, M., Tushemereirwe, W.K. (2007). *An economic assessment of banana genetic improvement and innovation in the Lake Victoria Region of Uganda and Tanzania*. IFPRI Research Report 155. Washington DC, IFPRI.

Smith, R. M. (1990). *Alpinia* (Zingiberaceae): A proposed new infrageneric classification. Edinburgh. *Journal of Botany,* 47, 1–75.

Sokovic, M., Grubisic, D., Ristic, M. (2005). Chemical composition and antifungal activity of the essential oils from leaves, calyx and corolla of *Salvia brachyodon* Vandas. *Journal of Essential oils Research,* 17, 227-229.

Sonenshein, A.L., Hoch, J.A., Losick, R. (2002). *Bacillus subtilis* and its closest relatives: from genes to cells. Washington, D.C: ASM Press

Soonthornpalin, P., Wasuwat, S., Kongsamran, S., Thianprasit, M. (1986). Pharmaceuticals from medicinal plants clinical study on antibacterial and antifungal activities of *Alpinia conchigera* Griff in skin infection. *Thailand Institute of Scientific and Technological Research*, p. 29.

Sulaiman, M.R., Zakaria, Z.A., Mohamad, A.S., Ismail, M., Hidayat, M.T., Israf, D.A. (2010). Antinociceptive and anti-inflammatory effects of the ethanol extract of *Alpinia conchigera* rhizomes in various animal models. *Pharmaceutical Biology,* 48, 861-868.

Sussman, M. (1997). *Escherichia coli: Mechanism of virulence*. United Kingdom: Cambridge University Press pp 4-19.

Suthisut, D., Fields, P.G., Chandrapatya, A. (2011). Fumigant toxicity of essential oils from three Thai plants (Zingiberaceae) and their major compounds against *Sitophilus zeamais*, *Tribolium castaneum* and two parasitoids. *Journal of Stored Products Research,* 47, 222-230.

Staniszewska, M., J. Kula, M. Wieczorkiewicz, D. Kusewicz, (2005). Essential oils of wild and cultivated carrots-the chemical composition and antimicrobial activity. *Journal of Essential oils Research*, 17, 579-583.

Stanly, C., Bhatt, A., Ali, H.M.D., Chan, L.K., Lim, B.P. (2011). Evaluation of free radical scavenging activity and total phenolic content in the petiole-derived callus cultures of *Zingiber zerumbet* Smith. *Journal of Medicinal Plants Research,* 5(11), 2210-2217.

Stanly, C., Chan, L.K. (2007). Micropropagation of *Curcuma zedoaria* Roscoe and *Zingiber zerumbet* Smith.*Biotechnology*, 6(4), 555-560.

Tam, N.K.M., Nguyen, Q.U., Huynh, A. H., Le, H.D., Tran, T.H., Serra, R.C., Henriques, A.O., Simon, M.C. (2006). The intestinal life cycle of *Bacillus subtilis* and close relatives. *Journal of Bacteriology*, 188(7), 2692–2700.

Tepe, B., Sokmen, M., Akpulat, H.A., Sokmen, A. (2005). *In vitro* antioxidant activities of the methanol extracts of four *Helichrysum* species from Turkey. *Food Chemistry,* 90, 685-689.

Teixeira, D.S. J. (2004). Ornamental chrysanthemums: Improvement by biotechnology. *Plant Cell, Tissue and Organ Culture,* 79, 1–18.

Tewtrakul, S., Yuenyongsawad, S., Kummee, S., Atsawajaruwan, L. (2005). Chemical components and biological activities of volatile oil of *Kaempferia galangal* Linn. *Songklanakarin Journal of Science and Technology*, 27(2), 503-507.

Thorpe, T. (2007). History of plant tissue culture.*Molecular Biotechnology,* 37, 169-180.

Timur, J., Timur, J., Timur, J. (2010). The effects of type and time of thermal processing on ginger (*Zingiber officinale* Roscoe.) rhizome antioxidant compounds and its quality*. International Food Research Journal,* 347, 335–347.

