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PUSAT PENELITIAN KELAPA SAWIT
Indonesian Oil Palm Research Institute

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LIPID PROFILE IMPROVEMENT EFFECT OF UNSAPONIFIABLE FRACTION CONTAINING MULTI COMPONENTS OF BIOACTIVE COMPOUNDS FROM PALM FATTY ACID DISTILLATE

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ABSTRACT: Palm fatty acid distillate (PFAD) is a by-product of palm oil refinery in producing palm frying oil. Unsaponifiable fraction (USF) of PFAD contained vitamin E, phytosterols, and squalene. Vitamin E of USF mainly comprised of tocotrienols and the remaining is tocopherol. Phytosterols of USF contained beta sitosterol, stogmasterol, and campesterol. USF was suggested to improve lipid profile. All of the bioactive compounds in USF were supposed to act as cholesterol lowering agents. Squalene and phytosterols have a role to increase cholesterol excretion into feses. Tocotrienols down-regulate the liver pathway from HMGCo-A reductase in cholesterol biosynthesis.

Keywords: hypercholesterolaemia, lipid profile, palm fatty acid distillate, phytosterol, squalene, tocopherol, tocotrienol, unsaponifiable fraction

1. INTRODUCTION

Physical refining of crude palm oil (CPO) to produce frying oil passes through several steps including degumming, bleaching, and deodorization. In deodorization, palm fatty acid distillate (PFAD) is produced as a by-product of palm oil refinery. The major components of PFAD are free fatty acid, lipid oxidation products, and other compounds such as tocopherols, tocotrienols, phytosterols, and squalene (Gapoor *et al.*, 2002). PFAD utilization currently is limited to oleochemical industries by neglecting the existence of bioactive compounds.

The production of PFAD is 4% based on CPO (Rakmi and Herawan, 2000). It is about 3.66 ton of PFAD is produced from every 100 ton of CPO (Chu *et al.*, 2003). PFAD is usually used as fatty acid source for non food industries (Cheah *et al.*, 2010) such as soap, feed, and oleochemical industries (Nang *et al.*, 2009).

According to Liu *et al.* (2008), as much as 5-57% of tocotrienols and tocopherols lost from CPO during deodorization. Most of tocotrienols and tocopherols are accumulated in PFAD with concentration of 0.7-1.0%. Goh and Gee (1985) indicated that hydrocarbon in PFAD is squalene as major component and n-alcane ($C_{12}H_{26}$-$C_{36}H_{74}$) as minor component. PFAD contains high amount of squalene that reaches 1.03%, and this quantity is higher than that found in other vegetable oil (Posada *et al.*, 2007). PFAD also contains free fatty acids and glycerides 96.1%, and minor bioactive compounds such as tocopherols and tocotrienols (0.48%), phytosterols (0.37%), squalene (0.76%), and other hydrocarbon (0.71%) (Gapoor *et al.*, 2002). PFAD could be used integratively as a source of bioactive compounds and free fatty acids for oleochemical industries (Estiasih *et al.*, 2012).

Bioactive components of PFAD were accumulated in unsaponifiable fraction (USF) (Khatoon *et al.*, 2010). USF could be separated from saponifiable fraction by simple saponification. Two fractions are formed during saponification, unsaponifiable fraction that contains bioactive compounds and saponification fraction that rich in free fatty acids or soap (Estiasih *et al.*, 2012).

USF contained tocopherols 4.05% and tocotrienols 8.04% (Ahmadi and Estiasih, 2009; 2010) and phytosterols (Ahmadi and Estiasih, 2011a). Purification of USF produced vitamin E rich fraction with vitamin E concentration as high as E 33.88% (Ahmadi and Estiasih, 2011b), and phytosterols rich fraction with phytosterols concentration of 17.33% (Ahmadi and Estiasih, 2011a). Our other previous study (Estiasih *et al.*, 2012) showed that USF from PFAD had vitamin E of 0.80%, phytosterols of 9.16%, squalene of 1.14%, meanwhile polycosanol and co-enzyme Q10 were not detected.

Vitamin E of PFAD is different to other source that rich in tocotrienols. The composition of vitamin E in PFAD is α tocopherols (20%), α tocotrienols (22%), γ tocotrienols (46%), and δ tocotrienols (12%). Beside rice bran oil, palm oil is a high source of tocotrienols (Ng *et al.*, 2004; Puah *et al.*, 2007). Tocotrienol is an important compound for pharmaceutical product, foods, and food supplements. Tocotrienols have hypocholesterolaemic, antioxidant, antithrombotic, anti atherogenic, anti inflammation, and immunomodulator properties. Tocotrienols are also known to have the ability to reduce blood LDL cholesterol level (Lewis, 2001). Tocotrienols are able to inhibit HMG Co-A reductase, an enzyme that was responsible to convert HMG into mevalonate in cholesterol biosynthesis. This conversion is a rate-limiting step in the cholesterol biosynthesis, and the primary statin target (Coskun *et al.*, 2013).

