

Calophyllum inophyllum L.

A Potential Plant for Biodiesel



By:
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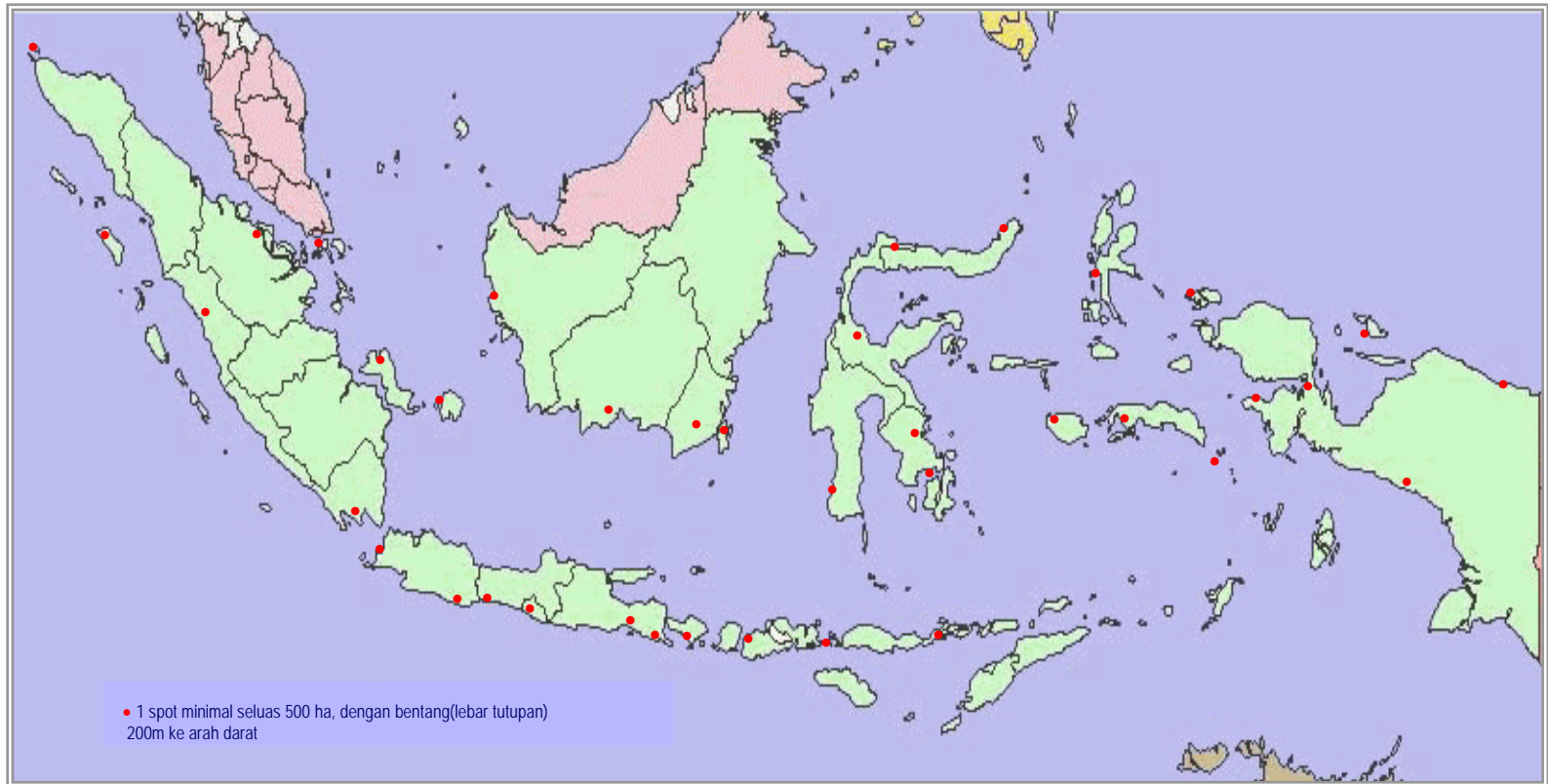
TREE CHARACTERISTICS



