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ON BIOSCIENCES AND BIOTECHNOLOGY

**MAINTAINING WORLD
PROSPERITY THROUGH
BIOSCIENCES,
BIOTECHNOLOGY
AND REVEGETATION**

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TABLE OF CONTENT

PREFACE	v
FOREWORDS-HEAD OF ORGANIZING COMMITTEE	vii
FOREWORDS-RECTOR OF UDAYANA UNIVERSITY	ix
KEYNOTE PRESENTATION (KP)	
1 Genetics, genomics and evolutionary theory for sustainable crop genetic improvement <i>Winthrop Prof. Wallace A. Cowling</i>	3
2 Environmental restoration by the development of new technology on prevention of soil erosion and revegetation in barren areas <i>Prof. Dr. T. Marumoto</i>	4
3 Plant immunity as host resistance actions against pathogen attack – <i>Arabidopsis</i> NSL2 and the interacting-proteins- <i>Prof. Junji Yamaguchi</i>	5
4 Influence of Additional Calcium in Poultry Diets on Growth, Blood Lipids Profile, Sperm Motility, and Sperm Cryosurvivability <i>F. Kayinji and Teruo Maeda</i>	6
5 Neurobiological study on altered states of consciousness in Bali <i>Norie Kawai</i>	9
6 The Sedative Effect and the Physiological Mechanism of Cedorol <i>Yada Yukihiro</i>	19
7 Function of A Mulching Sheet for The Prevention of Soil Erosion and Revegetation <i>Kazuo Yamamoto and Takuya Marumoto</i>	20
8 Determination and effect of Arbuscular mycorrhizal fungi, <i>Gigaspora margarita</i> CK inoculated in revegetation at Nukui dam site <i>Minh Thi Nguyen, Kazuhira Yokoyama, Takuya Marumoto</i>	21
9 Effects of pulsed electric treatment on cultivation system of caterpillar fungus, <i>Cordyceps sinensis</i> (Berk.) Sacc., a means of promoting mannitol production <i>Shoji Ohga</i>	32
10 Overview of Gunung Merapi National Park in The Post Eruption 2010 <i>Dhani Suryawan</i>	34
11 Agriculture and Biotechnology <i>Prof. Acram Taji</i>	38
12 The role of mycorrhizal fungi associated with plant root for their growth <i>Hiroaki Okabe</i>	39
13 Bioinduction technology increased agarwood (gaharu) production of <i>Aquilaria</i> spp. and <i>Gyrinops</i> spp. <i>Maman Turjaman and Erdy Santoso</i>	40
ORAL PRESENTATION: AGRICULTURE (OA)	
1 The Potential Implementation of Cocoa Based Agroforestry in Critical Land at Nagari Nan Tujuh, Palupuh District, West Sumatera within the Voluntary Carbon Market (VCM) <i>Santhyami, Endah Sulistyawati, Beria Leimona</i>	57

2	Application of Microspore Culture to Produce Homozygous Lines of a New Hexaploid Brassica Species <i>Ida Ayu Astarini, Anouska Cousin, Matthew Nelson, Sheng Chen and Wallace A. Cowling</i>	73
3	<i>Agrobacterium</i> -Mediated Transformation of An Indonesian Wild Orchid <i>Vanda tricolor</i> Lindl. var. <i>suavis</i> <i>Rindang Dwiyani, Azis Purwantoro, Ari Indrianto, and Endang Semiarti</i>	76
4	Possible role of cell wall degradation enzymes for bacteriophages infection and production <i>I Putu Sudiarta and Gusti Ngurah Alit Susanta Wirya</i>	81
5	Optimization of Vitamin-Mineral Supplementation in The King Grass-Based Rations to Minimize Methane Emissions in Bali Cattle Feedlot <i>I.B.G. Partama, I-G.L. Oka, I-P. Suyadnya, T.G.O. Susila, I-G.N.G. Bidura, E. Puspani</i>	86
6	Yield of Three Castor (<i>Ricinus communis</i> L.) Hybrid Varieties Treated with Different Rates of Fertilizer <i>I K.D. Jaya, I G.P.M. Aryana, B.B. Santoso, I W. Sudika</i>	94
7	The Increase of Protein Digestibility and Metabolizable Energy of Rice Bran By <i>Saccharomyces cerevisiae</i> Fermentation <i>I.G.N.G. Bidura, I. P. Suyadnya, D.A. Warmadewi, D.P.M.A. Candrawati, I.A.P. Utami, N.L.P. Sriyani, I. G. A. I. Aryani</i>	98
8	The Performance of Bali Cattle Fed on Urea Containing Diets <i>I B. Sudana, N. W. Siti and Dsk. P.M.A. Candrawati</i>	106
9	The Effect of Lactic Acid Bacteria Administration on The Performances, Total Bacteria in The Digestive Tract, and The Blood and Meat Cholesterol Content of Kampong Chickens <i>Sutarpa, I N.S., S.A. Lindawati, Y. Ramona, I N.S. Miwada, I N.T. Ariana and M. Hartawan</i> ..	110

ORAL PRESENTATION: AGRITECH AND FOOD (OAF)

