

Tree Species Diversity of Kerinci-Seblat National Park and Its Potentials for Natural Substances-Based Medicines

Agus Susatya
Department of Forestry UNIB, Bengkulu

Abstract

Indonesia has long been known as a country with enormous species diversity, which can be sustainably explored its various functions. Unfortunately such a natural treasury has been neglected, even though it contains many natural substances for medical uses that can generate significant economical advantages and increase human welfare. Plants generally develop defense mechanisms against herbivores and pathogens through both mechanical structures and biochemical substances. The latter can be explored for their pharmaceutical uses. The objective of the study is to conduct a preliminary assessment on the potential of Kerinci-Seblat as a source for natural substances for medical uses. A plot of 1 ha was established and all trees with > 5 cm were measured, and collected their herbarium specimens, then identified. Their pharmaceutical potentials were determined through various literature reviews. The results show 27, 147, and 11 tree species respectively potentially contain Benzyl-isoquinoline (BI), Ellagic acid dan proanthocyanins (EL&P), dan Iridoid (Ir). These substances can be used to fight heart-related disorder, diabetics, and to develop natural-based drugs for antioxidants, antiviral, and anti depressants. Natural substances within sixteen families and 60 species can be further developed into anti cancer drugs, while 13 families and 30 species contain potentially substances that can be used to fight HIV.

I. Introduction

Indonesia has long been recognized as one of megadiversity area and therefore can serve as many both tangible and intangible services. However, many people have narrow views on defining this enormous natural resources. They treat forest resource as a source of both timbers and land that can be later converted to other purposes such as plantation, agricultural area, and housing. These financial-driven purposes eventually conceal the intangible values which may serve to maintain life supporting systems, and have much higher values. The perception that heavily emphasizes only on tangible services indeed causes very cheap valuations on the environmental services, which further accelerates the deforestation and conversion of forest to the other purposes.

Non-timber aspects are growing to be more important in the near future. One of them is natural substances that can be extracted from forest vegetation. The use of plants for pharmaceutical purpose has been known to significantly influence the human health. The role of plants in the human health is even much greater in the developing countries, where the accesses to health system seems to be a main constraint. In general, the various parts of plants are being widely used by local people in many developing countries for preventing and curing various diseases, and maintaining health status. On the other hand, natural substances from various plants have been further explored to find new drugs to cure many diseases in the developed countries. Batubara et al (2009) stated that many plant species in the nature have many potential for pharmaceutical purposes. Data released by US National Cancer Institute in 2004 showed that more than 1400 tropical plants have potentials to be further extracted and developed into drugs against cancer. In the tropics, more than 600 plant species have been explored, and yet need to pharmacological tests for further uses.

Due to the difficulty to collect plant specimens, it is only a considerably small number of plant species that is actually explored their drug-related potentials (Wiar 2006).

Plant is a renewable natural resource that has produced primary and secondary compounds. Secondary compounds are parts of defence mechanism for plants to survive and protect them from herbivores and pathogens (Cronquist 1988). They also play important and complex roles both in the plant evolution and the raise of new families, orders, genera, dan species in the flowering plant (Ehrlich and Raven 1964). These secondary compounds are further used by pople for various purposes, especially for medical purposes (Leny 2006). The main objectives of the research are to know tree plant diversity at Tambang Sawah lower lowland forest of Kerinci-Seblat National Park, and to conduct a preliminary assesment its potential for medical purposes.

II. Methods

The research was conducted in Tambang Sawah tropical forest of Kerinci-Seblat National Park. Tambang Sawah site had been briefly selectively logged in early 80's. The research site was situated in the Kerinci-Seblat National Park and nearby a private land planted by mixed coffee crops and durian trees. The site had an altitude of 540 m, and was considered as lower montane forest formation (Susatya 2007). Data collected by Susatya (2007) from 1 ha plot at the site were used for the analysis. All plants with diameter at breast heigh (DBH) more than 5 cm were tagged and measured, and collected their herbarium specimens. Specimens were identified at Herbaria of Universitas Bengkulu (HUB), Universiti Kebangsaan Malaysia (UKMB), and Forest Research Institute of Malaysia (KEP). Species nomenclature was followed IPNI, Turner (1995), Ng (1979), and Whitmore (1972) (Susatya 2007). The potentials of tree species for medical purposes were determined through literature reviews, mainly from Qronquist (1988).