Phytosterols of PFAD comprises of campesterol (13%), β sitosterol (60%), stigmasterol (24%), and cholesterol (3%) (Loganathan *et al.*, 2009). Phytosterols lowers blood cholesterol level by inhibiting cholesterol absorption. The required dose of phytosterols to have beneficial effect on health is 2-3 g/day (Tasan *et al.*, 2006). Phytosterols also have the ability to increase breast milk production (Freitsche and Steinhart, 1999), as well as anti inflammation, anti cancer, immunomodulatory (Carr *et al.*, 2010), antithrombotic, and hypocholesterolaemic (Awad and Fink, 2000; Piiron *et al.*, 2000; Ostlund *et al.*, 2002). So far, the mechanism of cholesterol lowering properties of phytosterol is still unclear, but Bonsdorff-Nikander (2005) proposed some theories that phytosterols compete with cholesterol in micelle formation, phytosterols cocrystallize with cholesterols, and phytosterols inhibit ACAT activity in cholesterol synthesis.

Squalene as one of bioactive compounds in PFAD, has anti cancer and cholesterol lowering properties (Loganathan *et al.*, 2009). Squalene has the ability to increase fecal excretion of bile acid that leads to reduce blood cholesterol level (Qureshi *et al.*, 1996; Shin *et al.*, 2004; de Costa *et al.*, 2013). Other study showed that squalene increase cholesterol level (Zesheng *et al.*, 2002), due to incresing extent of cholesterol synthesis (Coskun *et al.*, 2013).

It is possible that bioactive compounds of USF synergistically have beneficial effects on lipid profile improvement.

2. BIOACTIVE COMPOUNDS OF PFAD AND USF

Bioactive compounds found in PFAD are vitamin E, phytosterols, and squalene. Loganathan *et al.* (2009) revealed that palm oil contained vitamin E 600-1.000 ppm, phytosterols 300-620 ppm, carotenoid 500-700 ppm, squalene 250-540 ppm, phospholipids 20-100 ppm, co-enzyme Q10 10-80 ppm, and poliphenol 40-70 ppm. Meanwhile, our previous study (Estiasih *et al.*, 2013) showed that PFAD contained bioactive compound that comprised of α-tocopherol 8.5-134.62 ppm, α-tocotrienol 11.97-51.63 ppm, δ-tocotrienol 4.56-63.65 ppm, γ-tocotrienol 32.18-117.98 ppm, total vitamin E 64.70-280.63 ppm, β-sitosterol 381.55-3,575.55 ppm, stigmasterol 10.99-1548.32 ppm, campesterol 18.96-1,720.30 ppm, total phytosterols 407.00-6011.72 ppm, squalene 205.73-1,273.64, but coenzyme Q10 and polycosanol were not detected.

Distillate deodorizer from various vegetable oils had different composition of bioactive compounds. Ceriani and Mirelles (2004) indicated that soybean oil distillate deodorizer contained tocopherols, and β sitosterol; wheat oil only had tocopherols; meanwhile canola oil contained β sitosterol and tocopherols. Benites *et al.* (2009) also showed that soybean oil distillate deodorizer contained tocopherols. Furthermore, Khatoon *et al.* (2010) showed that phytosterols were also found in soybean oil distillate deodorizer. Bondioli *et al.* (1993) revealed that olive oil distillate deodorizer had squalene. Winkle-Moser and Vaughn (2009) reported that distillate deodorizer of dried grain contained phytosterols, steryl ferulic, tocopherols, tocotrienols, and carotenoid.

Generally, phytosterols were the most prominent bioactive compound found in PFAD from several palm oil refineries in Java, Indonesia (Table 2). Phytosterols also the major component of bioactive compounds in soybean oil distillate deodorizer (Khatoon *et al.*, 2010) and canola oil, meanwhile tocopherols were dominant in wheat oil (Ceriani and Mirelles, 2004), and squalene in olive oil (Bondioli *et al.*, 1993).

