Ethnobotanical Leaflets 12: 231-244. 2008.

Phytochemicals From Genus *Diospyros* (L.) and their Biological Activities

M. Maridass
Animal Health Research Unit
St. Xavier's College (Autonomous)
Palayamkottai – 627 002, Tamil Nadu, India
E-mail:maridass_sxc@hotmail.com, or
orchideyadass@yahoo.com

Issued 11 May 2008

Abstract

Various constituents isolated and characterized from *Diospyros* species are described. These include naphthaquinones, triterpenoids and steroids. Some notable activities reported from the various part of the plant and from the extract and isolated constituents are antibacterial, antifungal, antiprotozoal, antimolluscocidal, anti-inflammatory and cytotoxicity activity.

Introduction

Human beings have been influenced in various ways by plants and their products. Plant parts are used in all branches of medicine such as Allopathy, Homeopathy, Unani and the Ayurvedic system. The genus *Diospyros* L. (Ebenaceae), which is distributed throughout the tropics, is characterized by its ability to produce triterpenes of the lupine series (Mariadel, 1995). The genus *Diospyros* consists of *ca* 240 species, 59 of which are distributed in India (Neeru Jain, 1994), Thailand, Japan, Nigeria, South Africa and Philippines.

In the Philippines the tree *D. blancoi* is commonly found in forest at low altitudes and is planted along the roadsides for shade. In the Philippines, it is called Mabolo Persimmon or Velvet apple. The taxonomic status of this plant is confusing and it has generally been called *D. discolor* Willd. The tree is also used for timber in the Philippines and, according to Burkill 1966, the best hair combs in the Phillipines are made from it. *Diospyros peregrine* Gurka (Syn. *D. embrypteris* Pers; *D. malabarica* Desr.) is reported to possess many medicinal properties. The plant has an astringent action and is particularly used for the treatment of diarrhoea and dysentery. An ether extract of the fruits possesses antibacterial properties, and has also been used for dye making and tanning fishing nets (Anon, 1952; Walt, 1980).

The leaves of the African medicinal plant, *D. leucomelas*, were tested and found to contain the triterpene components betulin, betulinic acid and ursolic acid. They showed anti-inflammatory activity in the carrageenan and serotonin, induced paw edema tests and TPA and EPP ear edema tests in mice (Mariadel *et al.,* 1995).

Another species, *D. morrisian*, known as Shan Hung Shig in the herbal medicine of Taiwan has been claimed to possess antibiotic activity (Wu *et al.,* 1972). The hexane extract of the stem parts of this plant was found to show significant cytotoxicity against *in vitro* tissue culture cells (Xiu-Zhen Yan *et al.,* 1989).

Several *Diospyros* species such as *D. ismailli* Ng, *D. siamang* Bakh., *D. wallichii* Williams, *D. toposoides* and *D. rufa* K & G are reported as being effective for curing skin diseases (Burkill, 1966). The extract of the fresh fruits of *D. mollis* Griff. are widely used in Thailand as an antihelmintic and a readily oxidizable phenolic component (Loder *et al.,* 1957). Identified from *D. usambarensis* root bark were the following components: 7-methljuglone, mamegakinone and isodiospyrin, the latter exhibiting mulluscicidal and antifungal properties (Marston *et al.,* 1984). *D. tricolor* Hiern is used in Nigeria as a chewing stick and in various indigenous formulations for leprosy and dysentery (Heyhauer, 1966; Loder *et al.,* 1957).

The bioactive compounds and biologically active extracts from different *Diospyros* species have been summarized in Table I and Table II. The chemical constituents isolated from different plant parts of *Diospyros* species have been given in the Table III.

Table I. Biological activity of different extracts from *Diospyros* species.

S. No	Plant species	Different extracts	Biological activity	Ref.
1.	*D. tricolor*	Petroleum ether	Antimicrobial	Abike *et al.,* 1994.
2.	*D. Montana*	Ethanol	-	
3.	*D. marrisiana*	Hexane	Cytotoxicity Antibiotic activity	Xiu-Zhen Yan *et al.,* 1989. Wu *et al.,* 1989.
4.	*D. peregrina*	Ethanol	Antiprotozoal Antiviral Hypoglycemic Antibacterial	Kirtikar *et al.,* 1935.

Table II. Biological activity of different compounds from *Diospyros* species.