III. Results and discussions

Fourty two families was found in the site, where Euphorbiaceae, Meliaceae, Sapotaceae, Moraceae, and Lauraceae were dominant families. The forest structure itself was assembled by species with Importance Value Index (IVI) less than 10 %. This structure indicated that the forest eventually consists of many species with few individual trees. This could lead to the difficulty in conservation. The research site was assembled by 94 genera and 185 species (Table 1, Susatya, 2007).

Table 1: Family, genus, tree species and its secondary compounds.

No	Family	genus	%	Species	%	Indv.	%	compounds
1	Euphorbiaceae	15	15.98	35	19.02	115	19.90	ELP
2	Lauraceae	8	8.51	12	6.53	24	4.15	ELP
3	Annonaceae	5	5.32	8	4.35	12	2.08	BI
4	Flacourtiaceae	4	4.26	8	4.35	16	2.77	ELP
5	Meliaceae	4	4.26	15	8.15	63	10.90	ELP
6	Rubiaceae	4	4.26	5	2.72	20	3.46	IR
7	Sapindaceae	4	4.26	5	2.72	21	3.63	ELP
8	Theaceae	4	4.26	5	2.72	14	2.42	BI
9	Burseraceae	3	3.19	5	2.72	13	2.25	ELP
10	Moraceae	3	3.19	15	8.15	42	7.27	ELP

11	Myristicaceae	3	3.19	7	3.80	17	2.94	BI
12	Sapotaceae	3	3.19	5	2.72	24	4.15	ELP
13	Sterculiaceae	3	3.19	3	1.63	6	1.04	ELP
14	Anacardiaceae	2	2.13	2	1.07	4	0.69	ELP
15	Fagaceae	2	2.13	4	2.17	9	1.56	ELP
16	Actinidiaceae	1	1.06	1	0.54	3	0.52	BI
17	Apocynaceae	1	1.06	1	0.54	3	0.52	IR
18	Bombacaceae	1	1.06	1	0.54	1	0.17	ELP
19	Celastraceae	1	1.06	1	0.54	3	0.52	ELP
20	Cornaceae	1	1.06	1	0.54	1	0.17	ELP
21	Dilleniaceae	1	1.06	1	0.54	1	0.17	ELP
22	Dipterocarpaceae	1	1.06	2	1.09	4	0.69	BI
23	Ebenaceae	1	1.06	6	3.26	8	1.38	ELP
24	Elaeocarpaceae	1	1.06	3	1.63	9	1.56	ELP
25	Guttiferae	1	1.06	1	0.54	1	0.17	BI
26	Lecythidaceae	1	1.06	1	0.54	6	1.04	ELP
27	Leguminosae	1	1.06	1	0.54	1	0.17	ELP
28	Melastomaceae	1	1.06	1	0.54	5	0.87	ELP
29	Myrtaceae	1	1.06	10	5.43	15	2.60	ELP
30	Oleaceae	1	1.06	2	1.09	3	0.52	IR
31	Poligalaceae	1	1.06	2	1.09	2	0.35	ELP
32	Proteaceae	1	1.06	1	0.54	1	0.17	ELP
33	Rhamnaceae	1	1.06	1	0.54	2	0.35	ELP
34	Rhizophoraceae	1	1.06	1	0.54	1	0.17	ELP
35	Staphyleaceae	1	1.06	1	0.54	4	0.69	ELP
36	Styracaceae	1	1.06	1	0.54	1	0.17	ELP
37	Symplocaceae	1	1.06	2	1.09	5	0.87	ELP
38	Tiliaceae	1	1.06	2	1.09	15	2.60	ELP
39	Ulmaceae	1	1.06	1	0.54	3	0.52	ELP
40	Urticaceae	1	1.06	1	0.54	31	5.36	ELP
41	Verbenaceae	1	1.06	3	1.63	17	2.94	IR
42	Violaceae	1	1.06	1	0.54	32	5.54	ELP
Total		94	100	184	100	578	100	

(Susatya 2007)

BI =Benzyl-iso Benzyl-isoquinoline (BI), Ellagic acid and proanthocyanins (EL&P), and Iridoid (Ir)