1	An Endo- β -D-1,4-Galactanase Secreted by <i>Aspergillus Niger</i> during Solid State Fermentation on Soybean Pulp <i>Kahar Muzahar</i>	115
2	Effect of Amylose Content and Heating Temperature on Characteristics of Fresh Rice Flour-based Spring Roll Wrappers <i>Anna Ingani Widjajaseputra, Harijono, Yunianta, Teti Estiasih</i>	122
3	Isolation and Identification of Yeasts from <i>Broussonetia papyrifera</i> Vent. from Trowulan, Indonesia <i>Dalia Sukmawati, Ariyanti Oetari, And Wellyzar Sjamsuridzal</i>	127
4	Physiological and Genetic Characterization of <i>Lactobacillus rhamnosus</i> From Sumbawa Mare Milk <i>I N. Sujaya, NP. Desy Aryantini, S. Tala, W. Nursini, K. Nocianitri, Y. Ramona, T. Urashima, W. Redi Aryanta</i>	130

ORAL PRESENTATION: BIODIVERSITY AND ENVIRONMENT (OBE)

1	Some Issues Related To Wildlife (Flora And Fauna) That Need To Be Managed By Hotels Seeking Sustainable Tourism Certification In Bali <i>Anak Agung Raka Dalem</i>	133
2	Identification Of Marine Turbo Species (Mollusca: Gastropoda) From Pemuteran and Canggu Beach Bali Using DNA Barcodes <i>Tjokorda Sari Nindhia, Muhammad Dailami and Christopher Meyer</i>	137



3	Rhizodegradation of Oil Waste <i>Iryanti Eka Suprihatin, Budiarsa Suyasa, Wahyu Dwijani Sulihingtyas, and Ravika Sugianti</i>	140
4	Potential of Seaweeds Collected at Sanur Beach as Biofuels <i>Ciawi, Y., Suastuti, N.G.A.M.D, Rita, W.S.</i>	145
5	Carbon Storage by Urban Trees in Srengseng and PT. JIEP Urban Forest in Jakarta <i>Dini Fardila and Sutomo</i>	150
6	Preparation of Regular Micro-patterned Thin Polymer Films for Potential Cell Culture Substrates <i>Oka Ratnayani</i>	156
7	Phytoplankton As Water Quality Indicator at Sasak Lake Ciputat <i>Lily Surayya Eka Putri and Fitri Maimunah</i>	162
8	Effectiveness of <i>Trichoderma</i> sp. isolate Td ₂₂ -grown compost in protecting pyrethrum plants from <i>Sclerotinia minor</i> infection <i>Yan Ramona and Martin A Line</i>	168

ORAL PRESENTATION: HEALTH (OH)

1	The Effect of Dark Red Roselle (<i>Hibiscus Sabdariffa</i> var <i>Sabdariffa</i> rubber) to The Level of Malondialdehyde (MDA) in Rats <i>Fachrurrozi, Fatma Zuhrotun Nisa, and Probosuseno</i>	175
2	Intake Of Sardinella Longiceps Oil As An Anti Dislipidemia Through Increase Of Hdl On Rat Wistar <i>Sri Wahjuni</i>	180
3	Human Immunodeficiency Virus Detected in the Gigolo Community in Surakarta <i>Denny Adriansyah, Afiono Agung Prasetyo</i>	185
4	Molecular Variations of Kunitz Domain-like Sequence Hepatitis B Virus X Protein <i>Martinus Nuherwan Desyardi, Afiono Agung Prasetyo, Sofina Kusnadi</i>	191
5	Serological and Molecular Amplification of Human Immunodeficiency Virus Integrase Gene in the Male Sex Workers in Surakarta <i>Hafriliantika Ramadhani, Afiono Agung Prasetyo</i>	196
6	Serological and Molecular Based Detection of Hepatitis C Virus Infection among Male Commercial Sex Workers in Surakarta, Indonesia <i>Sofina Kusnadi, Afiono Agung Prasetyo</i>	202
7	Growth Hormone Reduces Low Density Lipoprotein Of Dyslipidemic Wistar Rat <i>I Gusti Ayu Dewi Ratnayanti, Ida Ayu Ika Wahyuniari dan I Wayan Sugiritama</i>	209
8	The Influences of Ethanol Extracts Sambiloto againts the Differences of Interferon gamma Concentration in Lung Granulomas Culture of Mice infected with <i>Mycobacterium tuberculosis</i> <i>Linawati Ni Made, Sri Budayanti Ni Nyoman, Alit Widhiartini Ida Ayu, Mayun I Gusti Ngurah, Wande I Nyoman</i>	214
9	The Relationship Between Knowledge and Attitude of Worker's in Using Personal Protective Equipment in Department of Forging, Division Forging and Casting of Metal Company in Bandung West Java <i>Gurdani Yogisutanti dan Indrisari Christin</i>	218
10	Neurocysticercosis with Partial Secondary Generalized Epilepsy in An 11 Year Old Girl <i>Dewi Sutriani Mahalini</i>	223

