

PROCEEDINGS



The 3rd Bali International Seminar on Science and Technology

Bali, October 15-16th, 2015

**"TOWARDS FUNDAMENTAL AND APPLIED RESEARCH FOR
SOCIO-ENVIRONMENTALLY SAFE INDUSTRIAL DEVELOPMENT"**

Organized By:

**Faculty of Industrial Technology, University of Pembangunan Nasional "Veteran" Jawa
Timur,**

Bali State Polytechnic , and

College Of Engineering of National Cheng-kung University

EDITORIAL BOARD

Key advisors

Rector of UPN "Veteran" Jawa Timur
Director of Bali State Polytechnic

Person in charge

Ir. Sutyono, MT (Dean, Faculty Of Industrial Technology, UPN "Veteran" East Java)
Ir. Made Mudhina, MT (Director of Bali State Polytechnic)

Editor in Chief

Dr. Ir. Ketut Sari, MT

Associate Editor

Dr. Dedin F. Rosida, STP, Mkes
Dr. Dra. Jariyah, MP
Dr. Ir. Lilik Sudiajeng, M.Erg
Nyoman Indah Kusuma Dewi, SE, MBA, Ph.D

Editorials Board

M. Irwan Afandi, ST, MSc
Dr. Dira Ernawati, ST, MT
Intan Yuniar Purbasari, Skom, MSc
I Made Suartana, Skom, Mkom
Fetty Tri Anggraeny, Skom, Mkom
Agung Brastama Putra, Skom, MKom

Reviewer

Prof. A. P. Bayuseno, Drer Nat, B.Eng, M.SC. (Mechanical Engineering, UNDIP, Semarang, Indonesia)
Jamari, B.Eng, M.Eng, Dr. (Mechanical Engineering, UNDIP, Semarang, Indonesia)
Prof. Renanto Handogo, M.Sc, Ph.D. (Chemical Engineering, ITS, Surabaya, Indonesia)
Erma Suryani, ST, MT, Ph.D. (Information System, ITS Surabaya, Indonesia)
Anthony Halog, MBA, Ph.D (Industrial Engineering, Queensland University, Australia)
Prof. Takuya Sugahara (Ehime University, Japan)
Prof.Dr. Hj. Siti Mariyam (Computer Science, Universiti Teknologi Malaysia, Malaysia)
Prof. Dr. Ir. Mauridhi Hery Purnomo, M.Eng. (Electrical Engineering, ITS, Surabaya, Indonesia)
Prof. Inocencio E.Buot, Jr. (Faculty of Management and development Studies, University of Philippines Open University)
Prof. Jui-Hsiang Liu (College of Engineering, National Cheng Kung University)

ORGANIZING COMMITTEE

STEERING COMMITTEE

Prof. A. P. Bayuseno, Drer Nat, B.Eng, M.SC. (UNDIP Semarang, Indonesia)
Jamari, B.Eng, M.Eng, Dr. (UNDIP Semarang, Indonesia)
Prof. Renanto Handogo, M.Sc, Ph.D. (ITS Surabaya, Indonesia)

GENERAL CHAIR

Dr. Ir. Ni Ketut Sari, MT
Nyoman Indah Kusuma Dewi, SE, MBA, Ph.D

VICE CHAIRMAN

M. Irwan Afandi, ST. MSc
I Gusti Ketut Gede, SE, MM

SECRETARY

Fetty Tri Anggraeny, S.Kom. M.Kom
Dr. Putu Wijaya Sunu, ST, MT

FINANCIAL

Dr. Dira Ernawati, ST. MT
Khusnul Jaqien, ST
Dr. I Putu Astawa, SE, MM
A.A.A. Mirah Kencanawati, SE, MM
Ni Kadek Dessy Hariyanti, S.Kom, MM
Dr. Ir. Lilik Sudiajeng, M.Erg

ACCOMODATION

Dr. Ir. Minto Waluyo, MM
I Nyoman Gede Arya Astawa, ST, M.Kom
I Ketut Suwintana, S.Kom, MT
I Gede Iwan Suryadi, SE, MM
I Made Widianara, S.Psi, M.Si
Ida Bagus Gde Widianara, ST, MT
I Wayan Dana Ardika, SS., M.Pd
I Nyoman Rajin Aryana, S.Pd.M.Pd
Ketut Vini Elfarosa, S.E, M.M

PREFACE

Faculty of Industrial Technology, University of Pembangunan Nasional "Veteran" Jawa Timur in collaboration with Bali State Polytechnic and National Cheng-Kung University are organizing an international seminar entitled: Bali International Seminar on Science and Technology (BISSTECH) III 2015, with topic "Towards Fundamental and Applied Research for Socio-Environmentally Safe Industrial Development".

We wish to thank reviewers, keynote speakers, moderators, presenters, and participants for their cooperation and valuable suggestions. We would like to extend our appreciation to members of organizing committees of all events during this seminar.

Finally, we hope that the seminar would give a contribution in creating a better future for mankind.

Thank you.

Denpasar-Indonesia, October 15th, 2015

Editorial Board

BISSTECH III 2015

TABLE OF CONTENTS

A. Chemical Engineering

#	TITLE	#PAGE
#A1	NOVEL NON RESISTANT ANTIBACTERIAL SULPHATE CHELATING AGENT <i>Haryanto Wardoyo</i>	A.1-A.12
#A2	HYDROPHILICATION OF MESOPOROUS CARBON BY IMPREGNATING-SILICA METHOD AS SOLID-DESICCANT IN GAS DEHYDRATION PROCESS <i>Fadlilatul Taufany, Anita Rahmawati, Dessy Fatmawati, Nurhamidah, Fahmi</i>	A.13-A.16
#A3	APPLICATION OF CHIRALITY ON CHIRAL RECONITION OF ENATIOMERS AND PHOTONIC CRYATALS FABRICATION <i>Chih-Chieh Chien, Jui-Hsiang Liu</i>	A.17-A.20
#A4	SYNTHESIS OF TRIPODAL CONJUGATED PYRRYL-RHODAMINE CHEMOSENSOR AND SELECTIVE SENSING OF Zn ²⁺ ION <i>Yu-Jen Chen, Wen-I Chang, Jui-Hsiang Liu</i>	A.21-A.23
#A5	FABRICATION AND CHIRAL RECOGNITION OF PREDESIGNED SUPRAMOLECULE VIA CHIRAL DOPED ORGANOGELEATOR <i>Jian-Chin Lin, Bo-Han Huang, Jui-Hsiang Liu</i>	A.25-A.28
#A6	APPLICATION OF BUOYANCY WEIGHING-BAR METHOD TO ESTIMATE THE DROPLET SIZE DISTRIBUTION AND OPTIMAL TIME OF BIODIESEL-GLYCEROL SEPARATION <i>Rondang Tambun, Farida Hanum, Yudhy Sibagariang, Jhoni Manurung</i>	A.29-A.32
#A7	BIODISEL PRODUCTION FROM USED COOKING OIL USING COMPOSITE CATALYST CAO/KI/Γ-AL ₂ O ₃ <i>Nyoman Puspa Asri, Diah Agustina Puspita Sari, Bambang Poedjojono, Suprpto</i>	A.33-A.37
#A8	ORI BAMBOO POTENTIAL AS BIOETHANOL SOURCE <i>M. T. Safirin, Edahwati Luluk, D. S. Perwitasari</i>	A.39-A.42
#A9	EFFECT OF TEMPERATURE ON MANUFACTURING PROCESS OF POLYETHYLENE GLYCOL DIOLEATE (PDO) <i>Yan Irawan, Ika Juliana</i>	A.43-A.45
#A10	SOLID WASTE MIXTURE AS AN ALTERNATIF SOLID FUEL <i>Sri Rachmania Juliastuti, Nuniek Hendrianie, Imam Naufal, Eka Patriargadani</i>	A.47-A.51