Four subclasses of the flowering plants was found in the site, and consisted of Magnoliidae, Dilleniidae, Rosidae, Asteridae, and Hamamelidae. Magnoliidae was characterized by the presence of Benzyl-isoquinoline (Cronquist 1988). Benzyl-Isoquinoline is one of alkaloid compounds that has various potentials to be further developed into anti-cancer, antibiotics, anti depressant drugs, and also for relieving Alzheimer's dan Parkinson's (Wiat 2006). This subclass consisted of Annonaceae, Myristicaceae, and Lauraceae (Table 1). These three families composed 8, 7, dan 12 tree species. Meanwhile, Dilleniadae, Hamamelidae, and Rosidae were characterized by the presence of Ellagic acid and Proanthocyanins (EL&P), which have function as anti oxydant. Proanthocyanin can be extraxted to develop drugs for lowering the risk of the heart attack, lowering the blood pressure, improving blood circulation,

and is also known to have stronger anti oxydant than that of vitamin C (Murphy et al 2003). Within this group, it was found 35 families (83%) consisting of 147 tree species (79%) (Fig. 1 and 2). The last subclass was Asteridae, which was characterized by the abundance of Iridoid. The isolation and purification of this secondary compound can be further developed for making cardiovascular-related drugs, preventing and healing liver damaged by chemical substances (antipheptotoxic), anti tumor and virus, analgesic, and preventing swollen (Didna et al, 2007). This category contains Apocynaceae, Verbenaceae, Oleaceae, dan Rubiaceae with the total of 11 trees. In the family level, there were 3 (7.1%), 35 (83%), and 4 (9.4%) families with the presence of Benzyl-Isoquinoline, Ellagic acid and Proanthocyanins (EL&P), and Iridoid, respectively (Fig 1). Meanwhile in the species level, there were 27 (21%), 147 (79.5%), and 11 (5.4%) of tree species (Fig 2).

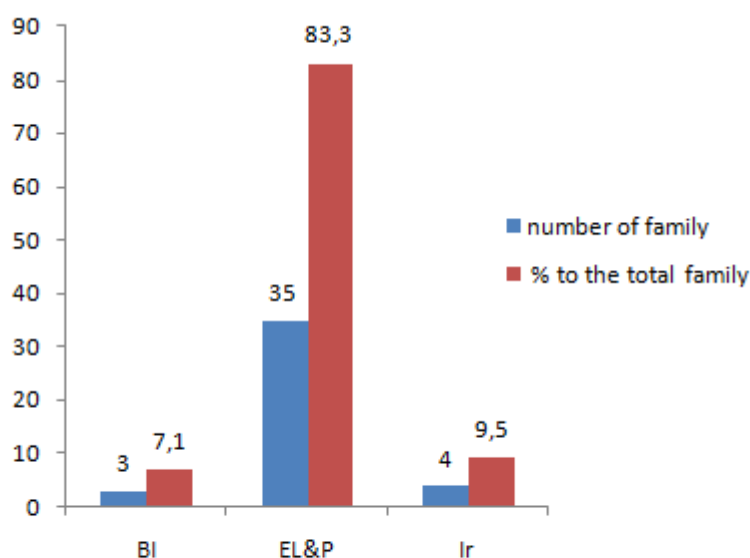


Fig 1: The number of family with the presence of Benzyl-isoquinoline (BI), Ellagic acid and proanthocyanins (EL&P), and Iridoid (Ir).

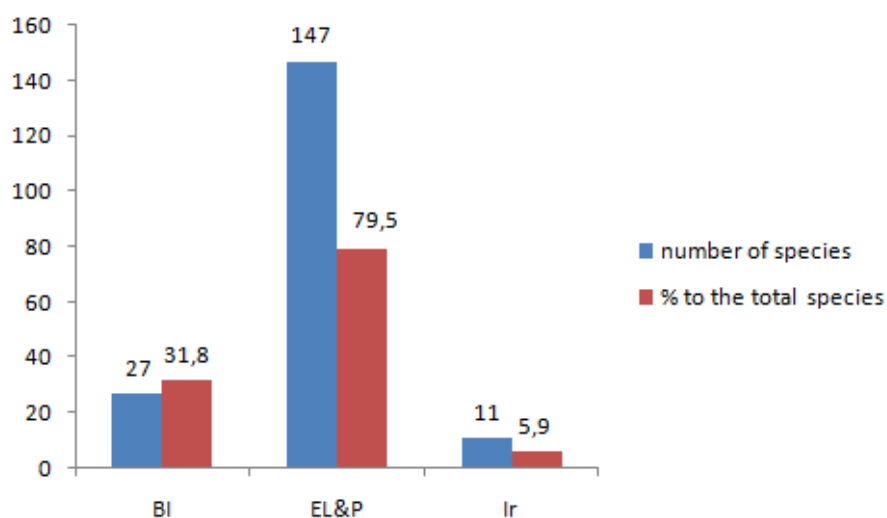


Fig 2: Number of species with the presence of Benzyl-isoquinoline (BI), Ellagic acid and proanthocyanins (EL&P), and Iridoid (Ir)