S. No	Plant species	Different compound	Biological activity	Ref.
1.	*D. leucomelas*	Betulinic acid	Anti-inflammatory	Recio *et al.,* 1995.
		Betuline	Anti-inflammatory	
		Ursolic acid	Anti-inflammatory	
2.	*D. morrisiana*	Isodiospyrin	Cytotoxicity	Xiu-Zhen Yan
		b-amyrin	Cytotoxicity	*et al.,* 1989.
		Olean-12-en-3-one	Cytotoxicity	
		Bi-Naphthoquinone	Cytotoxicity	
3.	*D. tricolor*	Diosquinone	Antibacterial	Alake *et al.,* 1994.

4.	*D. mollis*	Phenolic compound	Anthelmintic	Loder *et al.,* 1957.
5.	*D. usambarensis*	7-methyljuglone	Molluscocidal and antifungal	Marston *et al.,* 1984.
		Mamegakinone	Molluscocidal and antifungal	
		Isodiospyrin	Molluscocidal and antifungal	

Table III. Chemical compounds of *Diospyros* species.

S. No	Plant species / Plant part	Compound	Ref.
1.	*D. peregrine roots*	Dihydroflavonol glycoside	Chauhan *et al.,* 1979.
		5, 7, 3, 5' – Tetra hydroxyl – 3' – methoxy flavone	
		4'–O- a-L–Rharmnopyranoside	
	Leaves	Triterpenes, anthrocyanin	Neeru Jain *et al.,* 1994.
	Fruits	Lup-20 (29)-3n-3a, 27-diol-29	Mishra *et al.,* 1971.
		Lup-20 (29)-3n-3b-diol-29	
		Taraxerone	
		Sitosterol	
		Gallic acid	
		Peregrinol	
	Fruit Pulb	Hexacosane	
		Hexacosanol	
		b-sitosterol	
		Monohydroxy triterpene ketone	
		Betulin	
		b-D-Glycoside of b–sitosterol	
		Gallic acid	
		Betulinic acid	
		Methyl ester acetate, Methylester	

		B-D-Glycoside of b-sitosterol	
2.	*D. mollis* Griff		
	Fruits	Lupeol	Sturm *et al.,* 1971
		a-amyrine	
		b-sitosterol	
		Diospyrol	
		1, 8 dihydroxynapthalene	Yoshihira *et al.,* 1967.
		8-dihydroxy-2-acetyl-3-methyl	
		naphthalene	
3.	*D. Montana*		
	Leaves	Lupeul	Dutta *et al.,* 1972.
		Sitosterol,	
		Stigmasterol,	
		Epi-uvaol,	-
		Betulin,	
		Urs-12-en-3b-28-diol	
		Oleanolic acid	
4.	*D. melanoxlon* Roxb.		
	(Heart wood)	b-sitosterol terpenoid	Sidhu *et al.,* 1968.
		Lupeol	
		Betulin	
		Betulinic acid	
		2-methyl-5-methoxy-1	
		4-naphthaquinone,	
		3-methyl-8-methoxy-1, 9,	
		naphthaquinone,	
		2-methl-3-hydroxy-5-methoxy,	
		and 2-methyl 5, 6	
		Di methoxy-1, 4-napthaquinone.	
	Leaves	b-sitosterol	Sidhu *et al.,* 1968.

		Monohydroxy monocarboxylic acid, Monohydroxy triterpene Bauererys acetate, Ursolic, Betulinic acid, Baurenol, ursolic Diospyric acid, Isobanerenol, Methyl betulinate	
5.	*D. morrisiana* Root Stem	Isodiospyrin	Xiu-Zhen Yan *et al.,* 1989
		Betulinic acid	Yoshihira *et al.,* 1970. Kuroyanagi *et al.,* 1971. Lee *et al.,* 1984.
		Isodiospyrin b-amyrine Olean-12-en-3-one b-amrine acetate	Xiu-Zhen Yan *et al.,* 1989.
6.	*D. ismailli* Ng Fresh wood	Novel napthoquinone Coumarin Ismallin	Jeffreys *et al.,* 1985.
		4-hydroxy-5-methyl coumarins 4-hdroxy-5-methy	Zakaria *et al.,* 1989.
7.	*D. lotus* (L.)	Taraxerol, Isodiospyrin, 7-methyljugulone Betulinic acid	
		Xallobetulin 8, 8’-dihydroxy-6, 61-dimethl binaphtho quinonyl-2,2’	Yoshihira *et al.,* 1970.
8.	*D. tricolor*	Isodiospyrin Diosquinone	