B. Industrial Engineering

#	TITLE	#PAGE
#B1	ERGONOMIC DESIGN OF WATER BOTTLE CARRIER TO REDUCE MUSCULOSKELETAL DISORDER AND FATIGUE <i>Hudaya, Rio Ade Rakhmanto, R. Abdul Djalal</i>	B.1-B.5
#B2	THE IMPLEMENTATION OF THE TRACK LINK TANK MANUFACTURING FOR ARMY TANK AS A SUBSTITUTION IMPORTED COMPONENT <i>Hafid, Sri Bimo Pratomo, Sony Harbintoro</i>	B.7-B.11
#B3	EDUCATIVE TOY DESIGN FOR DEAF CHILDREN TO STIMULATE THE FINE MOTOR SKILLS GROWTH <i>Hartomo Soewardi, Dian Putri Rahmawati</i>	B.13-B.18
#B4	WORK POSITION AFFECTS THE MUSCULOSKELETAL DISORDERS, WORKLOAD AND CONCENTRATION AT LABOUR OF SMALL SCALE WOOD PROCESSING INDUSTRY <i>I Ketut Widana, Ni Wayan Sadiyani</i>	B.19-B.22
#B5	COST MINIMIZATION USING HYBRID MINIMAL REPAIR FOR CONTINUOUS PRODUCTION SYSTEM <i>Ellysa Nursanti</i>	B.23-B.27
#B6	THE STUDY OF FISHERY INDUSTRY SUPPLY CHAIN MANAGEMENT USING VALUE ADDED ANALYSIS <i>Rini Oktavera, Iga Sri Devyanti</i>	B.29-B.33
#B7	REDESIGNING POTTERY TURNTABLE USING PARTICIPATORY DESIGN METHODS <i>Hartomo Soewardi, Aldino Friga Putra Sudarmanto</i>	B.35-B.42
#B8	LAYOUT DESIGN OF FURNITURE MANUFACTURING FACILITIES BY USING ALGORITM SA-CRAFT <i>Hartomo Soewardi, Nabila Noor Qisthani</i>	B.43-B.48
#B9	INDEPENDENT DESIGN OF ERGONOMIC GRANTOR TOOLS FOR BROILER CHICKEN FEED IN THE HUSBANDRY INDUSTRY <i>Hartomo Soewardi, Astika Nuryani</i>	B.49-B.54
#B10	ERGONOMIC DESK DESIGN FOR LAPTOP USING AXIOMATIC DESIGN <i>Hartomo Soewardi, Gayuh Minang Lati</i>	B.55-B.60
#B11	REDESIGN THE ELDERLY BED BASED ON THE EXPECTATION-SATISFACTION GAP OF THE ELDERLY IN INDONESIA <i>Rachmad Hidayat</i>	B.61-B.69

#	TITLE	#PAGE
#B12	QUALITY ANALYSIS OF STEEL IN STORAGE BASED ON TENSILE STRENGTH CRITERIA USING NACE STANDARD TM-01-69 METHOD (CASE STUDY IN PT. "X") <i>Yustina Ngatilah, Aji Pujoningrat, Ngakan Gde Bayu Aditya, Endang Puji P., Caecilia Puji Astuti, C. Indri Parwati</i>	B.71-B.75
#B13	A MULTI CRITERIA DECISION MAKING APPROACH TO EVALUATE ALTERNATIVES OF SUPPLIERS <i>Dira Ernawati, Farida Pulansari, Ni Ketut Sari, Mochamad Nurul Huda</i>	B.77-B.82
#B14	EFFICIENCY ANALYSIS OF DEPARTMENTS OF NON ENGINEERING IN UNIVERSITY OF PEMBANGUNAN NASIONAL "VETERAN" JATIM <i>Enny Ariyani, Iriani, Sunardi, Akhmal Suryadi, Erlina Purnamawati, Husein Febriyanto</i>	B.83-B.90

C. Food Technologies

#	TITLE	#PAGE
#C1	IMMUNOSTIMULATORY EFFECT OF JELLYFISH COLLAGEN <i>Takuya Sugahara, Agus Budiawan Naro Putra, Kosuke Nishi, Mikiharu Doi</i>	C.1-C.5
#C2	IMMUNOSTIMULATORY EFFECT OF DRIED BONITO EXTRACT ON MACROPHAGES <i>Nanami Kunihiro, Kozue Shinohara, Kosuke Nishi, Katsuhiro Osajima, Tomokazu Suemitsu, Takuya Sugahara</i>	C.7-C.10
#C3	INHIBITORY EFFECTS OF ENZYME-TREATED DRIED SARDINE EXTRACT ON IGE-MEDIATED DEGRANULATION OF RBL-2H3 CELLS AND PASSIVE CUTANEOUS ANAPHYLAXIS REACTION IN MICE <i>Seiji Awane, Masaya Nakamoto, Kosuke Nishi, Katsuhiro Osajima, Tomokazu Suemitsu, Takuya Sugahara</i>	C.11-C.14
#C4	GUM XANTHAN MAKING FROM TOFU WASTE USING XANTHOMONAS CAMPESTRIS (A STUDY OF CULTURE CONCENTRATION AND SUGAR ADDITION) <i>Ulya Sarofa, Rudi Nurismanto, Asri Maulina</i>	C.15-C.19
#C5	MAKING HIGH FIBER COOKIES WITH BRAN (PROPORTION STUDY OF BRAN RICE AND MODIFIED CASSAVA FLOUR WITH THE ADDITION OF MARGARINE) <i>Sri Djajati, Tri Mulyani, Liea Dwi Rahayu</i>	C.21-C.23
#C6	THE CHARACTERISTIC OF SYNBIOTIC YOGHURT FROM PURPLE YAM (DIOSCOREA ALATA) WITH THE ADDITION OF BIFIDOBACTERIA BREVE AND LACTOBACILLUS CASEI <i>Sudaryati, Murtiningsih, Khalimatul Janah</i>	C.25-C.28