Table 1. Bioactive compounds of PFADs from several palm oil refineries

Palm Oil Refinery	Vitamin E (ppm)	Phytosterol (ppm)	Squalene (ppm)	Polycosanol (ppm)	Co-enzyme Q10 (ppm)
1	195.60	7476.56	2373.27	nd	nd
2	64.70	407.00	462.87	nd	nd
3	280.63	6011.72	2767.08	nd	nd
4	200.76	2310.52	1380.16	nd	nd
5	172.47	1956.15	2222.41	nd	nd
6	208.82	3915.22	nd	nd	nd

nd = not detectable
Reference: Estiasih *et al.* (2013)

USF and PFAD had different concentration and bioactive compound composition. Generally, USF had higher bioactive compounds than PFAD (Table 2). According to Khatoon *et al.* (2010), bioactive compounds of PFAD were accumulated in unsaponifiable fraction. Vitamin E increased 245% in USF compared to PFAD, phytosterols decreased 73%, and squalene increased 13611%. The increase of vitamin E and squalene was related to elimination of free fatty acid as the major component of PFAD during saponification. But, the decrease of phytosterols was still unknown. Our previous study (Estiasih *et al.*, 2012) showed that all of the bioactive compounds increased in USF after PFAD saponification, including phytosterols with the concentration in USF was 9.18%.

Our previous study (Estiasih *et al.*, 2012) regarding optimization of saponification conditions showed that USF from optimum condition for minimum free fatty acids content contained vitamin E of 0.80%, phytosterols of 9.18%, and squalene of 1.14%. USF from optimum conditions for maximum yield comprised of 0.47% vitamin E, 7.77% phytosterols, and 16.26% squalene. The multi components of bioactive compounds in USF were expected to synergetically reduce blood cholesterol level in hypercholesterolaemia condition.

The concentration of bioactive compounds in USF was high (800 mg/100 g). For example, daily reference value for vitamin E for 25-51 years is 14 mg vitamin E per day (Nielsen, 2009). Consumption of 1 g USF per day will provide 8 mg that meets the daily requirement of vitamin E or 57% of daily reference value. Other sources of vitamin E are rice bran (90.9 mg/100 g), wheat sprout (153.7 mg/100 g), coconut (1.1 mg/100 g), soybean (7.8 mg/100 g), and olive (11.9 mg/100 g) (Sheppard *et al.*, 1993). Meanwhile, USF contained 1960 mg/100 g.

Phytosterols was the highest concentration of bioactive compounds of PFAD (9,18%). This concentration was high compared to other sources such as crude corn fiber-oil (8.79%), crude corn kernel oil (7.94%), refined corn kernel oil (1.11%), and commercial corn oil (0.74%) (Moreau *et al.*, 2009). The study of Jiang and Wang (2005) showed that a by product of cereal processing (rice bran, wheat bran, wheat sprout, oat bran, and oat hull) contained phytosterols of 9.35 mg/g oil.

Table 2. Bioactive compound of unsaponifiable fraction of PFAD from optimum conditions of saponification

Bioactie Compounds	Concentration	
	ppm	%
Vitamin E	**7,968.04**	**0.80**
• α tocopherol	644.11	0.06
• α tocotrienol	1,860.54	0.19
• δ tocotrienol	4,853.78	0.49
• γ tocotrienol	609.61	0.06
• Total tocotrienol	7,323.93	0.73
Phytosterol	**91,846.30**	**9.18**
• Beta sitosterol	81,932.59	8.19
• Campesterol	61.87	0.01
• Stigmasterol	9,851.83	0.99
Polycosanol	**nd**	**nd**
Squalene	**11,436.66**	**1.14**
Co-enzyme Q10	**nd**	**nd**

nd = not detected

Reference = Estiasih *et al.* (2012)

Sabir *et al.* (2003) found the variability of phytosterols in several vegetable oil such as mustard (64 mg/g), corn (23 mg/g), soybean (9 mg/g), rapeseed (5 mg/g), and coconut (0,8 mg/g). Generally, crude vegetable oil contains 1-5 g/kg phytosterols, but rice bran oil contains phytosterols 30 g/kg (Hoed *et al.*, 2006). In palm oil, phytosterol is a minor component that comprises of campesterol, stigmasterol, and β-sitosterol (Puah *et al.*, 2004).

Squalene was the bioactive compound in USF with concentration of 1.14% or in 1 g of USF would provide 114 mgsqualene. It is estimated that average daily consumption of squalene in food stuff is 28 mg/day (Ahrens and Broucher, 1978). Olive oil contains 200 to 700 mg squalene/100 g (Liu *et al.*, 1976).

3. CHOLESTEROL LOWERING ACTIVITY OF USF

Hypercholesterolaemia condition was achieved by administration the rats with cholesterol. In USF, the bioactive compounds that were supposed to act as cholesterol lowering agents were phytosterols and squalene, although vitamin E also had a role to reduce cholesterol level. Phytosterols have similar action to cholesterol by micelle formation before being carried by enterocytes. The absorption of phytosterols was inhibited by efflux transporter activity, and this transporter contained a pair of ATP binding protein that were known as ABCG5 and ABCG8 (Yu *et al*, 2002; Sudhop *et al*, 2005). ABCG5 and ABCG8 formed a transporter that secreted phytosterols and unesterified cholesterol from enterocytes to digestive lumen (Sudhop *et al*, 2005).