Detail reviews in the family level showed an interesting result concerning the potency of tree plants to be tapped their substances for anti tumor and cancer. Myristicaceae was known to have indole compound (Wiart, 2006). Indole and its derivatives can be used to fight carcinogens induced by pesticides and other chemical compounds (<http://www.phytochemicals.info/>). Wiart (2006) also showed that phenolic compounds extracted from the bark of *Knema globerata* can inhibit the development of tumor cell. The substances from the member of Myristicaceae can also generate the hallucination effects which can be further used for developing antidepressant drugs, and healing the problem of central neural system (Wiart, 2007). Species of Myristicaceae found in the research site were *Gymnacranthera eugenifolia*, *G. farguhariana*, *G. forbesii*, *G. bancana*, *Horfieldia punctatifolia*, and *Knema glauca* (Susatya, 2007). Another subclass of Magnoliidae was Annonaceae consisting of 8 species distributed in the genus of *Cyathocalyx* (2 species), *Phaeanthus* (2 species), *Polyalthia* (1 species), *Pseuduaria* (1 species), and *Goniothalamus* (2 species). Annonaceae has been known to have substances for anti cancer, anti bacteria, and reducing the risks of high blood pressure (Wiart, 2006).

Saponins can be found in the families of Sapindaceae and Sapotaceae, and can be used to inhibit colon cancer, and controlling cholesterol level (Arnellia 2009). Furthermore, Sapindaceae contains Triterpenoid compound that can be used to reducing the risks of bone cancer or osteosarcoma (Yasumasa et al. 2001). Species of Sapindaceae in the site were found in the genus of *Nephelium* (2 species), *Paranephelium* (1 species), *Pometia* (1 species), and *Ganophyllum* (1 species), while species of Sapotaceae consisted of the genus of *Palaquium* (2 species), and *Madhuca* (2 species).

Various species of Lauraceae were found in the research site and distributed in the genera of *Alseodaphne*, *Beilschmiedia*, *Cryptocarya*, *Endiandra*, *Litsea*, *Neolitsea*, *Persea*, and *Phoebe*. Secondary compounds in this family have characteristics of cytotoxics which can be used to against the development of tumor cells, and also of neuroactives which can help to solve insomnia (Wiart 2006).

Species within Ebenaceae are characterized to have naphthoquinones and saponin. Naphthoquinones will generate black or brown effects on the various parts of plants when exposed to the direct sunlight. Naphthoquinones have capabilities for anti virus (Okuyama 1999, cytotoxins (Kuo et al 1997), anti oxydant (Wiart. 2006), and can be further developed to fight tumor (Kapadia et al. 1997) and leukemia (Maher et. al. 2009). Other uses of the secondary compounds within Ebenaceae were for anti inflammatory, and anti irritation. Furthermore, the saponins can be utilized to fight colon cancer, and to lower the cholesterol level (Arnellia 2009). Species of Ebenaceae found in the research site were *Diospyros apiculata*, *D. buxifolia*, *D. cauliflora*, *D. pendula*, *D. pilosanthera*, and *D. sumatrana* (Susatya 2007).

Flacourtiaceae consisted of 8 species in the genera of *Caesaria*, (3 species), *Hypnocarpus* (2 species), *Osmelia* (1 species), and *Ryparosa* (2 species) (Susatya, 2007). Generally, Flacourtiaceae can be sources of natural substances for anti inflammatory and anti irritation (Wiart, 2006). Different genera in this family have different substances for various purposes. Species of *Caesaria* have cytotoxic substances, anti oxydant, anti bacteria, and anti HIV (Mossadik et al. 2004). Furthermore, the species of *Hypnocarpus* have secondary compounds that can be extracted to produce substances to cure leprosy (Wiart 2006).