#	TITLE	#PAGE
#C7	MASS TRANSFER ON CONCENTRATION PROCESS OF CANE JUICE USING VACUUM FALLING FILM EVAPORATOR PART II <i>Suhadi, Wiwik Prihartanti, Nyoman Sriwidari</i>	C.29-C.32
#C8	THE CHARACTERISTICS OF EMULSION CREAM CONTAINING GOTUKOLA AND GINGER EXTRACT IN ADDITION OF FRAGRANCE <i>Yenny Meliana*), Witta Kartika Restu, Egi Agustian, Anny Sulaswaty, Yulianti Sampora, Sri Fahmiati, Melati Septiyanti</i>	C.33-C.38
#C9	MODIFICATION OF TARO FLOUR WITH FERMENTATION PROCESS <i>Endang Srihari, Farid Sri Lingganingrum</i>	C.39-C.43
#C10	EFFECT OF SOLVENT POLARITY ON ANTIOXIDANT ACTIVITY DURING FRACTIONATION OF ETHANOLIC EXTRACT OF CITRUS HYSTRIX PEEL <i>Wenny Irawaty, Aning Ayucitra</i>	C.45-C.48
#C11	EFFECT OF CHITOSAN ADDITION AND TEMPERATURE OF HEATING FOR TENSILE STRENGTH AND ELONGATION AT BREAK VELUE OF BIOPLASTICS FROM TARO STARCH (COLOCASIA ESCULANTA) WITH GLYCEROL PLASTICIZER <i>M. Hendra Ginting, Toni Pahri Sirait, Torasman Sidabudar</i>	C.49-C.57
#C12	EXTRACTION OF ESSENTIAL OIL BY ENFLEURATION PROCESS USING VEGETABLE AND ANIMAL FATS <i>Siswati Soe'eib, Nyoman Puspa Asri, A.S Dwi Saptati N.H, Diah Agustina P</i>	C.60-C.62

D. Information and Communication Technologies

#	TITLE	#PAGE
#D1	CONCEPTUAL MODEL TO INCREASE COCOA PRODUCTIVITY WITH SYSTEM DYNAMICS APPROACH <i>Syurfah Ayu Ithriah, Erma Suryani</i>	D.1-D.4
#D2	TEMPLATE MATCHING BASED PATTERN IDENTIFICATION WITH GEOMETRIC MOTIF OF BATIK <i>Eva Yulia Puspaningrum, Wahyu S.J. Saputra, Yisti Vita Via, Suryohadi</i>	D.5-D.7
#D3	PERFORMANCE OF ROBUST REGRESSION METHOD FOR SIDE VIEW FACE RECOGNITION <i>Budi Nugroho, Intan Yuniar Purbasari</i>	D.9-D.12

#	TITLE	#PAGE
#D4	SECURE VOIP PERFORMANCE MEASUREMENT: A ANALYTIC AND SIMULATION APPROACH <i>I Made Suartana, Henni Endah Wahanani, Aditia Mieka Darminta</i>	D.13-D.17
#D5	CHARACTER RECOGNITION OF VEHICLE LICENSE PLATE USING EXTREME LEARNING MACHINE <i>Chrystia Aji Putra, Basuki Rahmat, Stevanus Hardiristanto, Mauridhi Hery Purnomo</i>	D.19-D.22
#D6	MUSIC RECOMMENDATION FOR PREGNANCY THERAPY USING SELF ORGANIZING MAP <i>Kadek Cahya Dewi, I Made Widiantara</i>	D.23-D.27
#D7	AUTOMATIC COLOR BASED IMAGE SEGMENTATION USING K-MEANS CLUSTERING <i>Wahyu S. J. Saputra, Yisti Vita Via, Eva Yulia Puspaningrum</i>	D.29-D.33
#D8	CUSTOMER BEHAVIOR ANALYSIS TO REDESIGN STORE LAYOUT USING MARKET BASKET ANALYSIS <i>Vicky Andreas Dinata, Rizka Hadiwiyanti, Eka Dyar Wahyuni</i>	D.35-D.38
#D9	THE ACCOUNTING INFORMATION SYSTEMS OF WATER SPORTS COMPANY <i>I Gede Made Karma</i>	D.39-D.46
#D10	COMMUNITY-BASED COLLABORATIVE INFORMATION SYSTEMS FOR AGRICULTURAL USING SOCIAL MEDIA TECHNOLOGY <i>Mohamad Irwan Afandi, Budi Nugroho, Rizka Hadiwiyanti</i>	D.47-D.52
#D11	DEMAND FORECAST OF BROILER/LAYER EGG WITH SYSTEM DYNAMICS APPROACH <i>Agung Brastama Putra, Siti Mukaromah, Prisa Marga Kusumantara</i>	D.53-D.57
#D12	EVALUATION OF SERVICE LEVEL MANAGEMENT IMPLEMENTANTION FOR MANAGING INFORMATION TECHNOLOGY SERVICES USING INFORMATION TECHNOLOGY INFRASTRUCTURE LIBRARY VERSION 3 <i>Ivan Ramos Sampe Immanuel</i>	D.59-D.65
#D13	EXPERT SYSTEM TO IDENTIFY DISEASES SOYBEAN PLANT GROWTH BASED ON WEB <i>Kasirah, M. Syahrul Munir</i>	D.67-D.71