Squalene was the major bioactive compound in USF. Squalene from food was absorbed and converted into cholesterol, and the increase in cholesterol synthesis was not related to the increase of blood cholesterol level but increase the cholesterol in the feces (Standberg, 1990). Squalene was also reported to increase pravastin absorption and combination of pravastin and squalene was effective to reduce cholesterol (Chan *et al.*, 1996).

Squalene has a role to increase cholesterol excretion into feses (Strandberg *et al.*, 1990). Some studies shows different effect of squalene on lipid profile. The study of Zesheng *et al.* (2002) showed that squalene is hypercholesterolemic at least in hamsters. Meanwhile Shin *et al.* (2004) showed the hypolipidaemic effects of amaranth squalen (AS) that were evident in both serum and liver. AS markedly increased faecal excretions of cholesterol and bile acid, and slightly inhibited 3-hydroxy-3-methylglutaryl coenzyme A (HMG-CoA) reductase activity. That preliminary study suggested that the cholesterol-lowering effect of AS may be mediated by increased faecal elimination of steroids through interference with cholesterol absorption, and that different sources of squalene (plant versus animal) may affect cholesterol metabolism differently. Cholesterol-lowering effect of amaranth is associated, at least in part, with its squalene content. The effect of squalene may be attributed to enhanced excretion of faecal steroids through interference of cholesterol absorption.

Previously, the study of Qureshi *et al.* (1996) showed that all amaranth varieties contain tocotrienols and squalene compounds which are known to affect cholesterol biosynthesis. Serum total cholesterol and LDL-cholesterol were lowered 10-30% and 7-70%, respectively, in birds fed amaranth-containing diets. HDL-cholesterol was not affected by amaranth supplementation. Activities of liver cholesterol 7 alpha-hydroxylase (the enzyme responsible for cholesterol breakdown into bile acids) were 10-18% higher than those of controls for birds fed most forms of amaranth and its oil, whereas activities of liver 3-hydroxy-3-methylglutaryl coenzyme A reductase (the rate-limiting enzyme for cholesterol biosynthesis) were lowered by about only 9% by popped, milled amaranth and its oil. This lack of marked inhibition of this enzyme suggests the presence of some other potent cholesterol inhibitor(s) apart from tocotrienols and squalene in amaranth. Also, the study of de Castro *et al.* (2013) showed that amaranth oil, and its component squalene, increased the excretion of bile acids but did not have a hypocholesterolemic effect in hamsters fed on a diet containing high amounts of saturated fat and cholesterol.

Other bioactive compound in USF was vitamin E. Tocotrienols down-regulate the liver pathway from HMGCo-A reductase. The advantage of tocotrienols over statin that tocotrienols do not block coenzyme Q10 pathway as statin does. Therefore, tocotrienols dial down cholesterol production without side effects. Gamma and delta tocotrienols subtly affect the genes that program HMG reductase. Delta tocotrienol also uniquely down-regulate SREBP (sterol regulatory element binding protein), cell membrane factor that naturally regulate other genes linked to low density lipoprotein (LDL). This effect also may down-regulate harmful triglyceride synthesis. Other than delta tocotrienols, none of seven vitamin Es substantially regulates SREBP (Kidd, 2009).

4. CONCLUSIONS

USF from PFAD obtained by saponification contained vitamin E, phytosterols, and squalene. Multi component of bioactive compounds in USF suggested synergistically to improve blood lipid profile in hipercholesterolaemia condition.

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TENTATIVE CONFERENCE PROGRAM IOPC 2014

Bali Nusa Dua Convention Center
17 – 19 June 2014

CONFERENCE PROGRAM DAY 1, 17 June 2014	
Time	**TITLE**
07.00- noon	**REGISTRATION**
09.00 – 09.30	**Arrival of Minister of Research and Technology of Republic of Indonesia** **Opening Dance** **(Plenary Hall)**
09.30 – 09.45	**Welcome Remark by Director of IOPRI**
09:45 – 10.15	**Official Opening by Minister of Research and Technology of Republic of Indonesia**
10:15 – 10:45	**COFFEE BREAK/ EXHIBITION/POSTER**
10.45 – 11.15	**Keynote Speech By Minister of Agriculture of Republic of Indonesia**
11.15 – 12.45	**PL 1: Global Development of Oil Palm Industry** - Challenges and Oppurtunities of Oil Palm Industry in Africa, *Thompson Ayodele, Initiative for Public Policy Analysis, Lagos, Nigeria* - Current Trends and Outlook for The Oil Palm Agribusiness in Latin America, *Boris Hemandez, National Federation of Oil Palm Growers of Colombia (FEDEPALMA), Colombia* Discussion Chairman :Didiek Hadjar Goenadi
12.45 – 14.00	**LUNCH**
14.00 – 15.30	**PL 2: Food Security and Renewable Energy** - Palm Oil Feeds the World, *Xuebing Xu, Wilmar Global R&D Centre, China* - Indonesian Palm Oil Industry in Supporting Food and Energy Security, *Witjaksana Darmosarkoro, IOPRI, Indonesia* Discussion Chairman : Derom Bangun
15.30 – 17.00	**PL 3: Green Palm Oil for Prosperity** - Toward Green Agriculture: The Case of Oil Palm Development, *Fitrian Ardiansyah, The Australian National University, Australia* - Establishment of A Wealthy Oil Palm Community Through Sustainable Development in Malaysia with FELDA and FGV, *Mohd. Emir Mavani Abdullah, FELDA Global Ventures Holdings Berhard, Malaysia* Discussion Chairman : Joko Supriyono
17.00	**END DAY 1**