Species from Melastomataceae, Rhizophoraceae, Euphorbiaceae, Sapindaceae, Anacardiaceae, and Meliaceae have tannin substances that can be utilized to control high

blood pressure, to cure fever, and to stop diarrhea (Wiart 2006). Species of *Croton* (Euphorbiaceae) can be further developed into anti tumor and HIV drugs (Wiart 2006). Furthermore, species of both Melastomaceae (Wiart 2006) and Rhizophoraceae (Premanathan et al. 1996) have potentials for anti HIV. Species found in the research site were *Croton argyratus*, *C. laevifolius* (Euphorbiaceae), *Ptenandra tessalata* (Melastomaceae), dan *Carallia brachiata* (Rhizophoraceae) (Susatya 2007).

Species of both Apocynaceae and Verbenaceae have various substances that can be utilized for developing for analgesic, anti pyretic, and anti inflammatory drugs. Especially, for the species of Apocynaceae, it has long been investigated their alkaloid substances for fighting cancer (Wiart 2009). One of species of Apocynaceae found in the site, *Wrightia pubescens*, has been examined for developing anti leukemia drug (Kawamoto et al. 2003). Elaeocarpaceae consisting of *Elaeocarpus floribundus*, *E. petiolatus* dan *E. stipularis* was known to have both cucurbitacins which has can be used against cancer and indolizidine alkaloid which can be utilized against HIV and diabetics (Fang et al. 1984). Furthermore, in the family level, it was 16 and 13 families that have potentials for anti cancer and HIV respectively, while inn the species level, it was 60 and 30 tree species respectively (Fig.3).

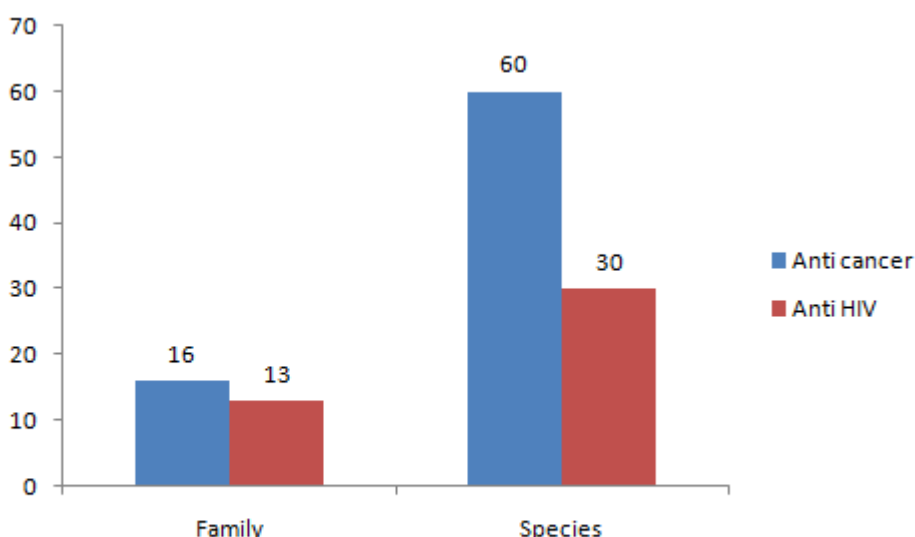


Fig 3: The number of family and species with anti cancer and HIV potentials

IV. Conclusion

Kerinci-Seblat National Park is known to have high tree species diversity. Within 1 ha plot, it was found 42 families, 94 genera and 185 species. All these tree species have evolved their defence mechanisms against herbivores through out developing various secondary compounds. Based on their secondary compounds, they can be examined their potentials as natural sources for bioactives, and further developed into drugs for againts depression, bacteria, tumor, cancer, oxydant, and for reducing the risk of heart attack, and protecting the liver. Sixteen families and 60 tree species have potentials for anti caner, while 13 families and 30 tree species can be used againts HIV.

Literatures

Arnelia. 2009. Fito-kimia Komponen Ajaib Cegah PJK, DM dan Kanker *Arnelia* .(Puslitbang Gizi Bogor). <http://www.kimianet.lipi.go.id/utama.cgi>

Batubara, I, T. Mitsunaha, H. Ohashi. 2009. Screening antiacne potency of Indonesian medical plants: antibacterial, lipase inhibition, and antioxidant activities. *J. Wood. Sci.* 55:230-235.

Cronquist, A. 1988. The evolution and classification of flowering plants. Second Edition. NYBG. New York.

Didna, B., Debnath, S., Harigaya, Y. 2007. Naturally occurring iridoids. A. Review Part 1. *Chem. Pharm. Bull* 55:159-222.).