11	Effect of Dietary Lipids Ratio and Choline Deficiency on Hepatic Antioxidant Enzyme Activities <i>Komang Ayu Nocianitri and Yoritaka Aoyama</i>	229
12	Inhibition of Iodized Table Salt on Growth of <i>Streptococcus mutans</i> in- Vitro <i>Nurdeviyanti, Nyoman</i>	233
13	Antibiotic Sensitivity Pattern among <i>Serratia marcescens</i> Isolates from Blood Specimens In Sanglah Hospital <i>Lidya Handayani, Ketut Sukardika, I Dewa Made Sukrama, Ida Bagus Putra Dwija, Ni Nyoman Sri Budayanti</i>	237
15	Identification Mitochondrial nucleotide 3130-3404 Mutation in 30 Indonesian Subjects with Type 2 Diabetes Mellitus <i>Mella Ferania, Allay Maududi, Apriliana Laily Fitri, Chris Adhiyanto, Takenori Nitta, Yukio Hattori, Yasuhiro Yamashiro, Rini Puspitaningrum</i>	239
16	Effects of Seaweed Extract on Plasma Levels of HDL (high density lipoprotein) and LDL (low density lipoprotein) of Wistar Rats <i>K. Sri Marhaeni Julyasih, K. Suata, I.G.P. Wirawan and I N. Mantik Astawa</i>	242
17	Water Extract of Sweet Potato Tuber Reduces Blood Pressure of Hypertensive Rats Induced by NaCl <i>I Made Jawi and I W. P. Sutirta Yasa</i>	247
18	Compartmentalized Notch Signaling Sustains Epithelial Mirror Symmetry <i>Indra Wibowo, Filipe Pinto-Teixeira, Chie Satou, Shin-Ichi Higashijima and Hernan Lopez-Schier</i>	252
19	Antimicrobial effects of Indonesian Medicinal Plants Extracts on Planktonic and Biofilm Growth of <i>Pseudomonas aeruginosa</i> and <i>Staphylococcus aureus</i> <i>Pratiwi, S.U.T., Lagendijk, E.L., de Weert, S., Hertiani, T., Van den Hondel, C.A.M.J.J.</i>	253

POSTER PRESENTATION: AGRICULTURE (PA)

1	The Effect Of Level Chicken Feather Meal Powder In The Ration For Production Of Quail (<i>Coturnix-coturnix japonica</i>) <i>G. A. M. Kristina Dewi, R.R. Indrawati, N. M. Laksmiwati, I K. A. Wiyana, I W. Wijana, I M. Wirapatha and I K. Karnama</i>	257
2	Estradiol and Progesteron Concentration of Six-month and One-year Old Female Rats that Supplemented by Somatotropin <i>Ni Wayan Sudatri</i>	263
3	Cadmium Toxicity in Growth of Red Lettuce (<i>Lactuca sativa</i> L. cv Red Sun) <i>Made Pharmawati</i>	267
4	Post Harvest Management of Rose (<i>Rosa hybrida</i>) as Cut Flower <i>Made Ria Defiani</i>	270
5	Mollusc Species at Rice Field Areas of Kesiman Kertalangu Cultural Village, Denpasar <i>Ni Made Suartini</i>	272
6	Antibabesial Activity of <i>Euchresta horsfieldii</i> Against <i>Babesia gibsoni</i> in Culture <i>A.A.S.A. Sukmaningsih, Subeki, Ida Bagus Wayan Gunam, Hideyuki Matsuura</i>	275
7	Optimising Rumen Function Of Bali Cattle Fed Ration Based On Agriculture By-products With Supplementation Of Multivitamins-minerals <i>I M. Mudita, I W. Wirawan, A.A.P. P. Wibawa, I G. L. O. Cakra and Ni W. Siti</i>	278



8	Antioxidants Compounds in Stem Bark of <i>Inocarpus fagiferus</i> Fosb <i>I Made Sukadana, Sri Rahayu Santi, Made Wira Aditya</i>	287
9	The Potential of Exposure to Natural Color of Mixed Areca Seed, Betel Leaf Gambier With KAlSO ₄ Mordant and it's Utilization towards Coloration of Albasia Wood <i>N W Bogoriani and Manuntun Manurung</i>	291
10	The Relationship Between Rearing System And Production Profile Of Etawah Cross Bred Goats In Some Goat Farmings In Bali <i>Doloksaribu L, W. Subagiana, AA. Oka and IGAA. Putra</i>	300
11	The Development Of Laticifer On Callus Culture Of <i>Catharanthus Roseus</i> (L) G Don Which Were Induced In Zenk Medium And Plant Growth Regulator Bap + Naa <i>Ni Nyoman Darsini</i>	301
12	Cellulase And Pectinaseactivities Of <i>Fusarium Oxysporum</i> F.Sp. <i>Vanillae</i> Exposed To The Extract Of <i>Aglaophenia</i> Sp., A Marine Animal <i>I Ketut Suada</i>	302
13	The Effect Of Concentrate Supplementation On Nitrogen Balance Of Bali Cattle Fed Rice Straw Based Diet <i>T. G. O. Susila, I. B. Gaga Partama and I. G. N. G. Bidura</i>	308

POSTER PRESENTATION: AGRITECH AND FOOD (PAF)