<table>
<tr><th colspan="4">CONFERENCE PROGRAM DAY 2, 18 June 2014</th></tr>
<tr><th>Time</th><th>AGRICULTURE CONFERENCE</th><th>PRODUCT DEVELOPMENT & PROCESS TECHNOLOGY CONFERENCE</th><th>ENVIRONMENT AND SOCIAL ECONOMICS CONFERENCE</th></tr>
<tr><td>08.00 – 09.30</td><td>AGR 1: OIL PALM BREEDING
AGR-1.1. Screening Methodology to Select Oil Palm Planting Material Partially Resistant to Ganoderma boninense, Tristan Durand - Gasselin, PalmElit, France
AGR-1.2. Progress of Elaeis oleifera Breeding in IOPRI Hernawan Yuli Rahmadi, IOPRI, Indonesia
AGR-1.3. Genotype Effect on Oil Palm Tissue Culture Callogenesis and Callus Differentiation, Choo Chin Nee, AAR, Malaysia
Chairman : Cheah Suan Choo</td><td>TEC 1: PALM OIL MILL
TEC-1.1. Advances in Ultrasound for Palm Oil Milling – Its Contribution to Food Security and A Greener Process, Mary Ann Augustine, CSIRO, Australia
TEC-1.2. Increasing Palm Oil Yields By Measuring Oil Recovery Efficiency From The Fields To The Mills, James Cock, IPNI, Malaysia
TEC-1.3. Maximising Hydrolysis of Sugar (Gum/Hemicellulose) that Binds Fruits to Stalk and Cell to Cell; Ensure Greater Detachment of Fruits from Stalk and Very Low Viscosity Pressed Crude that Enhances Separation of Oil During Clarification, Abdul Azis Ariffin,UPM, Malaysia
TEC-1.4. Technological Developments in Palm Processing – The Way Forward, Rajan Skhariya, Mecpro Heavy Engineering Ltd., India
Chairman : K.H. Lee</td><td>ESE 1: PALM OIL BUSINESS
ESE-1.1. Palm Oil at the Crossroads : the Role of Plantation Intelligence to Support Change, Profit, and Sustainability, Simon Cook, IPNI, Malaysia
ESE-1.2. Contribution of MP3EI for Development of Indonesian Palm Oil Industrial Cluster, Iyung Pahan, PT. Energi Hijau Pertiwi, Indonesia
ESE-1.3. Future Sustainable Biodiesel Business Model by Integrating Palm Oil And Sugar Cane Factory: Case Study at PT. Salim Ivomas Pratama, Hernawan Febriansyah, PT Salim Ivomas Pratama, Indonesia
Chairman : Thompson Ayodele</td></tr>
<tr><td>09.30 – 10.30</td><td colspan="3">COFFEE BREAK/ EXHIBITION/POSTER</td></tr>
<tr><td>10.30 – 12.30</td><td>AGR 2: AGRONOMIC PRACTICES
AGR-2.1. Oil Palm Yields And Yield Gaps in West Africa: The Effects of Climate, Soil and Oil Palm Management Practices on Yields in West Africa, Thiemen Rhebergen, IPNI, Kenya
AGR-2.2. Response of Oil Palm to Abiotic and Mechanical Stress, Walter Ajambang, IRAD, Cameroon
AGR-2.3. Oil Palm Plantation in Semi-Arid Area and Its Impact to MicroclimateShanges, Taufiq Caesar Hidayat, IOPRI, Indonesia
AGR-2.4. Application Of Remote Sensing and GIS Based Technology for Oil Palm Thinning, Totok Suswanto, PT AARI, Indonesia
AGR-2.5 Enhancing Oil Palm Productivity on Sandy Soils in Kalimantan through BMPs, Peter Lim, Bumitama Gunajaya Agro, Indonesia
Chairman : Gede Wibawa</td><td>TEC 2. BIOCHEMICAL AND BIOENERGY PROCESSING
TEC-2.1. Palm Bioglycerols Conversions to Value Added Chemicals, Mohamed Kehireddine, U. Malaya, Malaysia
TEC-2.2. Bio-Oil Derived from Indonesian Palm Oil Empty Fruit Bunch using Middle-Scale Slow Pyrolysis, Arif Budiman, UGM, Indonesia
TEC-2.3. Palm-Based Methyl Ester Sulphonates (MES) Synergy in Linear Alkyl Sulphonates (PAS) Application, Zahariah Ismail, Sime Darby, Malaysia
TEC-2.4. Applications Short Path Evaporators In The Oils & Fats and Oleochemical Industry, Reiner Fabricius,Canzler GmbH,Germany
TEC-2.5. Development of Biopro Diesel Fuel: A Novel Super Clean, Environmental Friendly, and Cheaper from Palm Oil Mill Effluent (POME), Ishenny M.N., Gyrus Tech Sdn Bhd, Malaysia
Chairman : Xuebing Xu</td><td>ESE 2: SUSTAINABLE PALM OIL
ESE-2.1. The Indonesian Palm Oil Industry Facing ISPO 2014, Rosediana Suharto, ISPO Comission, Indonesia
ESE-2.2. Motivating Smallholders to Sustainability: PT. Hindoli Experience, Yunita Sidauruk. PT Hindoli, Indonesia
ESE-2.3. Early Replanting Program in Ganoderma-Infected Oil Palm Plantations for Sustainable Oil Palm Industry, Rizki Amalia, IOPRI, Indonesia
ESE-2.4. Directions for Effective Team Play among Scientists, Technologists, Practitioners, Service Providers for a Greener Sustainable Oil Palm Milling, KH Lee, IHMS, Malaysia
TEC-2.5. Sustainable Food Products Based Palm Oil, A. Suwita, PT. SMART, Tbk, Indonesia
Chairman : Boris Hernandez</td></tr>
</table>