9.	*D. canaculata* De Wild	Napththoquinone Coumarin Ismailin Canaculation	Jeffreys *et al.,* 1985.
10.	*D. mollis*	Tetra hydroxy dimethyl-2, 2' Binaphthyl	Loder *et al.,* 1957.
11.	*D. usambarensis*		
	Root bark	7-methyljuglone, Mamagakinone, Isodiospyrin, Diosindigo A 7-methyluglone Diosindigo B	Marston *et al.,* 1984. Mohammad Rafiulla Khar
	Stem bark	Diosindigo A 7-methyljuglone	*et al.,* 1989.
12.	*D. leucomelas*		
	Leaves	Betulin Betulinic acid Ursolic acid	Maria del Garmen Recio *et al.,* 1975.
13.	*D. chloroxlon* Wood	7-methyljuglone Diospyrin Isodiospyrin Xylospyrin 2-methyl-3, 6-dihdroxy-4, 5 Dimethoxy haphthalenes 2-methyl-3, 4, 5, 6-tetra methoxy-napthalene	Sidhu *et al.,* 1971.

The steam – volatile constituents of *D. blancoi* A.DC has been studied and 24 components of the oil have been identified by RI, IR and MS spectra. The major components of the a–farnesene (Collins *et al.,* 1976).

Chemical constituents of *Diospyros* species

Different classes of compounds have been isolated from different species. They are as follows.

The main components isolated from the *Diospyros* species are triterpenes and their steroids compounds.

Dichloromethane extract of *D. leucomelos* Poir leaves isolated three triterpenes betulin, betulinic acid and ursolic acid were identified by ^{1}H – and ^{13}C-NMR spectra studies (Chopra *et al.,* 1956).

The chemical composition of the root of *D. lotus* (L.) was investigated by Yoshihira *et al.*, 1970, the chloroform extract separated in four napthoquinones, 7-methyljugulone, 150 diospyrin, and quinines besides the three tri-terpenoids, taraxerol, betulinic acid and oxallobetulin.

A new triterpene was isolated from the fruits of *D. peregrina* and its structure elucidated as lup 20(20) – en-3a, 27 diol on the basis of spectral analysis (Jeffreys *et al.,* 1985). Maridass, 1999 analyzed the chemical composition by the fruit oil of *D. malabarica* Desr. by capillary GC and GC/MS studies. More than 35 constituents were isolated of which 29 were identified. The main constituents of trans methyl isoeugenol (31.86%), b-bisabolene (25.91).

Biological activities of *Diospyros* species

Fifty percent of extracts of *D. peregrina* minimum tolerated dose of significant activities of antiprotozoal, antiviral and hypoglycemic activity are reported (Yoshihira *et al.,* 1967).

Antibacterial activity

Active constituent of Diosquinone was isolated from *D. tricolor* inhibited against 11 gram-positive bacteria. Among the gram-positive bacteria active of diosquinone was found to be very active (8.19mm) against *Staph aures* E_3^+etc., except *S. faecalis* and *B. cereus* (Watt *et al.,* 1980).

Anti-inflammatory activity

Betulin, betulic acid and ursolic acid were isolated from *D. leucomelas.* The three triterpenoids compounds have been found to exert pronounced anti-inflammatory activity against different model of experimental inflammation (Misra *et al.,* 1967).

Cytotoxic activity

Two cytotoxic compounds isodiospyrin and b-amyrin and in active triterpene, olean-12-3-one have been isolated from *D. morrisiana* (Collins *et al.,* 1976).

References

1. Anon, 1952. *The Wealth of India,* Raw Materials, CSIR, New Delhi, India. 3, 85.
2. Bhanmik, T., Dey, A.K., Das, P.C., Mukhopadhay, A.K and Chatterjee, A. 1982. *Ind. Chem. Soc.*, 20B, 664.
3. Burkhill, I.H. 1966. *A Dictionary of the Economic products of the Malay Peninsula.* Ministry of Agriculture and Co.op., Kuala Lumpur, Malaysia.
4. Chauhan, J.S and Kumari, G. 1978. *J. Chem. Soc.* 55, 1068.
5. Chauhan, J.S., Sarawat, M and Kumari, G. 1979. *Planta Med.,* 35, 373-375.
6. Chauhan, J.S., Saraswat, M and Kumari, G. 1982. *Ind. J. Chem. Soc.,* B., 21B, 169.
7. Chopra, R.N., Nayar, S.L and Chopra, I.C. 1956. *Glossary of Indian Medicinal Plants,* CSIR, 99.
8. Collins, R.P and Halim, A.F. 1976. *Eco. Bot.,* 30, 713-716.
9. Dhar, M.L., Dhar, M.M., Dhawan, B.N., Mehrotra and Ray, 1968. *Indian J. Exp. Biol.,* 6, 222-247.
10. Dutta, P.K., Dutta, N.L and Chakravarthi, R.N. 1972. *Phytochemistry,* 11, 1180-1181.
11. Heynauer, R. 1966. *Chemotaxonomy of plants,* Birkhauser, Basel. 4, 45.
12. Jeffreys, J.A.D., Zakaria, M.B., Waterman, P.G and Zhong, S.M. 1985. *Tetrahedron Lett.* 24, 1085.
13. Kirtikar, K.R and Basu, B.D. 1935. *Indian Medicinal Plants,* II, 1502.