1	Increasing Activity of Antioxidant of Millet (<i>Pennisetum</i> sp) on Sprague Dawley Rats <i>G.A.K. Diah Puspawati</i>	311
2	The Effect of Yellow Cassava Flour (<i>Manihot esculenta</i> Crantz.) as Substitute for Wheat Flour at Different Concentrations on The Wet Noodle's Production..... <i>A.A.Made Dewi Anggreni, Gusti Putu Ganda Putra, and I G.A.A.Sri Suliskin</i>	315
3	Re-fermentation Process Based on Polyphenol Oxidase Enzyme to Improve The Quality of Cocoa Bean from Farmers Products <i>Ganda-Putra G.P., Arnata I.W., and Wirajaya A</i>	319
4	The Influence Type of Solvent and Extraction Times on the Yield and Characteristics Essential Oil of Sandalwood Frangipani Flower (<i>Plumeria alba</i>) <i>Ni Made Wartini, I Gusti Bagus Harland Surya Tenaya, A.A.Made Dewi Anggreni</i>	322
5	Analysis of Artificial Sweeteners in Mix Ice Drink Sold by Roadside Traders in South Denpasar District <i>Putu Timur Ina and G.A.K Diah Puspawati</i>	327
6	Enzymatically Liquefaction OF Sweet Potato (<i>Ipomea batatas</i> L) to Bioethanol Production Using <i>Saccharomyces cerevisiae</i> <i>I Wayan Arnata, Bambang Admadi H., and Esselon Pardede</i>	331
7	Oxidation of Cassava Starch With H ₂ O ₂ to Improve Baking Properties <i>A.A.Istri Sri Wiadnyani</i>	335
8	The Effect of Maltodextrin Concentration on The Characteristics of Grapes' Skin and Seed Microcapsule (<i>Vitisvinifera</i> L.) <i>Sri Mulyani, I G.A. Lani Triani and Isna Fajriyul Rahmi</i>	339
9	The Activity of <i>Aspergillus parasiticus</i> and The Potent to Produce Aflatoxin B1 on Wheat Flour During Storage <i>Agus Selamat Duniaji and I G.N. Agung</i>	343
10	Effect of Early Treatment In Storage Life of Rose Cut Flower (<i>Rosa Damascena</i> Mill). <i>I Gusti Ayu Lani Triani, Bambang Admadi H and Farkhan A</i>	349

11	The Effects of Packaging Materials on Sensory Characteristics and Nutrition Fact of Instant <i>Ledok</i> During Storage <i>I Ketut Suter, I Made Sugitha, I Nengah Kencana Putra, I Putu Suparthana, Ni Made Yusa, Komang Ayu Nocianitri, dan Ni Wayan Wisaniyasa</i>	353
12	The Effect of Soybean and <i>Euchema spinosum</i> Seaweed Ratio on Characteristic of Tempeh <i>Ni Made Yusa, Agus Selamat Duniaji and Dewa Gede Adiputra</i>	357
13	Effect of Boiling Time in Sugar Solute on Characteristic of Eggplant Dry Candy <i>Gusti Ayu Ekawati, Putu Timur Ina Ika Novita Sari</i>	360
14	Changes in Polyphenol Oxidase Enzyme (PPO) on the Fresh-cut Bamboo Shoots during Storage at Room Temperature <i>Pande Ketut Diah Kencana</i>	364
15	The Effect of Sugar Concentration and Use of <i>Saccharomyces bayanus</i> EC 118 on Total Population of Fungi in Purple Sweet Potato's "Brem" <i>Putu Ari Sandhi Wipradnyadewi, N.L. Ari Yusrini and A.S. Duniaji</i>	367
16	Bioassay of Brotowali (<i>Tinospora crispa</i> (L) Miers) Leaves Crude Extract on Gram positive Bacteria, Gram Negative Bacteria and <i>Artemia salina</i> L. Larvae <i>Ida Ayu Putu Suryanti</i>	370
17	Comparative Analysis Of Heavy Metal Content Cadmium (Cd) And Heavy Metal Lead (Pb) To Apple Fruit Apple Local And Imported Rum Biuty Fuji Around Town Denpasar <i>Ni Luh Suriani and Ni Made Susun Parwanayoni</i>	371
18	Change of Chemical Properties and Carotene Degradation of Refined Bleached Deodorized Palm Oil (RBDPO) during Frying of Tofu <i>I Wayan Rai Widarta and Ni Luh Ari Yusrini</i>	374
19	Improving The Nutrition of Purple Sweet Potato (<i>Ipomoea batatas</i> L) through Biofermentation of <i>Aspergillus niger</i> as Feed Substance Containing Antioxidants <i>Tjokorda Gede Belawa Yadnya and A.A.A.S. Trisnadewi</i>	378
20	The Determination Of Ethanol Levels In <i>Arak</i> By Gas Chromatography Techniques <i>Ni Made Suaniti and Ni Putu Widyastuti</i>	384
21	Food Safety by Means of Vegetarian Lifestyle <i>Wayan Suena</i>	387
22	The Model of Weight Losses on Potatoes Distribution Chain from Farmers in Baturiti, Tabanan Regency until Retailer in Denpasar <i>Bambang Admadi Harsojuwono, W R Aryanta and I B Neo Kurnia Amadea</i>	390
23	Efficacy of Ethanol Extract of Liligundi Leaf (<i>Vitex trifolia</i> L) as Adulticide for <i>Aedes aegypti</i> Mosquito <i>I Kadek Swastika</i>	399
24	Production of Crude Enzyme Amyloglucosidase From "Onggok" by <i>Aspergillus niger</i> <i>I Wayan Arnata, Dwi Setyaningsih, Nur Richana</i>	400
25	Effect of Concentration of Liquid Food Dyes and Time of Soaking On The Quality of Tuberose (<i>Polianthes tuberosa</i> L.) <i>Amna Hartiati</i>	401
 POSTER PRESENTATION: BIODIVERSITY AND ENVIRONMENT (PBE)		
1	Biodesulfurization of Dibenzothiophene by Growing and Immobilized Cells of KWN5 Strain <i>Ida Bagus Wayan Gunam, Nyoman Semadi Antara, Agus Selamat Duniaji, I Gusti Ayu Lani Triani, Yohanes Setiyo And Ardiansah Sitepu</i>	405

2	Fungal diversity associated with litter-mycelial mats in the litter layer of Korean forests <i>Joo Young Cha, Sang Yong Lee, Sangjun IM and Shoji Ohga</i>	409
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POSTER PRESENTATION: HEALTH (PH)