Time	AGRICULTURE CONFERENCE	PRODUCT DEVELOPMENT & PROCESS TECHNOLOGY CONFERENCE	ENVIRONMENT AND SOCIAL ECONOMICS CONFERENCE
12.30 – 14.00	**LUNCH**		
14.00 – 15.30	**AGR 3: OIL PALM BIOTECHNOLOGY** **AGR-3.1.** DNA Sequencing Technology: Progress and Application in Oil Palm, *Cheah Suan Choo, ACGT, Malaysia* **AGR-3.2.** Genomic Selection of Oil Palm, *David Cros, CIRAD, France* **AGR-3.3.** Oil Palm Molecular Breeding : Progress in IOPRI, *Sri Wening, IOPRI, Indonesia* Chairman : Tristan Durand - Gasselin	**TEC 3: FOOD PRODUCTS AND TECHNOLOGY** **TEC-3.1.** Small-Scale Production of Palm Kernel Oil Based Tropical Chocolate Products, *Donald Siahaan, IOPRI, Indonesia* **TEC-3.2.** MPOB Modified Fractionation Process for Increased Olein Yield during Dry Fractionation of Palm Oil, *Chong Chiew Let, MPOB, Malaysia* **TEC-3.3.** Food Products from Palm Oil in Japan, *Haruyasu Kida, Fuji Oil, Japan* **TEC-3.4.** Enzymes Enable Improve Profit for Palm Oil Processing, *Hans Christian Holm, Novozymes, Denmark* Chairman : Kalanithi Nesaretnam	**ESE 3: POLICY** **ESE-3.1.** The Impact of Export Tax of Indonesian for Vegetable Oil Sector, *M. Fadhil Hassan, GAPKI, Indonesia* **ESE-3.2.** Important Role of Palm Oil in Food Security : Policy and Regulation, *Derom Bangun, IPOB, Indonesia* **ESE-3.3.** Commodity Model and Policy Impacts in The Case of Indonesian Palm Oil, *Bambang Drajat, PT. RPN, Indonesia* Chairman : Arul Raj
15.30 – 16.00	**COFFEE BREAK/EXHIBITION/POSTER**		
16.00 – 17.30	**AGR 4: FERTILIZER** **AGR-4.1.** Evidence of Co-occurrence of Potassium Location in Oil Palm Tissues Linked with Sugars Reserve at Tree Scale : Preliminary Consequences for Oil Palm K Status Determination, *Emmanuella Lamade, CIRAD, France* **AGR-4.2.** Nutrient Balance Approach to Improve Fertilizer Efficiency in Oil Palm, *Eko Noviandi Ginting, IOPRI, Indonesia* **AGR-4.3.** The Important Role of Trace Elements to Obtain and Maintain The Optimum Yield of Oil Palm in North and South Sumatra, *Tohiruddin L, PT. London Sumatera, Indonesia* Chairman : Peter Lim	**TEC 4: HEALTH AND NUTRITIONAL ASPECTS** **TEC-4.1.** Recent Advancements in The Health Benefits of Palm Phytonutrients, *Kalanithi Nesaretnam, MPOB-Malaysia Embassy, Belgium* **TEC-4.2.** Tocotrienols: Anti-cancer and Immune Modulatory Effects, *Kanga Rani, MPOB, Malaysia* **TEC-4.3.** Lipid Profile Improvement Effect of Unsaponifiable Fraction Containing Multi Component Bioactive Compounds from Palm Fatty Acid Distillate, *Teti Estiasih, UB, Indonesia* **TEC-4.4.** Vitamin A Fortification of Palm Cooking Oil: A Continuing Controversy, *Purwiyatno Hariyadi, SEAFAST Centre, Indonesia* Chairman : Mary Ann Augustine	**ESE 4: SMALLHOLDERS** **ESE-4.1.** Profile of Sumatran Oil Palm Smallholders, *Abdul Razak Purba, IOPRI, Indonesia* **ESE-4.2.** Potential for Enhancing Oil Palm Production in India, *S. Arul Raj, DOPR, India* **ESE-4.3.** Role of The Smallholders in Thailand Oil Palm Supply Chain, *Sutonya Thongkrak, PSU, Thailand* **ESE-4.4.** New Paradigm in Developing Smallholders in Indonesia through Partnership, *Teguh Wahyono, IOPRI, Indonesia* Chairman : Mohd. Emir Mavani Abdullah
17.30	**END DAY 2**		