Tisserand, R., Balacs, T. (1995). *Essential oils safety, a guide for health care professionals.* Churchill Livingstone. Page 15.

Tiwari, B.K., Valdramidis, V.P., O'Donell, C.P., Muthukumarappan, K.,Bourke, P., Cullen, P.J. (2009). Application of natural antimicrobials for food preservation. *Journal of Agricultural and Food Chemistry*, 57, 5987-6000.

Trigiano R.N., Gray, D.J. (2005). *Plant Development and Biotechnology*, Washington DC: CRC Press.

Tripathi, B.K., Bitaillon, C. (1985). *In vitro* plant regeneration of *Hedychium roxburghii* blume through rhizome-meristem culture. *Plant Cell Tissue Organ Culture*, 11-17.

Trivedi, N.A., Hotchandani, S.C. (2004). A study of the antimicrobial activity of oil of *Eucalyptus*. *Indian Journal of Pharmacology,* 36:93-94.

Tyagi, R.K., Yusuf, A., Dua, P., Agrawal, Ajaffar. (2004). *In vitro* plant regeneration and genotype conservation of eight wild species of*Curcuma*. *Biologia Plantarum,* 48(1), 129-132.

Valko, M., Leibtritz, D., Moncol, J., Cronin, M.T.D., Mazur, M., Telser, J. (2007). Free radicals and antioxidants in normal physiological functions and human disease. *The International Journal of Biochemistry and Cell Biology,* 39, 44-84.

Valko, M., Rhodes, C.J., Moncol, J., Izakovic, M., Mazur, M. (2006). Free radicals, metals and antioxidant in oxidative stress-induced cancer. *Chemico-Biological Interactions,* 160, 1-40.

Valente, J., Zuzarte, M., Liberal, J., Goncalves, M.J., Lopez, M.J., Cavaleiro, C., Cruz, M.T, Salgueiro, L. (2013). *Margotia gummifera* essential oils as a source of anti-inflammatory drugs*. Industrial Crops and Products,* 47, 86-91.

Vendruscolo, A., Takaki, I., Bersani-Amado, L.E., Dantas, J.A., Bersani-Amado, C.A., Cuman, R.K. (2006). Anti-inflammatory and antinociceptive activities of *Zingiber officinale* roscoe essential oils in experimental animal models. *Indian Journal of Pharmacology* 38,58-9.

Velioglu, Y.S., Ekici, L., Poyrazoglu, E.S. (2006). Phenolic composition of European cranberrybush (*Viburnum opulus* L.) berries and astringency

removal of its commercial juice. *International Journal of Food Science and Technology*, 41, 1011–1015.

Victor, P. G. (2005). Plant growth regulators in plant tissue culture and development. In: Trigiano, R. N. and D. J. Gray (eds.), *Plant Development and Biotechnology*. Boca Raton, Florida:CRC Press LLC,8, 87-100.

Viuda-Martos, M., Ruiz-Navajas, Y., Fernández-López, J., Perez-Álvarez, J. A. (2008). Antibacterial activity of different essential oils obtained from spices widely used in Mediterranean diet. *International Journal of Food Science and Technology*, 43, 526-531.

Wainwright, H., Marsh, J. (1986) The micropropagation of watercress (*Rorippa nasturtium- aquaticum* L.). *Journal of Horticultural Science*, 61, 251–225.

Wang, W., Wu, N. Zu, Y.G., Fu, Y.J. (2008). Antioxidative activity of *Rosmarinus officinalis* L. essential oils compared to its main components. *Food Chemistry,* 108: 1019-1022.

Warrier, P.K., Nambiar, V.P.K., Ramankutty, C. (1993). *Indian Medicinal Plants*. Vol.1-5. Madras: Orient Longman Ltd.