1	The Role of Hemopurifier-Coated with Herbal Antibodies to Clean Infected Blood in Reduction Viral Load in HIV Infected Patients <i>Ricardo Adrian Nugraha, Ilham Ikhtiar, Rina Judiwati</i>	413
2	Effect of <i>Temu Putih</i> (<i>Curcuma zedoaria</i> (Berg.) Roscoe.) on Body Weight and Reproductive Organs of Male Mice (<i>Mus musculus</i> L.) <i>Ngurah Intan Wiratmini, A.A.S.A Sukmaningsih</i>	418
3	Histological Structure of Respiratory Ductus of Mice (<i>Mus musculus</i> L.) After Being Exposed to Vapour Electrical Mosquito Repellent <i>Dwi Ariani Yulihastuti</i>	421
4	Improvement of Papain Stability through Microencapsulation Using Alginate-Chitosan for Oral Delivery <i>Cokorda Istri Sri Arisanti, Yeyet Cahyati Sumirtapura, Jessie Sofia Pamudji, Heni Rachmawati</i>	425
5	Identification of Anticancer Compounds Against Myeloma and HeLa Cells from White Turmeric (<i>Curcuma zedoaria</i> (Berg.)Roscoe) Chloroform Extract <i>Wiwik Susanah Rita, I Made Dira Swantara, Luh Gede Sumahiradewi</i>	435
6	In vitro migration of murine lymphokine-activated killer (LAK) cells <i>Inna Narayani</i>	441
7	Concentration of 20% in The Extract of <i>Areca catechu</i> L. May Reduce The Number of Colonies of <i>Candida albicans</i> on The Heat Cured Acrylic Resin <i>Kadek Sugianitri</i>	445
8	The Effect of infusion Purple Rosela Flower (<i>Hibiscus sabdariffa</i> var <i>sabdariffa</i> rubber) on the levels of SGOT (<i>Serum Glutamate oxaloacetate Transaminase</i>) and SGPT (<i>Serum Glutamate Pyruvate transaminase</i>) In Hyperlipidemia Rats <i>Lastdes Cristiany Friday, Fatma Zuhrotun Nisa, Umi S Intansari</i>	450
9	Carbapenem Resistant- <i>Klebsiella pneumoniae</i> in Sanglah Hospital: Distribution and Susceptibility Pattern <i>Agus Eka Darwinata, Ketut Sukardika, I Dewa Made Sukrama, Ni Made AdiTarini, Made Agus Hendrayana</i>	454
10	Detection of <i>Toxoplasma gondii</i> Antibodies from Sera of Experimentally Infected Mice by ELISA Method <i>Ida Ayu Pasti Apsari</i>	457
11	The Effect of Isoflavone Tempe on The Superoxida Dismutase (SOD) and Malondialdehyde (MDA) of Female Rats as Animal Osteoporosis Model <i>I Nyoman Suarsana, I Nyoman Sadra Dharmawan, Bambang Pontjo Priosoeryanto</i>	460
12	Grant of Mucus Snail (<i>Achatina fulica</i>) topically Heal Faster Because Calculus Gingivitis than Grade 3 Povidone iodine 10% <i>I G A Ayu Putu Swastini, I Dewa Made Sukrama I Wayan Putu Yasa Sutirta</i>	464
13	The Role of Protein 53 and Protein bax in The Chemoradiation Response of Cervical Squamous Cell Carcinoma Stage III <i>I G A S Mahendra Dewi</i>	472

14	Ethanol Extract of Sweet Purple Potato Tubers (<i>Ipomoea batatas</i> L) Decreases Blood Glucose and Increases Total Antioxidant Level in Rats with High Glucose Intake. <i>I W. P. Sutirta Yasa and I M. Jawi and Agung Nova Mahendra</i>	476
15	Water Extract of Sweet Potato Leaf Improved Lipid Profile and Blood SOD Content of Rats with High Cholesterol Diet <i>I W Sumardika and I Made Jawi</i>	481
16	Detection of Extended-Spectrum Betalactamase (ESBL) Phenotype from <i>Escherichia coli</i> and <i>Klebsiella</i> spp Isolates Resistance Cephalosporin at Sanglah Hospital Denpasar <i>Ni Made Adi Tarini, I Dewa Made Sukrama, Ketut Sukardika, I Made Agus Hendrayana</i>	486
17	Blood Levels of Interleukin-6 and Tumor Necrosis Factor-Alpha of Pre-term Newborns <i>Trisna Windiani IGA</i>	489
18	Pattern of Influenza Virus in Denpasar During Influenza-like Illness Survey in 2009-2011 <i>Dwija, IBN.Putra, Budayanti Sri, Handayani Komang, Hidayati Wahyu, Astuti Ketut Nanik, Sukrama IDM, Darwinata AE, Agus Somia, Susila Utama, Tuti Parwati, Inayanti Bisma, Putri Tjatera</i>	492
19	The Different of Abate 1G® Killing Ability With Supporting Substance and Without Supporting Substance To <i>Aedes aegypti</i> Mosquito Larvae <i>Dwi Sutiningsih, Leni Febriyanti</i>	497
20	The Extract of <i>Morinda Citrifolia</i> L Fruit Lower Blood Pressure of Male White Wistar Rat (<i>Rattus Norvegicus</i>) with Hypertension <i>Gusti Ngurah Bagus Tista</i>	507
21	The effect of Mengkudu Extract in Hampering the growth of <i>Streptococcus Mutans</i> as the Source of Dental Plaque <i>I G A Ayu Dharmawati, I Wayan Putu Sutirta Yasa, I Dewa Made Sukrama</i>	510
22	Residue Of Smoke Mosquito Coil Made Of Leaves Of <i>Legundi</i> (<i>Vitex Trifolia</i> L.) Active Ingredient On The Lungs Of Mice <i>Trismariadhari-Pratiwi K., Putra-Manuaba, I. B., and Suirta, I W</i>	513
23	Effectiveness <i>Centella asiatica</i> Extract The Original Bali to Stimulate Tumor Necrosing Factor Alpha Secretion on Mice Infected by <i>Salmonella typhi</i> <i>Wande I Nyoman</i>	514
24	Comparison of Residue of Smoke Mosquito Coil Active Ingredient from Leaves of <i>Vitex trifolia</i> and Branded Mosquito Coil in Lungs of Mice <i>Ni Wayan Ayu Arini</i>	515
25	Polymorphisms of EXON-1 insl3 Gene is Marker for The Occurrence of Cryptorchidism in Boys <i>Wayan Bikin Suryawan</i>	516