CONFERENCE DAY 3, 19 June 2014			
08.00 – 10.00	**AGR 5: PESTS AND DISEASES** **AGR-5.1.** Nutritional Characteristics of Ganoderma Susceptible and Ganoderma Tolerant Oil Palm Seedlings, *Fabien F. Tengoua, IRAD,Cameroon* **AGR-5.2.** Management of Ganoderma Isolate for Breeding Programme, *Agus Susanto, IOPRI, Indonesia* **AGR-5.3.** Biology of Lacewing *Leptopharsa gibbicarina* Froeschner (Hemiptera: Tingidae) and Selection of Fungal Entomopathogens to Control Its Populations in Oil Palm Plantations in Colombia, *Alex Enrique Bustillo Pardey, CENIPALMA, Colombia* **AGR-5.4.** Sustainable Biological Control of Rats Using Barn Owls *Tyto alba* in Agricultural Habitat in Malaysia: Fifty Years of Research, *Hafidzi Mohd Noor, UPM, Malaysia* Chairman : Johnny A. Lopez	**TEC 5: PALM BIOMASS** **TEC-5.1.** Green and Valuable Chemicals Based on Palm Oil Mill Solid Waste, *Tjahjono Herawan, IOPRI, Indonesia* **TEC-5.2.** A Case Study on Biorefinery of Oil Palm Empty Fruits Bunch: Microbial Production of Xylitol, *M.T.A.P. Kresnowati, ITB, Indonesia* **TEC-5.3.** Oil Palm Biomass for Cellulose and Its Derivatives, *Wan Hasamudin Wan Hasan, MPOB, Malaysia* **TEC-5.4.** Batch Anaerobic Digestion of Palm Oil Mill Wastes, *Ria Millati, UGM, Indonesia* **TEC-5.5.** Production Process Of Fuel Grade Bioethanol From Lignocellulosic Biomass Of Oil Palm In A Pilot Plant, *Haznan Abimanyu, LIPI, Indonesia* Chairman : Abdul Aziz Arifin	**ESE 5: PALM OIL AND ENVIRONMENT** **ESE-5.1.** Opportunity of Oil Palm-Cattle-Energy Integration, *Edy Sigit Sutarta, IOPRI, Indonesia* **ESE-5.2.** Carbon Emission in Oil Palm Plantations: Case Study from Sumatera, Kalimantan and Sulawesi, *Yudha Asmara Adhi, PT. AAL, Indonesia* **ESE-5.3.** Oil Palm Biomass for Supporting Renewable Energy, *Erwinsyah, IOPRI, Indonesia* **ESE-5.4.** Complete Management of Organic Matter in the Oil Palm Sector – Case Study of Integration Between Biogas Plant and Liquid Organic Fertilization System, *Baptiste Kervyn, Biotec International, Malaysia* **ESE-5.5.** Critical Analysis of The GHG Calculation Methodology for Palm Oil of The European Renewable Energy Directive, *Heinz Stichnothe, Thünen Insitute of Agricultural Technology, Germany* Chairman : Fitrian Ardiansyah
10.00 – 10.30	**COFFEE BREAK/EXHIBITION/POSTER**		
10.30 – 12.00	**AGR 6: BIO-AGENTS** **AGR-6.1.** Status Of *Elaeidobius Kamerunicus* Towards 30 Years In Indonesia, *Agus Eko Prasetyo, IOPRI, Indonesia* **AGR-6.2.** The Occurrence of Poor Fruit Set at Central Kalimantan, Fizrul Indra Lubis, *PT. Citra Borneo, Indonesia* **AGR-6.3.** The Effect of *Bacillus thuringiensis* and Other Insecticides Against The Oil Palm Pollinating Weevil, *Elaeidobius kamerunicus. Johnny A. Lopez, Valent BioSciences Corporation, United States* Chairman : Fabien F. Tengoa	**TEC 6. ENVIRONMENT TECHNOLOGY** **TEC-6.1.** Increase Palm Oil Production Sustainability by Methane Capture and Utilization and Different Palm Oil Residue Processing Techniques, *Kor Zwart, Wageningen UR, Netherland* **TEC-6.2.** Potency of Gas Production from POME and Its Aplication, *M. Anshori Nasution, IOPRI, Indonesia* **TEC-6.3.** Kis Group Zphb™ Technology for Pome Treatment Case Study of 3 Successful Projects In Indonesia, *KR Raghunath, KIS Group, India* **TEC. 6.4.** Production of Polyhydroxyalkanoate from Palm Oil Mill Effluent, *Martha Aznury, Politeknik Negeri Sriwijaya, Indonesia* Chairman : Baptiste Kervyn	**ESE 6. MARKET OPPORTUNITIES** **ESE-6.1.** Biofuel and Biochemical Markets Drive The Palm Oil Industry Globally, *Andrew Soare, Lux Research Inc., Singapore* **ESE-6.2.** The Co-Operative Benefits of Malaysia and Indonesia in Palm Oil, *Mohamed Rizwan Habeeb Rahuman, Bank Negara Malaysia, Malaysia* **ESE-6.3.** The Impact of Regional Trade Agreements to The Commodity Trade Flows (Case Study : International Palm Oil Trade), *Riska Pujiati, Georg August Universität Göttingen, Germany* Chairman : Bambang Drajat
12.00 – 13.00	**LUNCH**		
13.00 – 15.00	**Talk Show: ' Enhancing Biofuel Opportunities to Support Palm Oil Industry'** - Accelerating The Implementations and Usage of Biofuel in Indonesia, *IGN. Wiratmaja Puja, Ministry of ESDM, Indonesia* - Development of Biofuel from Palm Oil in Indonesia, *Paulus Tjakrawan, APROBI, Indonesia* - Business Strategic of Pertamina in Facing Mandatory Biodiesel. *Taryono, Senior Vice President (SVP) Non Fuel, PT. Pertamina, Indonesia* Chairman : Derom Bangun		