DISTRIBUTION AND NATURAL POTENCY

- ◆ In the world : South East Asia, India, Africa, Northern Australia, North Queensland, etc.
- ◆ **In Indonesia** : In almost all seashore, mangrove areas, National Parks : Alas Purwo, Thousand Island, Baluran, Ujung Kulon, Pananjung Pangandaran, Batu Karas, Pantai Carita, Yapen Island, Jayapura, Biak, Nabire, Manokwari, Sorong, Fakfak, Halmahera, Ternate, Berbak
- ◆ Total area of natural stand (indicative) : 480,700.0 ha, actual stand about 50,000.0 ha

INDICATIVE DISTRIBUTION MAP OF *Calophyllum inophyllum* L. NATURAL STAND IN INDONESIA



Source: (1). Forest Thematic Base Map
(2). Land cover map based on Landsat7 ETM⁺ (2003)

NYAMPLUNG ACREAGE DISTRIBUTION

	outside forest	inside forest
• 1. Sumatra	6,800	7,400
• 2. Jawa	14,200	2,200
• 3. Bali & NT	13,500	15,700
• 4. Kalimantan	21,700	10,100
• 5. Sulawesi	5,600	3,100
• 6. Maluku	21,100	8,400
• 7. Papua	14,700	107,800
• Total	78,200	177,100

ADVANTAGES OF *Calophyllum inophyllum* L.

- ✓ High survival potency in nature, still productive until 50 years
- ✓ Lot of seedlings and easy silviculture
- ✓ Does not compete with food crops
- ✓ High multipurpose (seed, wood, gum, processing by products)
- ✓ As windbreaker, soil and seashore conservation

BIODIESEL Advantage

- ✓ High yield
- ✓ Meet the US and European Union biodiesel standards
- ✓ High heating value
- ✓ Compatible with diesel, better lubrication capability, more environmentally sound

Seed source

(identified seed stand)



Sagara Anakan



NC Alas Purwo
(E.Java)



Fresh fruit, dried fruit, seed before and after peeling

Generative Propagation

Seedling



Seed



Age: 6 months



Natural plant



Seedling from seed and from natural plant for nursery

Vegetative Propagation



Stump



Tissue culture



Seedling from vegetative propagation



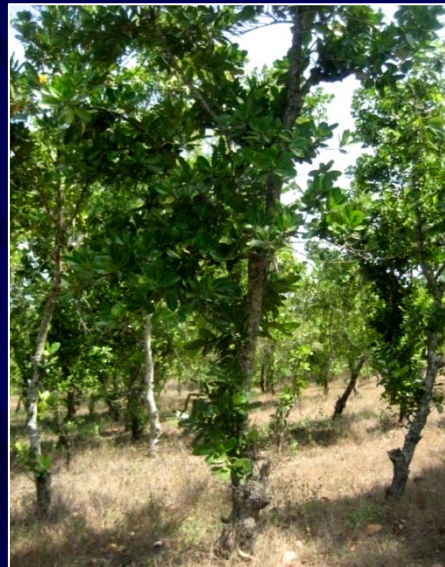
Age : 6 months



Age : 1 year



Age : 10 years



Age : 28 years



Age : 58 years

Calophyllum inophyllum from various age

Research History

The Puslitbang Hasil Hutan (Centre for Forest Products Research and development) has been conducted research on manufacturing biodiesel from Nyamplung intensively since 2005, and now (2008) it has been accomplished as referred to the results have been achieved :

- Biodiesel from nyamplung has been tested for its physico-chemical characteristics by Puslitbang Minyak dan Gas Bumi (2008) and all 17 characteristics has met the Indonesian Biodiesel Standard (SNI) No: 04 –7182–2006.
- Nyamplung biodiesel has been road rally-test three times giving totally 320 km distance. All road test obtained in succesfull results, no trouble at alll during and after road-test.