14. Keay, R.W.J., Onochie, E and Standfield, D.D. 1964. *Nigerian Trees.* 1, 62, FRIN, Ibadan.
15. Kuroanagi, M., Yoshihira, K and Natori, 1971. *Chem. Pharm. Bull.*, 19, 2308.
16. Alake, L.B. 1994. *Planta Med.*, 60, 477.
17. Lee, T.J., Shih, T.S., Liu, Y.M and Chen, F.C. 1984. *Formosan Sci.*, 38, 147.
18. Loder, J.W., Mongolsuk, S., Robertson, A and Whalley, W.B. 1957. *J. Chem. Soc.*, 2233.
19. Mariadel Carmen Recio, Rosa Maria Giner, Manez, S., Gueho, J., Julien, H.R., Hostettmann, K and Rio, S.J.L. 1995. *Planta Med.* 61, 9-12.
20. Maridass, M. 1999. Essential oils of an ethnomedicine *Diospyros malabarica* Fruits, M.Sc Thesis, Sri Paramakalyani Centre for Environmental Sci. Alwarkurichi, India.
21. Marston, A., Msonthi, J.D and Hostettman, K. 1984. *Planta Med.*, 279.
22. Misra, G and Mitra, C.R. 1967. *Phytochemistry,* 6, 1309.
23. Misra, G and Mitra, C.R. 1968. *Phytochemistry*, 7, 501.
24. Misra, P.S., Misra, G., Nigam, S.K and Mitra, C.R. 1971. *Phytochemistry,* 10, 904-905.
25. Khan, M.R., Kishimba, M.A and Harry Locksley, 1989. *Planta Medica.*, 581.
26. Muhamad Bin Zakaria, 1989. *Planta Med.*, 55, 204-205.
27. Neeru Jain and Rajnath Yadav, 1994. *Phytochemistry*, (35)4, 1070-1072.
28. Okogun, J.I., Enenishi, U.V and Ehong, D.E.U. 1978. *Tetrahedron*, 34, 1221.
29. Ramachandra Row, L., Sanakra Rao, C and Sundara Ramaiah, T. 1969. *Indian J. Chem.*, 7, 204-206.
30. Sidhu, G.S and Prasad, 1971. *Indian J. Chem,* 9, 767-769.
31. Sidhu, G.S., Sankaran, A.V.B and Mahmood Ali, S. 1968. *Indian J. Chem.*, 6, 681-691.
32. Sturm, V.G and Zilliken, 1969. *Planta Med.*, 21, 61-66.
33. Sundaramaiah, T., Ramraj, S.K., Rao, K.L and Vimalabai, 1976. *J. Ind. Chem. Soc.*, 53, 638.
34. Watt, G. 1980. *The Dictionary of Economic Products of India,* 3, 141.
35. Wu, S.C., Yang, Y.H., Hsu, K.K and Chen, F.C. 1972. *Technical Bull. Exp. Forest,* NTU (Taipei), 97, 11.
36. Xiu-Zhen Yan, Yao-Haur Kuo, Tsong-Jyh Lee, To-Shii Shih, Chung-Hsiung Ghen, Donald, R., Mephail, Andrew, T., McPhail, Kuo-Hsium Lee and Andrew, 1989. *Phytochemistry*, 28, 5, 1541-1543.
37. Yoshihira, K., Michiko Tezuka and Natori, 1970. *Tetrahedron Letter*, 1, 7-10.
38. Yoshihira, K., Natora, S and Pandia Kanchanapee, 1967. *Tetrahedron Letters*, 48, 4857-4860.
39. Yoshihira, K., Tezuka, M and Natori, S. 1970. *Tetrahedron Letters,* 1, 7.
40. Zakaria, M.B., Jeffreys, J.A.D., Waterman, P.G., Zhong, S.M. 1984. Phytochemistry, 23, 1481.