E. Civil and Environment Engineering

#	TITLE	#PAGE
#E1	ENVIRONMENTAL RISK ANALYSIS OF SUGAR FACTORY WASTE <i>Kris Tri Basuki</i>	E.1-E.4
#E2	STUDY ON THE POTENTIAL TRAVEL DEMAND OF THE TOURISTS IN BALI, INDONESIA <i>Putu Hermawati, Muhammad Isran Ramli</i>	E.5-E.11
#E3	STRENGTH ANALYSIS OF SERIRIT MARKET BUILDING STRUCTURE AFTER THE FIRE <i>I Wayan Suasira, I Made Jaya, Made Suardana Kader, I Wayan Dana Ardika</i>	E.13-E.17
#E4	SLOPE STABILITY EVALUATION USING LIMIT EQUILIBRIUM METHOD (LEM) AND FINITE ELEMENT METHOD (FEM) FOR INDONESIA SOFT SOIL <i>Putu Tantri Kumala Sari, Yudhi Lastiasih</i>	E.19-E.26
#E5	A STUDY ON TRAVEL FACTORS OF DAILY SHOPPING TRIP TO TRADITIONAL MARKET USING STRUCTURAL EQUATION MODELING <i>M. Isran Ramli, Qarnila Rhidaniah, Sakti Adji Adisasmita, Mubassirang Pasra</i>	E.27-E.33
#E6	TRANSPORTATION INFRASTRUCTURE DEVELOPMENT TO INCREASE TOURISM IN MADURA ISLAND OF EAST JAVA PROVINCE <i>Ari Widayanti, Mirza Aulia</i>	E.35-E.39
#E7	ERGONOMIC ANALYSIS OF MODEL FURNITURE MULTIFUNGSI FOR FLATS TYPE 18m ² <i>Dyan Agustin, Wiwik Dwi Susanti</i>	E.41-E.46
#E8	INFRASTRUCTURE DEVELOPMENT OF EASTERN RING ROAD SURABAYA AND ECONOMIC POTENTIAL MAPPING IN FIVE MUNICIPAL DISTRICTS <i>Yuniningsih, M Taufiq, Ririt Iriani Sri S, Sugeng Purwanto</i>	E.47-E.50
#E9	A PROPOSED CLAMP SYSTEM FOR MECHANICAL CONNECTION OF REINFORCING STEEL BARS <i>Tavio, Parmo</i>	E.51-E.56
#E10	BLANK SPOT ANALYSIS OF PUBLIC TRANSPORT IN SUPPORTING MONORAIL OPERATION IN SURABAYA <i>Anita Susanti and Aryo Dwi Kurnianto</i>	E.57-E.61
#E11	REDUCTION OF ORGANIC SOLID WASTE BY BLACK SOLDIER FLY (HERMETIA ILLUCENS) LARVAE <i>Elvita Sari Saragi, Arseto Yekti Bagastyo</i>	E.63-E.68

#	TITLE	#PAGE
#E12	ANALYSIS AND MAPPING OF TRAFFIC FLOW CHARACTERISTIC IN KENJERAN ROADWAY SURABAYA BASED ON GEOGRAPHIC INFORMATION SYSTEM <i>Hendrata Wibisana</i>	E.69-E.73
#E13	SUBSEQUENT FENTON PROCESS AND NEUTRALIZATION FOR WASTEWATER TREATMENT OF TEXTILE HOME INDUSTRY <i>Wilda Charisma Yunaz, Arseto Yekti Bagastyo</i>	E.75-E.82
#E14	REMOVAL OF HEAVY METAL IONS FROM METAL FINISHING INDUSTRIAL WASTEWATER BY CHEMICAL TREATMENT-A FULL SCALE WASTEWATER TREATMENT PLANT RETROFITTING CASE STUDY <i>Rudy Laksmono W. and Qomarudin Helmy, Edwan Kardena</i>	E.83-E.88
#E15	THE INFLUENCE OF CULTURAL TO THE LOCAL COFFEE SHOP (ANGKRINGAN) ARCHITECTURAL CHARACTERS (OBSERVED BASED ON THE MEANING AND SYMBOL AT ANGKRINGAN TUGU, YOGYAKARTA) <i>Wiwik Dwi Susanti, Dyan Agustin</i>	E.89-E.93
#E16	THE MODEL OF PUBLIC MASIVE TRANSPORTATION THAT IS DESIRED BY SOCIETY <i>Dadang Supriyatno</i>	E.95-E.99
#E17	THE MODEL OF DAMAGE PREVENTION KARST REGION CITATAH - RAJAMANDALA WEST BANDUNG, WEST JAVA <i>Bambang Sudaryana</i>	E.101-E.106

F. Machine and Electrical Engineering

#	TITLE	#PAGE
#F1	ANALYSIS OF FLUE GAS REACTOR ON PROCESSING OF THE CARBON BLACK <i>Mamat, Bambang Prihandoko, Suharwadji Sentana</i>	F.1-F.4
#F2	NIGHT OF THE BALINESE HINDU DAY OF SILENCE OBSERVERS FROM THE VIIRS NIGHT TIME SATELLITE IMAGERY <i>I Ketut Swardika, Putri Alit Widyastuti Santuary</i>	F.5-F.11
#F3	FEASIBILITY ANALYSIS OF A GRID-CONNECTED PV SYSTEM FOR HOME APPLICATION <i>Wayan G. Santika, Putu Wijaya Sunu, I Made Arsawan</i>	F.13-F.18

G. Social and Law

#	TITLE	#PAGE
#G1	STRUCTURING FEMALE BODY: BETWEEN CULTURAL IDENTITY AND IMAGING TECHNOLOGY OF JAVANESE COMMUNITY IN SURABAYA EAST JAVA <i>Sarmini</i>	G.1-G.5
#G2	REGIONAL AUTONOMY POLICIES, SUSTAINABLE DEVELOPMENT AND ENVIRONMENTALLY TOWARDS A HEALTHY AND GREEN CITY IN DEPOK WEST JAVA <i>Muh. Kadarisman, Ismiyati</i>	G.7-G.12
#G3	FACTOR ANALYSIS OF ETHIC, CULTURE OF BUREAUCRACY, SOCIAL PRESSURE, AND INDIVIDUAL CAPACITY TOWARDS BUDGETARY SLACK STUDY OF EXECUTIVE BEHAVIOR DURING BUDGET PLANNING AT REGIONAL COORDINATOR BODY (BAKORWIL) JAWA TIMUR <i>Ali Maskun, Sumarto</i>	G.13-G.17
#G4	THE EFFECTIVENESS OF USING INSTAGRAM AS A MEDIUM FOR THE PROMOTION OF PRODUCTS (A QUALITATIVE STUDY OF THE ONLINE SHOP WHICH IS OWNED BY THE SURABAYA'S STUDENTS) <i>Juwito Himajati</i>	G.19-G.26
#G5	HOTEL CORPORATE SOCIAL RESPONSIBILITY PROGRAM BASED ON TRI HITA KARANA PHILOSOPHY: A WEB UTILIZATION CASE <i>Nyoman Indah Kusuma Dewi, I Gusti Agung Bagus Mataram and I Wayan Siwantara</i>	G.27-G.33
#G6	THE ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY EMPOWERMENT IN TRADITIONAL VILLAGE TO PRESERVE BALINESE CULTURE <i>I Gusti Ketut Gede, I Wayan Wirga, I Gede Iwan Suryadi</i>	G.35-G.48
#G7	OPTIMIZATION MODEL TAX REVENUE AS OF SMEs REVENUE IMPROVEMENT EFFORTS OF EAST JAVA <i>Soewarno, Djohan Mashudi, Siti Ning Farida, Sigit Dwi Nugroho</i>	G.49-G.52
#G8	TRUST IN ELECTRONIC COMMERCE BUSINESS RELATIONSHIPS: A STUDY OF STUDENTS' PERCEPTIONS ON WEB SITE DESIGN <i>Nyoman Indah Kusuma Dewi, Nyoman Abdi, I Gusti Agung Bagus Mataram</i>	G.53-G.57