Socialisation of Results

- Publishing book entitled: Nyamplung sumber energi biofuel yang potensial.(Nyamplung a potential biofuel energy). This book has been free of charged disseminated in some seminars.
- Presentation in “Nasional Seminar of Nyamplung”, held in Jakarta (Manggala Wanabhakti), 23 Septembere 2008 (Prof. Sudradjat)
- Presentation in “Wood-base bioenergy in Asia Pacific Woprkshop”, held in Jakarta (Meridien Hotel), 14 – 17 October 2008 (Prof. Sudradjat)
- Presentation in “ Discussion on biofuel policy in Asia Workshop” , 24 – 27 September in Beijing China (Prof. Sudradjat)
- Presentation in “Temu Nasional Desa Mandiri Energi Workshop”, 11 – 13 Nopember 2008 in Sanur, Bali (Prof.Sudradjat)
- Presentation in “Bilateral meeting FORDA – FRIM (Malaysia)”, 18 December 2008 (Prof. Sudradjat).
- Road tests three times: a) 7 Nopember 2008, Bogor – Jakarta (bf) using Jeep with 100% biodiesel (B-100), b) 28 Nopember 2008, Bogor-Jakarta (bf) using 2 jeeps with B-100, c) 23 Desember 2008, Jakarta – Bogor – Banten (bf), using bus with B-100

Superiority of Seed and Other Products

- High dry-seed productivity: 10 ton (5 x 10 m plants distance), and 20 ton for 5 x 5 m. High oil content of 60 - 65% total capacity, and 40 – 45% oil extracted
- Besides oil, wood has been long time commercial marketing for people manufacturing boat as wood has high resistancy to marine borer.
- Many commercial by pruducts achieved from processings such as: activated carbon, fruit briquette, glycerol, stearin
- Unsaponified oil (coumarine) as other processing byproducts can be sold for HIV/Aids medicine

PROCESSING

- Seed extraction from its shell
- Seeds steaming for 2 hours
- Degumming using concentration of 1% phosphoric acid
- Processing of nyamplung biodiesel takes 3 more specific steps:
 - Esterification, using methanol, 1% HCl as catalyst. It takes 1 hour for this process
 - Transesterification, using methanol, 1% NaOH as catalyst. It takes 1 hour for this process.
 - If the acid number of the oil resulted is higher than the limit ($> 0,8$), it will take neutralization process, based on the free fatty acid (FFA) content.

BIODIESEL QUALITY

The quality of nyamplung biodiesel has met the requirements of Indonesian National Standard (SNI 04-7182-2006) for all parameters, including density, viscosity, fog point, carbon residue and acid number.

Contact for Technology Processing :