Wasuwat, S., Wannissorn, P., Chamchaang, W., Suntorntanasat, T., Soontornsaratune, P., Chotippong, A. (1986). Pharmaceuticals from medicinal plants: Pharmacological study on the antibacterial and antifungal activity of active principles from *Alpinia conchigera* Griff. *Thailand Institute of Scientific and Technological Research*, p. 19.

Watanabe, K.N., Pehu, E. (1997). *Plant biotechnology and plant genetic resources for sustainability and productivity*. London, United Kingdom: Academic Press, pp 227-234.

Waterman, P.G. (1993). The chemistry of volatile oils. In: Volatile oil crops. 47-61.

Wearing, J. (2010). Bacteria: Staph, Strep, Clostridium and other bacteria: A class of their own. Unites States of America: Crabtree Publishing Company, pp 7-11.

Weeks, B.S. (2008). Microbes and society, Second edition.United States of America: Jones and Bartlett Publishers pp 95-96.

Wondyfraw, T., Surawit, W. (2004). A micropropagation method for korarima (*Aframomum corrorima* (Braun) Tonsen). *Science Asia*, 30, 1-7.

Wong, K.C., Lee, B.C., Lam, N.F., Ibrahim, P., (2005). Essential oils of the rhizomes of *Alpinia conchigera* Griff.and*Alpinia latilabris*. Ridl. *Flavour and Fragrance Journal*, 20(4), 431-433.

Wojciechowicz, M.K. (2009). Organogenesis and somatic embryogenesis induced in petal cultures of sedum species. *Acta Biologica Cracoviensia Series Botanica* 51(1), 83–90.

Wojdylo, A., Oszmianski, J., Czemerys, R. (2007). Antioxidant activity and phenolic compounds in 32 selected herbs. *Food Chemistry,* 105, 940-949.

Wu, J.Q., Kosten, T.R., Zhang, X.Y. (2013). Free radicals, antioxidant defense systems and schizophrenia. *Progress in Neuro-Psychopharmacology & Biological Psychiatry* In Press, Corrected Proof.

Wungsintaweekul, J., Sitthithaworn, W., Putalun, W., Pfeifhoffer, H.W., Brantner, A. (2010). Antimicrobial, antioxidant activities and chemical composition of selected Thai species. Songkhlarin *Journal of Science and Technology,* 32(6), 589-598.

Yoshikawa, M., Hatakeyama, S., Chatani, N., Nishino, Y., Yamahara, J. (1993). Qualitative and quantitative analysis of bioactive principles in *Zingiberis Rhizoma* by means of high performance liquid chromatography and gas liquid chromatography. *Yakugaku Zasshi,* 113, 307-315.

Yu, J., Fang, H., Chen, Y. and Yao, Z. (1988). *Zhongyao Tongbao,* 13, 354–356.

Yusoff, M.M., Ibrahim, H., Hamid, M.H., (2011). Chemical characterization and antimicrobial activity of rhizome essential oils of very closely allied Zingiberaceae species endemic to Borneo: *Alpinia ligulata* K. Schum. and*Alpinia nieuwenhuizii* Val. *Chemistry and Biodiversiy,* 8, 916–923.

Zaripheh, S., Erdman, J.W. (2002). Factors that influence the bioavailability of xanthophylls. *Journal of Nutrition,* 132,531–534.

Zeb, A., Mehmood, S. (2004). Carotenoids contents from various sources and their potential health applications. *Pakistan Journal of Nutrition,* 3(3), 199-204.

Zhang, J., Dou, J., Zhang, S., Liang, Q., Meng, Q. (2010). Chemical composition and antioxidant properties of the essential oils and methanol extracts of rhizoma *Alpinia officinarum* from China *in vitro. African Journal of Biotechnology,* 9(28), 4414–4421.

Zhang, Y.H., Shu, H. (2003). Relationship between ratio of alpha-farnesene to conjugated trienes, antioxidant activity and scald development on cool-stored apples.*Acta Horticulturae* (ISHS), 628, 501-507.

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