AUTHOR INDEX.....	Telah diperiksa kebenarannya dan sesuai dengan aslinya Declares this translation to correspond to the original	517
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14	Ethanol Extract of Sweet Purple Potato Tubers (<i>Ipomoea batatas</i> L) Decreases Blood Glucose and Increases Total Antioxidant Level in Rats with High Glucose Intake. <i>I W. P. Sutirta Yasa and I M. Jawi and Agung Nova Mahendra</i>	476
15	Water Extract of Sweet Potato Leaf Improved Lipid Profile and Blood SOD Content of Rats with High Cholesterol Diet <i>I W Sumardika and I Made Jawi</i>	481
16	Detection of Extended-Spectrum Betalactamase (ESBL) Phenotype from <i>Escherichia coli</i> and <i>Klebsiella</i> spp Isolates Resistance Cephalosporin at Sanglah Hospital Denpasar <i>Ni Made Adi Tarini, I Dewa Made Sukrama, Ketut Sukardika, I Made Agus Hendrayana</i>	486
17	Blood Levels of Interleukin-6 and Tumor Necrosis Factor-Alpha of Pre-term Newborns <i>Trisna Windiani IGA</i>	489
18	Pattern of Influenza Virus in Denpasar During Influenza-like Illness Survey in 2009-2011 <i>Dwijia, IBN.Putra, Budayanti Sri, Handayani Komang, Hidayati Wahyu, Astuti Ketut Nanik, Sukrama IDM, Darwinata AE, Agus Somia, Susila Utama, Tuti Parwati, Inayanti Bisma, Putri Tjatera</i>	492
19	The Different of Abate 1G® Killing Ability With Supporting Substance and Without Supporting Substance To <i>Aedes aegypti</i> Mosquito Larvae <i>Dwi Sutiningsih, Leni Febriyanti</i>	497
20	The Extract of <i>Morinda Citrifolia</i> L Fruit Lower Blood Pressure of Male White Wistar Rat (<i>Rattus Norvegicus</i>) with Hypertension <i>Gusti Ngurah Bagus Tista</i>	507
21	The effect of Mengkudu Extract in Hampering the growth of <i>Streptococcus Mutans</i> as the Source of Dental Plaque <i>I G A Ayu Dharmawati, I Wayan Putu Sutirta Yasa, I Dewa Made Sukrama</i>	510
22	Residue Of Smoke Mosquito Coil Made Of Leaves Of <i>Legundi</i> (<i>Vitex Trifolia</i> L.) Active Ingredient On The Lungs Of Mice <i>Trismariadhari-Pratiwi K., Putra-Manuaba, I. B., and Suirta, I W</i>	513
23	Effectiveness <i>Centella asiatica</i> Extract The Original Bali to Stimulate Tumor Necrosing Factor Alpha Secretion on Mice Infected by <i>Salmonella typhi</i> <i>Wande I Nyoman</i>	514
24	Comparison of Residue of Smoke Mosquito Coil Active Ingredient from Leaves of <i>Vitex trifolia</i> and Branded Mosquito Coil in Lungs of Mice <i>Ni Wayan Ayu Arini</i>	515
25	Polymorphisms of EXON-1 ins13 Gene is Marker for The Occurrence of Cryptorchidism in Boys <i>Wayan Bikin Suryawan</i>	516
AUTHOR INDEX		517

EFFECT OF AMYLOSE CONTENT AND HEATING TEMPERATURE ON CHARACTERISTICS OF FRESH RICE FLOUR-BASED SPRING ROLL WRAPPERS

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ABSTRACT

The effects of amylose content and heating temperature on characteristics of fresh rice flour-based spring roll wrappers were investigated by using added free amylose of cassava to rice flour. The used rice flour in this research was from variety Mentik (an Indonesian local rice variety). Amylose content of blended rice flour ranged from 25% up to 40%. The fresh rice flour-based spring roll wrappers were made without frying oil on Teflon frying pan at 72°C and 82°C during 4 minutes. After heating, the product was tempered for 30 minutes at 25°C. The product was evaluated for rice starch granules size, moisture content, water activity and elongation at break. Each experiment was conducted by three replications. All of the data were analyzed by analysis of variance (α 5%). Duncan multiple range test (α 5%) was used to determine the significant difference among the treatments. The result showed that free amylose adding to rice flour blends homogenized the swelling of rice starch granules. The increasing of amylose content more than 34% increased water activity. The amylose content from 31 % up to 40% increased the moisture content. Increasing amylose content decreased elongation at break. Calculated amylose content in the range of 25% to 31% at 72 ° C for 4 minutes produced products with relatively high elongation at break of 14.45% -16.84%. Heating temperature at 82 ° C for 4 minutes produced lower elongation at break characteristics which ranged between 10, 16% to 12.02%.