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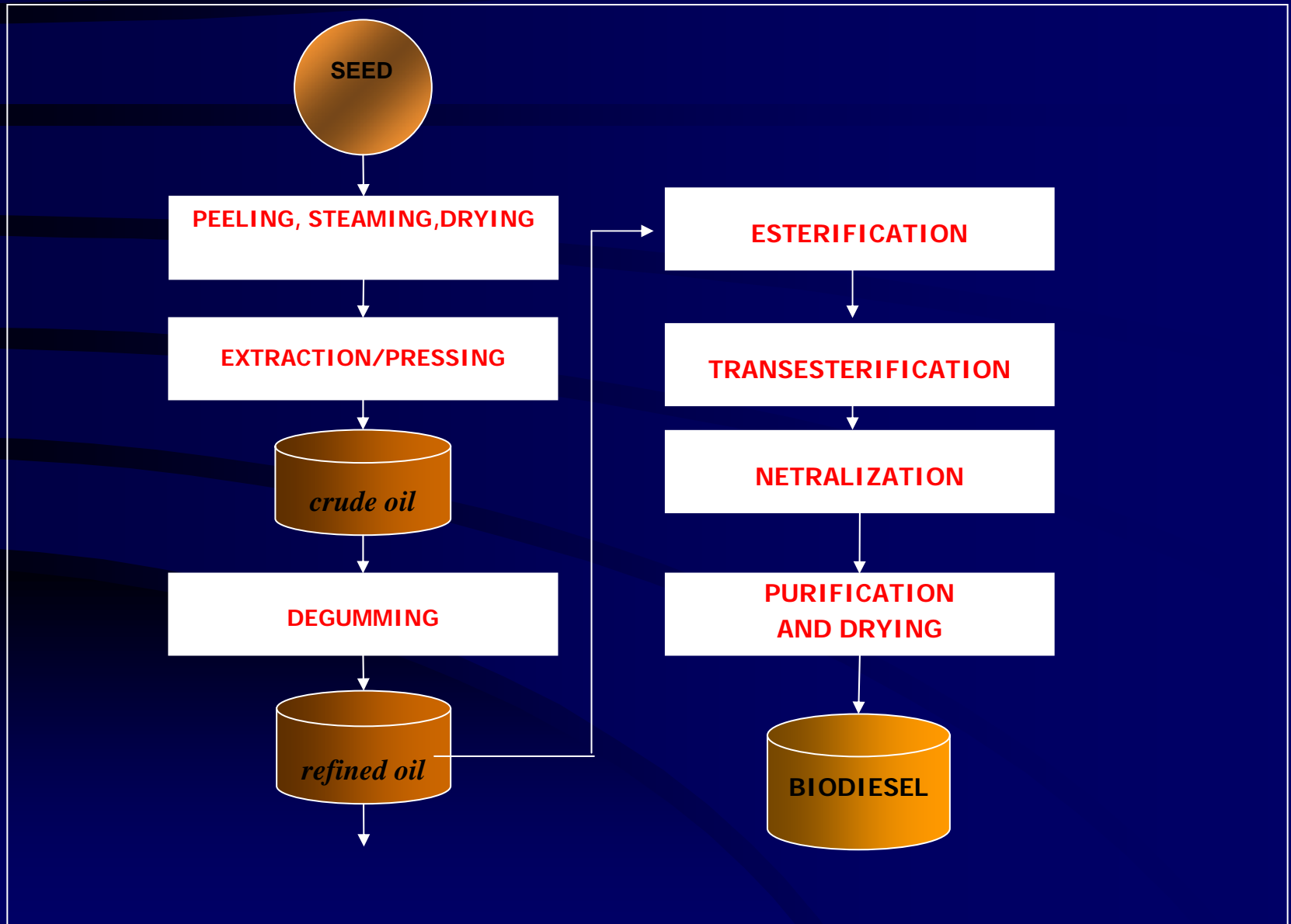
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FLOW CHART OF PRODUCTION PROCESS



PRODUCTS



The best and efficient transesterification process : 60 °C, time 30 minutes, stirring speed 400 rpm, catalyst NaOH 1% from oil, mol methanol ratio 6:1 from oil

Sifat Fisiko Kimia Biodiesel Nyamplung Dibandingkan dengan Standar SNI 04-7182-2006