#	TITLE	#PAGE
#G9	THE EFFECTIVENESS OF USE OF SOUNDCLOUD APPLICATION AS SOCIAL MEDIA FOR PROMOTING POP PUNK INDIE BAND (Qualitative Descriptive Study on the Use of SoundCloud by Indie Band in Surabaya to Promote Pop Punk Songs and Music) <i>Zainal Abidin Achmad, Oktavira Wahyu Setiyanti</i>	G.59-G.64
#G10	LEGAL PROTECTION AGAINST ACTORS RIGHTS SALE TRANSACTIONS USING THE INTERNET <i>Haryo Sulistiyantoro, SitiMarwiyah</i>	G.65-G.69

H. Economy and Management

#	TITLE	#PAGE
#H1	EMPOWERING THE EMPLOYEES AS A COMPETITIVE STRATEGY OF EAST JAVA REGIONAL PUBLIC HOSPITAL(RSUD) IN THE ERA OF PUBLIC SERVICE ASSOCIATION (BLU) <i>Ignatia Martha Hendrati, Sukirmiyadi, Kustini, Nuruni Ika K. W.</i>	H.1-H.8
#H2	OPTIMIZATION OF THE BUSINESS LEARNING GROUPS THROUGH INNOVATIVE PRODUCTS AND PARTNERSHIPS FOR COMMUNITY EMPOWERMENT <i>Pandji Soegiono, Sja'fii, Gideon Setyo B, Supriyono</i>	H.9-H.13
#H3	THE BIASED FACTORS OF INVESTOR'S BEHAVIOR IN STOCK EXCHANGE TRADING <i>Tri Kartika Pertiwi</i>	H.15-H.20
#H4	UTILIZATION OF TECHNO-PRENEURSHIP TO INCREASE CRAFTSMEN INCOME OF RURAL AREAS IN BALI <i>Ni Nyoman Aryaningsih</i>	H.21-H.29
#H5	ANALYSIS OF STOCK SPLIT AND CORPORATE FINANCIAL PERFORMANCE IN INDONESIAN STOCK EXCHANGE <i>Dhani Ichsanuddin Nur</i>	H.31-H.35
#H6	EVALUATION OF E-AUDIT IMPLEMENTATION ON FINANCIAL AUDIT PROCESS: A STUDY ON AUDITORS AND FINANCIAL STATEMENT AUDIT REPORTS OF AUDIT BOARD OF INDONESIA (BPK) <i>Rini Rahma, Siti Sundari, Indrawati Yuhertiana</i>	H.37-H.46
#H7	BEHAVIOR IN ACCOUNTING LECTURERS TECHNOLOGY ADOPTION: CASE OF E-LEARNING IMPLEMENTATION <i>Indrawati Yuhertiana</i>	H.47-H.50

I. Agribusiness

#	TITLE	#PAGE
#11	COMMUNITY DEVELOPMENT MODEL: LOCAL RESOURCE POTENTIAL MAP IN BANGKALAN MADURA <i>Teguh Soedarto, Sumartono, Ertien Rining N, Sukendah</i>	I.1-I.12
#12	BUILD OF FARMER WELFARE THROUGH THE COCOA VILLAGE MODEL PROGRAM IN DISTRICT OF BLITAR <i>Effi Damaijati, Sumarto, Sri Widayanti dan Indriya Radiyahanto</i>	I.13-I.16
#13	ANALYSIS OF COCOA FARMING AND ECONOMIC LEVEL OF FARMERS ESTATE IN EAST JAVA <i>Pawana Nur Indah, Suroso Imam Djazuli</i>	I.17-I.21
#14	STUDY GLUCOMANNAN, STARCH AND FIBER CONTENT OF TUBER PORANG (<i>AMARPHOPHALLUS ONCOPHYLLUS L.</i>) IN SOME AGE OF HARVEST <i>Ramdan Hidayat</i>	I.23-I.27

EFFECT OF SOLVENT POLARITY ON ANTIOXIDANT ACTIVITY DURING FRACTIONATION OF ETHANOLIC EXTRACT OF CITRUS HYSTRIXPEEL

Wenny Irawaty¹ and Aning Ayucitra²

Chemical Engineering Department, Faculty of Engineering, Widya Mandala Catholic University Surabaya, East Java, Indonesia
 e-mail: wenny_i_s@ukwms.ac.id

ABSTRACT

Citrus hystrix has been claimed to exhibit tremendous performance to repair organ damage caused by free radicals developed during metabolism. The present study was undertaken to evaluate the antioxidant power of *Citrus hystrix* peel. Antioxidant activity of several fractions (water, ethyl acetate, and hexane) obtained from the fractionation of ethanolic extract of *Citrus hystrix* peel was investigated. The effect of the solvents on phytochemical content was also evaluated. The research methods involve the *Citrus hystrix* peel preparation (sizing, drying), extraction of the peel by using ethanol 41% for 8 hours, fractionation of the ethanolic extract by different solvents, and then followed by antioxidant activity measurement of the fractions obtained. The results revealed that all fractions of the ethanolic extract of *Citrus hystrix* peel exhibited variable antioxidant activity. Specially, the ethyl acetate fraction showed the highest values of antioxidant capacity (% DPPH scavenging activity). The different activity of the fractions was correlated with phytochemical content in each fraction.