15.00 – 15.15	**SUMMING UP**
15.15 – 15.45	CLOSING CEREMONY by Vice Minister of Trade
15.45 – 16.30	DoorPrize
16.30	THE END

International Oil Palm Conference 2014 (IOPC 2014)
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IOPRI

May 20th, 2014

No. : 08/IOPC_2014/PPKS/V/2014
Encl. : 1 sets
Subject: *Letter of Acceptance*

Mrs. Teti Estiasih
Dept. of Food Science and Technology
Agricultural Technology Faculty, Brawijaya University
Jl. Veteran, Malang, Jawa Timur, Indonesia

Dear Mrs. Teti Estiasih,

The organizing committee is pleased to inform you that your abstract entitled "Lipid Profile Improvement Effect of Unsaponifiable Fraction Containing Multi Component Bioactive Compounds from Palm Fatty Acid Distillate" for the 2014 International Oil Palm Conference in Bali, 17-19 June 2014 has been accepted for **oral presentation**. We would like to remind you that due date for full paper is June 1st, 2014. Please send your full paper as soon as possible to:

IOPC Organizing Committee
IOPRI, Jl. Brigjen Katamso No. 51,
Medan-20158 Indonesia
Phone : +62-61 7862477, 7862466
Fax. : +62-61 7862488
Email : rizki.amalia987@yahoo.com or sriwening.sw@gmail.com

so that we can reformat accordingly. Please find enclosed the instructions for the preparation of manuscripts and thank you for your participation.

Should you have any enquires regarding the above matter, please free to contact us. Thank you very much and we are looking forward to seeing you in Bali.

Sincerely yours,

Dr. Agus Susanto
Executive Chairman of Organizing Committee of IOPC 2014