Keywords: amylose content, heating temperature, fresh spring roll, rice flour, characteristics.

INTRODUCTION

Characteristics of fresh rice flour-based spring roll wrapper are affected by several factors, such as natural properties of rice, heating temperature and duration of heating. Gertz (2000) in Jack (2006) described the changes during heating, it is involved mass transfer, heat transfer, removal of heat, internal cooking and several physicochemical reactions. The rate of evaporation and water migration within the product will determine the final characteristics of the food product. If the rate of evaporation and water migration were not optimal, the gummy texture will be produced. There are some parts that bind more hydration water, so that the impression is not mature (under-cooked). Evaporation of water in the layers of material (subsurface water) will also cause heat loss from the surface toward the center of the material. Lanner *et al.* (2001) stated that the heating temperature must be regulated in order to optimize the evolution of water vapor from the constant rate period of moisture loss during heating or frying. Certain degree of gelatinization should be reached in order to get sufficient tensile strength and to prevent cracking due to uneven distribution of water (Wanous, 2004).

Low heating temperature resulted insufficient gelatinization process. The gummy texture due to excessive hydration during inefficient heating process (Lanner *et al.*, 2001). Mechanical properties of formed gel are strongly influenced by time and temperature in addition to tempering conditions. It was also affected by protein and polysaccharide content, pH and the addition of salt (Nunes *et al.*, 2003). Heating temperature has a role in the decomposition of the biopolymer structure into smaller parts which results in increased molecular interactions. Heating temperature is an important factor in the formation of a stable film, in related to the implementation of thermal gelation, denaturation, and precipitation (Li, *et al.*, 2005). Heating temperature has to provide enough energy to denature various proteins of rice varieties, at 73.3 ° C for albumin and 82.2 ° C for glutelin, whereas the temperature is required for protein-starch interaction of rice around 80.5 ° C (Ju *et al.*, 2001). Egg white albumin began to coagulate at 62 ° C and becomes very solid at temperatures higher than 70 ° C (Endre and Monegle, 1987 in Mukprasirt *et al.*, 2000). Increasing heating temperature 70°C to 80°C induced protein denaturation that produce an increase in the number and localization of a stronger bond between the chains of the protein. It will decreased ability of detention stretches that can be observed with elongation decreasing of edible films made from green bean protein (Bourtoom, 2008). Thus the heating temperature will determine the characteristics of food product, which is included spring roll wrapper. Too long heating will result in fracture of the matrix due to shrinkage as

a result of evaporation of water and damage the binding material ability of starch (Anderson and Hodson, 2006). Proper heating temperature will produce a cohesive mass that can be caused by an increasing amount of amylose in a continuous phase of the system and the occurrence of strong interactions between starch granules and the continuous matrix system (Rodriguez-Sandoval *et al.*, 2008). Thus, the temperature and duration of heating determine the characteristics of the product.

Starches with higher amylose content will form stronger gel and will be more difficult to damage. Increasing of amylose content will inhibit the swelling of the granules thus maintained the integrity of the swollen starch granules. The purpose of this study is to investigate the influence of amylose content and heating temperature on the characteristics of fresh rice flour-based spring roll wrappers.

MATERIALS AND METHOD

Materials

Mentik rice from Candi, Nglames, Madiun, obtained from the UD. Eka Jaya rice mill at Surabaya. Rice flour obtained by grinding the rice in dry process (without soaking) and be sifted by a 80 mesh sieve size. Amylose extraction from tapioca used modified method of Takeda *et al.* (1986) and Patindol *et al.* (2003). Leghorn chicken eggs obtained from a local shop in Surabaya.

Methods

The research design was factorial experiment with randomized completely block design. Various factors is the amylose content consists of six levels: 25%; 28%; 31%; 34%; 37% and 40% (w / w); while heating temperature on 72°C and 82 °C. The observed dependent variables are starch granule size, a_w , moisture content and elongation at break. The data were processed by analysis of variance, the difference of among treatments were tested by Duncan Multiple Range Test with $\alpha = 5\%$. Starch granules size was measured by using Olympus DP 20 Digital Camera Microscope. Water activity was measured with a Rotronic hygrometer AW1 Hygro Palm at 85% RH + / - 1% at temperature of 25 °C + / - 2 °C. Moisture content was measured by gravimetric method (AOAC, 2000). Elongation at break was measured by Shimadzu Autograph. The batter has been mixed to be homogeneous by placing the mixture on a Labinc magnetic stirrer hot plate model L-81 with speed of 100 rpm for 2 minutes, then placed on a Teflon material frying pan (diameter 10 cm). Heating was held for 4 minutes. The formulation are listed in Table 1.

Table 1. Formula of Fresh Rice flour-based Spring Roll Wrapper

Ingredients (g)	Amylose Content (%)					
	25	28	31	34	37	40
Rice Flour	3.00	2.85	2.70	2.55	2.40	2.25
Crude amylose of						
85% purity*	0.00	0.15	0.30	0.45	0.60	0.75
White Egg	3.50	3.50	3.50	3.50	3.50	3.50
Water	6.00	6.00	6.00	6.00	6.00	6.00
Tapioca	0.50	0.50	0.50	0.50	0.50	0.50
Total (g)	13.00	13.00	13.00	13.00	13.00	13.00

RESULTS AND DISCUSSION

Rice Starch granules size

Data in Table 2. showed a significant difference in the effects of amylose content and there was interaction between two factors to the size of rice starch granules.