Keywords: *Citrus hystrix* peel, antioxidant, fractionation

INTRODUCTION

Plants and plant products are being used as a source of medicine since long time. The medicinal properties of plants have been widely investigated due to their potent antioxidant activities, no side effect, and economic feasibility (Hui et al., 2009). The natural antioxidants or phytochemicals are the secondary metabolites of plants that are widely distributed in foods of plants and count as phenolic compounds. As antioxidant, phenolic compounds comprising flavonoids and phenolic acids play an important role in the prevention of human pathologies by acting as radical scavenger against degenerative diseases such as cardiovascular diseases, neurodegenerative diseases, blood disorder diseases, diabetes mellitus (Zhao et al., 2012), and cancers. Therefore, there is growing interest toward natural antioxidant from herbal sources (Ebrahimzadeh et al., 2008, Sarepoua et al., 2015, Gorinstein et al., 2001). Phenolic compounds are frequently found in fruits (Nizam Uddin et al., 2014, Ebrahimzadeh et al., 2008, Gorinstein et al., 2001), vegetables (Hui et al., 2009, Widyawati et al., 2014, Harbaum et al., 2008), and grains (Singh et al., 2012, Chiremba et al., 2012). The chemical composition of fruits, including leaves and peels have been widely investigated and it was found that the peel possesses higher antioxidant activity compared to other parts of the fruit (Gorinstein et al., 2001, Li et al., 2006). For example, Gorinstein et al. (2001) found that the amount of phenolic compounds in the peels of orange, lemon, and grapefruit were higher than the peeled fruits. Similar result was reported by Li et al. (2006) when pomegranate was selected in their study (Li et al., 2006).

Citrus fruits contain high content of flavonoids compared to other type of fruits. Citrus fruits contain a wide range of flavonoid compounds which are sub-classed in flavanones, flavones, flavonol, and dihydrochalcone C- and/or O-glycosides (Roowi and Crozier, 2011, Gattuso et

al., 2007). Therefore, since in the early nineties the presence of flavonoids in citrus fruits began to attract a number of researchers. This study focused on *Citrus hystrix*. The leaves of this citrus have commercial importance and its byproduct, i.e. the fruit itself has not been utilized yet.

This work evaluates the effect of solvent polarity used during fractionation of *Citrus hystrix* peel extract on the antioxidant capacity. The aim of this work was to propose a suitable solvent for the separation of phenolic compounds in crude *Citrus hystrix* peel extract.

LITERATURE REVIEW

Citrus hystrix, commonly known as Kaffir lime or wild lime, is originated from South East Asia and cultivated throughout the tropical regions. *Citrus hystrix* is greenish yellow, acidic flavor, bumpy, and pear-shaped. This citrus is reported rich in phenolic compounds including flavonoids, limonoids, glycerolglycolipids, furanocoumarins, benzenoid derivative and quinolinone alkaloids with potential health-promoting properties.

Several methods such as maceration (Cha et al., 2010), heat treatment (Xu et al., 2007), microwave (Chiremba et al., 2012), ultrasonic (Ma et al., 2008), far-infrared radiation (Lee et al., 2006), subcritical water (Plaza et al., 2010), high pressure – pulsed electric field (Sánchez-Moreno et al., 2005), fermentation (Harbaum et al., 2008), and cellulases treatment (Kim et al., 2005) have been studied to extract phenolic compounds from plant materials. Among the methods mentioned earlier, maceration is the most economical feasible and this led to commercial application in the future.

Solvent plays an important role in the extraction of plant natural antioxidant compounds. The amount of compounds extracted is influenced by the polarity of both compounds and solvent used. Hegazy and Ibrahim (2012) investigated the effect of solvent (methanol, ethanol,

dichloromethane, acetone, hexane, and ethyl acetate) polarity on the antioxidant capacities of orange peel extracts (Hegazy and Ibrahim, 2012). It was found that the antioxidant capacities vary with solvent polarity and the high polar solvent of ethanol exhibited the highest antioxidant activities. Patel et al. (2011) reported the antioxidant activities of *Hybanthus enneaspermus* (Linn.) F. Muell. (Violaceae) was greatly influenced by solvent polarity that influence phenolic compounds being extracted by certain solvent which in turn its activity (Patel et al., 2011). Similar finding was also reported by other work (Widyawati et al., 2014).

METHODOLOGY

Material: *Citrus hystrix* obtained around East Java was collected in January-March. Chemicals used were ethanol, methanol, hexane, ethyl acetate, ascorbic acid, DPPH, in this work were purchased from Sigma Chemical Co.

Methods: Citrus fruits were manually peeled and the edible portions were carefully separated. The peels were further cut into 0.5 x 0.5 cm and air dried for 2 days. The dry peel was then soaked with ethanol solution 41% for 8 h at room temperature. The solid part was then separated by a What man filter paper. The filtrate was concentrated under a vacuum by evaporating the ethanol. The water residue was then fractionated under solvents of varying polarity. The phytochemical analysis of the various fractions was carried out independently by using methods described in (Harbone, 1973, Adewole et al., 2014). Antioxidant capacity was quantified by the DPPH radical method. For this assay, a solution of DPPH in methanol (0.2 mM) was prepared freshly. 1.25 mL aliquot of this solution was added to 1 mL sample at different concentrations in the range of 0.03-4 mg/mL. The sample solution was shaken and left to react in the dark for 30 min. Then the solution was transferred into a cuvette, and the absorbance was determined at 520 nm using a spectrophotometer (Shimadzu, UVmini-1240). A decrease in absorbance was recorded and the antioxidant capacity was expressed as IC₅₀. The IC₅₀ is the concentration where 50% inhibition occurs. The control contained all reagents except the fraction was prepared under the same treatment. The antioxidant capacity was compared to standard compound of ascorbic acid which is already known for its good antioxidant activity. The percentage inhibition of the radicals was calculated using the formula:

$$\% \text{ inhibition} = [(A_0 - A_1) / A_0] \times 100 \dots\dots\dots (1)$$

where A₀ is the absorbance of the control, and A₁ is the absorbance of the fraction/standard.

RESULTS

Free radical scavenging activity expressed as IC₅₀ ranged from 0.03 to 2.37 mg crude extract/mL as shown in Table 1.

Table-1. DPPH free radical scavenging activity of different fractions of ethanolic *Citrus hystrix* peel extract

Fraction	IC ₅₀ (mg/mL)
Hexane	2.37 ± 0.16
Ethyl acetate	0.03 ± 0.00
Water residue	1.09 ± 0.05
Ascorbic acid (standard)	0.04 ± 0.00

As seen, the three fractions exhibit DPPH radical scavenging capacity and the ethyl acetate shown the best activity among the others with the IC₅₀ reached a value of 0.03±0 mg/mL. The water residue exhibited the second highest value in the DPPH free radical test after the ethyl acetate fraction where the IC₅₀ was recorded at 1.09±0.05 mg/mL. With the IC₅₀ value of 2.37±0.16 mg/mL, hexane fraction occupied the third highest rank in the same test method. Ascorbic acid as the control compound has also exhibited the scavenging activity toward DPPH free radical compound with the IC₅₀ value of 0.04 mg/mL.