Ehrlich, P. R., and P.H. Raven. 1965. Butterflies and plant. A study in co-evolution. *Evolution* 18:586-608.

Fang, X., Phoebe, Jr. C.H. Pezzuto. J. M., Fong. H. Farnsworth, N. R., Yellin, B., and Hech. S.M. 1984. Plant anticancer agents. XXXIV. Cucurbitacins from *Elaeocarpus dolichostylus*. *J. Nat. Prod.* 47:988-933

Ishikawa, T., Nishigaya, K., Uchikoshi, H., and Tsai, I.2004. Isolation of salicin derivatives from *Homallium cochinchinensis* and their antiviral activities. *J, Nat. Prod* 67.659-665

Jaykaran, 2008. Acute toxicity study of an aqueous extract of *Ficus racemosa* Linn bark in albino mice. *The Internet Journal of Toxicology*. ISSN 1559-3145.

Kapadia GJ; Balasubramanian V; Tokuda H; Konoshima T; Takasaki M; Koyama J; Tagahaya K; Nishino H. 1997. Anti-tumor promoting effects of naphthoquinone derivatives on short term Epstein-Barr early antigen activation assay and in mouse skin carcinogenesis. *Cancer Lett*, 1997 Feb, 113:1-2, 47-53.

Kawamoto, S., Koyano, T., Kowithayakorn, T., Fujimoto, H., Okuyama, E., Hayashi, M., Komiyama, K., and Ishibashi, M. 2003. Wrightiamines A and B, two new cytotoxic pregnane alkaloid from *Wrightia javanica*. *Chem. Pharm. Bull.* 52.737-745.

Kuo, Y.H., Chang, C.I., Li, S.Y., Chou. C.J. dan Lee, K.H. 1997. Cytotoxic constituents from the stems of *Diospyros maritima*. *Planta Med.*63.363-372.

Lenny. S. 2006. Senyawa terpenoid dan steroid. Departemen Kimia. FMIPA. USU

Maher, H., Win, T., Shpilberg, O., Shmuel Bittner ³, Yosef Granot ⁵, Itai Levy ¹ and Ilana Nathan. 2009. The anti-leukemic activity of novel synthetic naphthoquinones against acute myeloid leukemia: induction of cell death via the triggering of multiple signaling pathways. *British Journal of Haematology* <http://www3.interscience.wiley.com/journal/122581156/>

Mosaddik, M.A., Banbury, L., Forster, P., Booth, R., dan P.M. Waterman. 2004. Screening of some Australian *Flacourtiaceae* species for *in vitro* antioxidant, cytotoxic, and antimicrobial activity. *Phytomedicine* 11:461-472.

Murphy KJ, Chronopoulos AK, Singh I, *et al.* 2003. "Dietary flavanols and procyanidin oligomers from cocoa (*Theobroma cacao*) inhibit platelet function". Am. J. Clin. Nutr. 77 (6): 1466–73. PMID 12791625. <http://www.ajcn.org/cgi/pmidlookup?view=long&pmid=12791625>.

Okuyama, E., Homma, M., Satoh, M., Fujimoto, H., and Ghazalli, A. 1999. Monoamine oxidase inhibitory naphthoquinone and /or naphthalene dimers from Lemuo hitam (*Diospyros sp.*), a Malaysian herbal medicine. Chem. Pharm. Bull (Tokyo) 47:1473-1485.

Premanathan, M., Nakashima, H., Kathiresan, and Yamamoto. 1996). In vitro anti HIV virus activity of mangrove plant. *Indian. J. Med. Res.*103:278-285

Susatya. A. 2007. Taxonomy and ecology of Rafflesias in Bengkulu, Indonesia. Ph.D's dissertation. Universiti Kebangsaan Malaysia.

Susatya, A. 2009. Valuasi hutan dan model dinamika daya dukung lingkungan desa-desa sekitar Taman Nasional Kerinci-Seblat. Hibah Strategi Nasional 2009

Wiart, C. 2006. Medical plants of Asia and Pacific. Taylor and Francis Group. Boca Raton. FL.

Yasumasa Ito, Pramod Pandey, Michael B. Sporn, Rakesh Datta, Surender Kharbanda, and Donald Kufe. 2001. The Novel Triterpenoid CDDO Induces Apoptosis and Differentiation of Human Osteosarcoma Cells by a Caspase-8 Dependent Mechanism. *Molecular pharmacology*: Vol. 59, Issue 5, 1094-1099