Table 2. Rice Starch Granule Size of Fresh Rice Flour-based Spring Roll Wrappers on Different Levels of Amylose and Heating Temperature

Heating Temperature (° C)	Rice Starch Granule Size (µm ²)*					
	Amylose Content (%)					
	25	28	31	34	37	40
72	1673.14 h	1531.39 f	1476.12 d	1408.92 c	1323.34b	1271.57 a
82	1700.85 i	1609.67 g	1506.48 e	1484.40 de	1415.69 c	1344.85 b

*Values in same column with different letter are significantly different based on DMRT test with $\alpha=5\%$

Starch granules size decreased significantly with increasing amylose content on both heating temperatures. This is caused by increasing levels of amylose starch, the more hydrophilic side of the dough system, resulting in competition between the granules in water absorption and produced restriction of swelling. Swelling restrictions would affect the cohesiveness and elongation (Shih, 1996). It also affected distance between the granules with one another, so at the optimal distance will result cohesive and flexible product with sufficient high elongation characteristics. The data also showed an increase in the size of rice starch granules in the respective levels of amylose starch at 82°C compared to products of heating temperature at 72 ° C. Increased temperature lead to breaking of some bonds between and intra molecular which makes the structure of starch granules are more open and to facilitate the entry of water in the structure of starch granules (Hongsprabhas, 2007).

Water activity (a_w)

Table 3 showed a trend of increasing in a_w as increased levels of amylose. This phenomena could be influenced by amylose alignment molecules which produced free water.

Table 3. A_w of Fresh Rice Flour-based Spring Roll Wrappers on Different Levels of Amylose and Heating Temperature

Heating Temperature (° C)	Amylose Content (%)*					
	25	28	31	34	37	40
72	0.509 a	0.512 ab	0.514 b	0.521 c	0.527 c	0.535 d
82	0.653 h	0.659 i	0.665 j	0.609 g	0.603 f	0.598 e

*Values with different letter are significantly different based on DMRT test with $\alpha=5\%$

This phenomenon is supported by the strong correlation between size of rice starch granules and A_w with a coefficient of determination (R^2) of 0.92 ($Y = 7506.6 X - 11688.05$) as shown on Fig. 1.

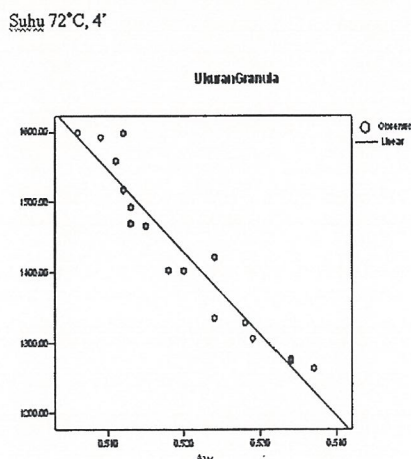


Figure.1 Regression Curve between Starch Granule Size and A_w on 72 ° C Heating Moisture Content
 The average moisture content showed a trend of increasing water content as increasing levels of amylose.



Table 4. Water Content of Fresh Rice Flour-based Spring Roll Wrappers on Different Levels of Amylose Content

Amylose content (%)	Water content (%)*
25 %	34.76 a
28 %	36.49 ab
31 %	38.15 bc
34 %	38.85 bc
37 %	40.35 c
40 %	40.74 c

*Values with different letter are significantly different based on DMRT test with $\alpha=5\%$

This phenomenon is caused by the amount of water trapped in the gel system will increase along with greater levels of amylose in the material system. The data in Table 5 showed an average decline in water levels with an increase in heating temperature from 72 ° C to 82 ° C. This is due to the increase in heating temperature means an increase in the rate of evaporation of free water that produce lower water content.

Table 5. Water Content of Fresh Rice Flour-based Spring Roll Wrappers on Different Heating Temperature

Heating Temperature (° C)	Water content (%)*
72	39.67 b
82	36.74 a

*Values with different letter are significantly different based on DMRT test with $\alpha=5\%$

Elongation

An increasing of amylose content decreased elongation due to longer distance of molecular components as the consequence of more amount of water trapped in gel system (Table 6). The increasing levels of amylose starch provided the more hydrophilic side of the dough system. In this condition, water acted as a plasticizer materials (Chang et al., 2006).

Table 6. Elongation at Break of of Fresh Rice Flour-based Spring Roll Wrappers on Different Levels of Amylose Content and Heating Temperature

Heating Temperature (° C)	Amylose Content (%)*					
	25	28	31	34	37	40
72	16.84f	14.62 e	14.45e	13.68d	11.85 c	10.02a
82	12.02c	11.83c	11.11b	10.97b	10.85b	10.16a

*Values with different letter are significantly different based on DMRT test with $\alpha=5\%$

CONCLUSION

Based on the study of all the response of depended variables, it can be concluded that the treatment of amylose content of rice flour and heating temperature influenced the characteristics of fresh rice flour-based spring roll wrappers. Amylose content in the range of 25% to 40% tend to increase the moisture content of product. Heating temperature at 72°C for 4 minutes with 34% of calculated amylose content

produced best characteristics of fresh rice-based spring rolls wrappers, based on elongation. Heating temperature at 82°C for 4 minutes decreased elongation significantly compared with product at 72°C for 4 minutes. Higher heating temperature could strengthen the chemical bonds among the polymers and affected elongation of product.

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