When the concentration of the fractions was increased, it was observed that the antioxidant capacity was improved as shown in Figure 1 for the fraction of ethyl acetate (r² = 0.9581). Other fractions showed the similar trend (data not shown).

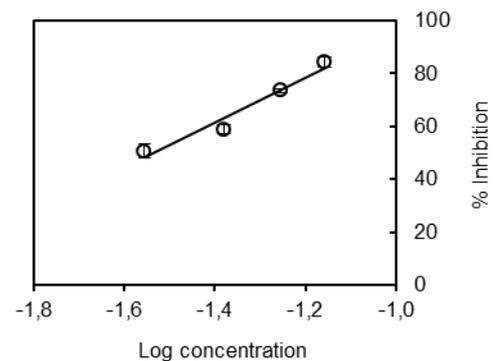


Figure-1. DPPH scavenging activity for different amount of ethyl acetate fraction

In order to get insight into the scavenging activity of each fractions observed in this study, phytochemical analysis of the three fractions were performed and the results are tabulated in Table 2. As seen, each fractions exhibited different compounds that may contributed to the activity of each fractions. Alkaloids, phenolics, and flavonoids were detected in all fractions. While compounds of saponins, tannins, sugars, and carbohydrates were not identified in the fraction of hexane, however, all the compounds were revealed in the fractions of ethyl acetate and water residue.

DISCUSSIONS

As shown in Table 1, the IC₅₀ values varied in the following order: ethyl acetate fraction < water residue < hexane fraction. Similar result was found by other work (Anagnostopoulou et al., 2006) that the fraction of ethyl acetate exhibited the highest antioxidant capacity compared to other fractions (ether, dichloromethane, and water fraction) when sweet orange peel was selected in

their study. The IC₅₀ values were then compared to the standard of ascorbic acid. The standard suggests that its activity was 25% lower than the ethyl acetate fraction, while compared to the other two fractions, the standard was 27 and 59% higher for the fractions of water residue and hexane, respectively. The results show that ethyl acetate is regarded as the most effective solvent to extract compounds from the ethanolic extract of *Citrus hystrix* peel. This can be explained by the possible complex formation of phenolic compounds with other components which are more extractable in ethyl acetate than those of other fractions (hexane and water) (Zhao and Hall, 2008, Zhu et al., 2011).

The antioxidant capacity of plants is contributed by the presence of phenolic compounds or phytochemicals. The fractions of *Citrus hystrix* peel extract contain some potent phytochemical constituents such as phenolics, flavonoids, saponins, alkaloids, carbohydrates, and tannins which may be responsible for this activity (Table 2). Phenolic compounds such as phenolic acid, flavonoids, and tannins have been well known contribute the antioxidant activity/capacity (Gorinstein et al., 2001). Flavonoids found in citrus juice were reported flavanone aglycones, flavone aglycones, polymethoxy flavones, flavanone-*O*-glycosides, flavone-*C*-glycosides, and flavone-*O*-glycosides. Earlier investigations on saponins found that the compound reduced the risk factor of atherosclerosis (Rodrigues et al., 2005). Tannins was also reported to possess antioxidant

activity (Beninger and Hosfield, 2003). Since the fraction of hexane contains least phytochemical compounds (Table 2), thus it is not surprising if the fraction exhibited the lowest activity to quench DPPH free radical compound. The higher antioxidant capacity exhibited by ethyl acetate fraction cannot only be explained by phytochemical analysis performed. However, the mechanism behind this could be due to the presence of high content of phenolic compounds.

CONCLUSIONS

The fraction of ethyl acetate has shown impressive antioxidant capacity toward DPPH free radical scavenging activity. The comparable antioxidant capacity of ethyl acetate fraction compared to the standard of ascorbic acid indicates that the fraction may have beneficial implication for human health. The mechanism behind this could be due to the presence of high content of phenolic compounds. Accordingly, further investigation on analysis of compounds in the ethyl acetate fraction is required to confirm this.

ACKNOWLEDGMENTS

The authors thank to RISTEKDIKTI for supporting this work through Hibah Fundamental (DIPA Kopertis Wilayah VII Surabaya No. 003/SP2H/P/K7/KM/2015).

Table-2. Phytochemical analysis of various fractions of *Citrus hystrix* peel extract

Fraction	Component						
	Alkaloids	Saponins	Tannins	Sugars	Carbohydrates	Phenolics	Flavonoids
Hexane	+	-	-	-	-	+	+
Ethyl acetate	+	+	+	+	+	+	+
Water residue	+	+	+	+	+	+	+

REFERENCES

- ADEWOLE, E., ADEWUMI, D. F., JONATHAN, J. & FADAKA 2014. Phytochemical constituents and proximate analysis of orange peel (citrus fruit). *Journal of Advanced Botany and Zoology*, 1, 1-2.
- ANAGNOSTOPOULOU, M. A., KEFALAS, P., PAPAGEORGIOU, V. P., ASSIMOPOULOU, A. N. & BOSKOU, D. 2006. Radical scavenging activity of various extracts and fractions of sweet orange peel (*Citrus sinensis*). *Food Chemistry*, 94, 19-25.
- BENINGER, C. W. & HOSFIELD, G. L. 2003. Antioxidant activity of extracts, condensed tannin fractions, and pure flavonoids from *Phaseolus vulgaris* L. seed coat color genotypes. *Journal of Agricultural and Food Chemistry*, 51, 7879-7883.
- CHA, K. H., KANG, S. W., KIM, C. Y., UM, B. H., NA, Y. R. & PAN, C.-H. 2010. Effect of pressurized liquids on extraction of antioxidants from *Chlorella vulgaris*. *Journal of Agricultural and Food Chemistry*, 58, 4756-4761.
- CHIREMBA, C., ROONEY, L. W. & BETA, T. 2012. Microwave-assisted extraction of bound phenolic acids in bran and flour fractions from sorghum and maize cultivars varying in hardness. *Journal of Agricultural and Food Chemistry*, 60, 4735-4742.
- EBRAHIMZADEH, M. A., POURMORAD, F. & BEKHRADNIA, A. R. 2008. Iron chelating activity, phenol and flavonoid content of some medicinal plants from Iran. *African Journal of Biotechnology*, 7, 3188-3192.
- GATTUSO, G., BARRECA, D., GARGIULLI, C., LEUZZI, U. & CARISTI, C. 2007. Flavonoid composition of citrus juices. *Molecules*, 12, 1641-1673.
- GORINSTEIN, S., MARTÍN-BELLOSO, O., PARK, Y.-S., HARUENKIT, R., LOJEK, A., ČÍŽ, M., CASPI, A., LIBMAN, I. & TRAKHTENBERG, S. 2001. Comparison of some biochemical characteristics of different citrus fruits. *Food Chemistry*, 74, 309-315.
- HARBAUM, B., HUBBERMANN, E. M., ZHU, Z. & SCHWARZ, K. 2008. Impact of fermentation on phenolic