No.	Parameter	Satuan	Metode Uji	Nilai	Biodiesel Nyamplung
					g
1.	Massa jenis pada 40 °C	kg/m ³	ASTM D1298	850-890	880,6
2.	Viskositas kinematik pada 40 °C	mm ² /s(cSt)	ASTM D445	2,3-6,0	5,724
3.	Bilangan setana	-	ASTM D613	Min. 51	71,9
4.	Titik nyala (mangkok tertutup)	°C	ASTM D93	Min. 100	151
5.	Titik kabut	°C	ASTM D2500	Maks. 18	38
6.	Korosi kepingan tembaga (3 jam pada 50 °C)	-	ASTM D130	Maks.no 3	1 b
7.	Residu karbon dalam : - Contoh asli - 10% ampas distilasi	% massa	ASTM D4530	Maks.0,05 Maks.0,30	0,04
8.	Air dan sedimen	% volume	ASTM D1796	Maks.0,05	0
9.	Suhu distilasi 90%	°C	ASTM D1160	Maks. 360	340
10.	Abu tersulfatkan	% massa	ASTM D874	Maks.0,02	0,026
11.	Belerang	ppm-m (mg/kg)	ASTM D1266	Maks. 100	16
12.	Fosfor	ppm-m (mg/kg)	ASTM D1091	Maks. 10	0,223
13.	Bilangan asam	mg KOH/g	AOCS Cd 3d-63	Maks. 0,8	0,76
14.	Gliserol total	% massa	AOCS Ca 14-56	Maks.0.24	0,222
15.	Kadar ester alkil	% massa	SNI04-7182-2006	Min. 96,5	96,99
16.	Bilangan iodium	% massa (g I ₂)	AOCS	Maks. 115	85

Cooking equipments using biodiesel from *Calophyllum inophyllum* oil and charcoal briquette



Stove



Kompur semawar



Cement-sand furnace

Financial analysis of *Calophyllum* plants

Criteria	Unit	Monoculture	Taungya
NPV	Rp'000/ha	19.927	22.510
IRR	%	30,53	32,95
Development cost	Rp'000/ha	11.522	11.522
Payback period	Year	9	9
Net B/C	-	2.70	2,92
<i>BEP</i> seed production	Kg/tree/year	18,54	14,46

Financial analysis of biodiesel industry

Criteria	Unit	Value
NPV	Rp	326.707.843,5
IRR	%	31,19
Payback period	Year	6
Net B/C	-	2,4
<i>BEP</i> biodiesel	Kg	69 .816,6
<i>BEP</i> glycerol	Kg	14.012,7

PROSPECTS OF BIODIESEL DEVELOPMENT

- ❑ **Plant and Seed** –are quite abundant (natural stands)
- ❑ **Land** - for plantations are available throughtout the country
- ❑ **Silviculture** – easy, applies the general technique of forest plant silviculture
- ❑ **Processing**, has been succesfully solved and applied for road tests
- ❑ **Economic feasibility** - B/C ratio calculation from *Calophyllum* oil processing (2.4) and IRR (31,2%) showed that this business is reasonable to be implemented
- ❑ **Employment resource utility** – *Calophyllum* process industry along with the use of industrial waste and their byproducts can absorp many local labor
- ❑ **Multiple effects** – *Calophyllum* trees serve as windbreaker at the seashore where it can reduce abrasion, protect crops and provide ecotourism



Press Machine and Estrans Reactor



First and second road test rally using Daihatsu Jeep and Mitsubishi Strada filled in with 100% biodiesel (B100), Bogor- Jakarta (bf)



Third road test rally using bus filled in 100% biodiesel (B 100), Bogor-Banten (bf)



LITERATURES

- Anonim. 2008. Nyamplung sumber energi biofuel yang potensial. Departemen Kehutanan. Jakarta.
- ESDM.2006. Blueprint pengelolaan energi nasional 2006 – 2025. Sesuai Peraturan Presiden nomor 5 tahun 2006.Jakarta.
- Heriansyah,I.2005. Potensi pengembangan energi dari biomassa hutan di Indonesia. INOVASI online.Ed.Vol.3?XVII/Maret 2005.Website: <http://io.ppi.jepang.org> Email:redaksi ppi-jepang.org.
- Heyne.1997. Tumbuhan Indonesia berguna. Badan Litbang Kehutanan. Departemen Kehutanan.
- Sudradjat.2006. Laporan penelitian pembuatan biodiesel dari biji nyamplung. Laporan Hasil Penelitian P3HH. Tidak diterbitkan
- Sulaeman,A.G.(2008). Jenis-jenis tanaman biofuel dan karakteristiknya. Calophyllum elatum<http://macjclin.tmip-unpad>.



THANK YOU