- compounds in leaves of pak choi (*Brassica campestris* L. ssp. *chinensis* var. *communis*) and chinese leaf mustard (*Brassica juncea* Coss). *Journal of Agricultural and Food Chemistry*, 56, 148-157.
- HARBONE, J. B. 1973. *Phytochemical Methods: A guide to modern techniques of plants analysis (terjemahan)*, ITB.
- HEGAZY, A. E. & IBRAHIUM, M. I. 2012. Antioxidant activities of orange peel extracts. *World Applied Sciences Journal*, 18, 684-688.
- HUI, H., TANG, G. & GO, V. L. W. 2009. Hypoglycemic herbs and their action mechanisms. *Chinese Medicine*, 4, 1-11.
- KIM, Y. J., KIM, D.-O., CHUN, O. K., SHIN, D.-H., JUNG, H., LEE, C. Y. & WILSON, D. B. 2005. Phenolic extraction from apple peel by cellulases from *Thermobifida fusca*. *Journal of Agricultural and Food Chemistry*, 53, 9560-9565.
- LEE, S.-C., KIM, S.-Y., JEONG, S.-M. & PARK, J.-H. 2006. Effect of far-infrared radiation on catechins and nitrite scavenging activity of green tea. *Journal of Agricultural and Food Chemistry*, 54, 399-403.
- LI, Y., GUO, C., YANG, J., WEI, J., XU, J. & CHENG, S. 2006. Evaluation of antioxidant properties of pomegranate peel extract in comparison with pomegranate pulp extract. *Food Chemistry*, 96, 254-260.
- MA, Y.-Q., YE, X.-Q., FANG, Z.-X., CHEN, J.-C., XU, G.-H. & LIU, D.-H. 2008. Phenolic compounds and antioxidant activity of extracts from ultrasonic treatment of satsuma mandarin (*Citrus unshiu* Marc.) peels. *Journal of Agricultural and Food Chemistry*, 56, 5682-5690.
- NIZAM UDDIN, HASAN, M. R., HOSSAIN, M. M., SARKER, A., HASAN, A. H. M. N., ISLAM, A. F. M. M., CHOWDHURY, M. M. H. & RANA, M. S. 2014. *In vitro* α -amylase inhibitory activity and *in vivo* hypoglycemic effect of methanol extract of *Citrus macroptera* Montr. fruit. *Asian Pacific Journal of Tropical Biomedicine*, 4, 473-479.
- PATEL, D. K., KUMAR, R., LALOO, D. & HEMALATHA, S. 2011. Evaluation of phytochemical and antioxidant activities of the different fractions of *Hybanthus enneaspermus* (Linn.) F. Muell. (Violaceae) *Asian Pacific Journal of Tropical Biomedicine*, 4, 391-396.
- PLAZA, M., AMIGO-BENAVENT, M., CASTILLO, M. D. D., IBANEZ, E. & HERRERO, M. 2010. Facts about the formation of new antioxidants in natural samples after subcritical water extraction. *Food Research International*, 43, 2341-2348.
- RODRIGUES, H. G., DINIZ, Y. S., FAINE, L. A., GALHARDI, C. M., BURNEIKO, R. C., ALMEDIJA, J. A., RIBAS, B. O. & NOVELLI, E. L. B. 2005. Antioxidant effect of saponin: Potential action of a soybean flavonoid on glucose tolerance and risk factors for atherosclerosis. *International Journal of Food Sciences and Nutrition*, 56, 79-85.
- ROOWI, S. & CROZIER, A. 2011. Flavonoids in tropical citrus species. *Journal of Agricultural and Food Chemistry*, 59, 12217-12225.
- SÁNCHEZ-MORENO, C., PLAZA, L., ELEZ-MARTÍNEZ, P., ANCOS, B. D., MARTÍN-BELLOSO, O. & CANO, M. P. 2005. Impact of high pressure and pulsed electric fields on bioactive compounds and antioxidant activity of orange juice in comparison with traditional thermal processing. *Journal of Agricultural and Food Chemistry*, 53, 4403-4409.
- SAREPOUA, E., TANGWONGCHAI, R., SURIHARN, B. & LERTRAT, K. 2015. Influence of variety and harvest maturity on phytochemical content in corn silk. *Food Chemistry*, 169, 424-429.
- SINGH, B., SHARMA, H. K. & SARKAR, B. C. 2012. Optimization of extraction of antioxidants from wheat bran (*Triticum spp.*) using response surface methodology. *Journal of Food Science and Technology*, 49, 294-308.
- WIDYAWATI, P. S., BUDIANTA, T. D. W., KUSUMA, F. A. & WIJAYA, E. L. 2014. Difference of solvent polarity to phytochemical content and antioxidant activity of *Pluchea indicia* Less leaves extracts. *International Journal of Pharmacognosy and Phytochemical Research*, 6, 850-855.
- XU, G., YE, X., CHEN, J. & LIU, D. 2007. Effect of heat treatment on the phenolic compounds and antioxidant capacity of citrus peel extract. *Journal of Agricultural and Food Chemistry*, 55, 330-335.
- ZHAO, B. & HALL, C. A. 2008. Composition and antioxidant activity of raisin extracts obtained from various solvents. *Food Chemistry*, 108, 511-518.
- ZHAO, W., YIN, Y., YU, Z., LIU, J. & CHEN, F. 2012. Comparison of anti-diabetic effects of polysaccharides from corn silk on normal and hyperglycemia rats. *International Journal of Biological Macromolecules*, 50, 1133-1137.
- ZHU, K.-X., LIAN, C.-X., GUO, X.-N., PENG, W. & ZHOU, H.-M. 2011. Antioxidant activities and total phenolic contents of various extracts from defatted wheat germ. *Food Chemistry*, 126, 1122-1126.