



A review of phytochemical and biological studies of *Diospyros* species used in folklore medicine of Jharkhand

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Abstract

Diospyros is one of the most important genus of Ebenaceae family. Out of its more than 475 species, about 100 are well explored phytochemically. The medicinal uses and chemical constituents of various *Diospyros* species have been reviewed earlier by Mallavadhani *et.al* in 1998 [1]. The present review has been focused only on 9 species of *Diospyros* which are potent and are being used in folklore medicines of Jharkhand to cure diarrhea, fever and ulcer. This review is an extension of the work of Mallavadhani *et.al* with regards to these 9 species. These days *Diospyros* species are being explored as a cytotoxic agent to cure cancer and AIDS also. Considering these facts an attempt has been made to present a review on phytochemical and biological studies of *Dispyros* species along with their traditional uses.

Keywords: *Diospyros* species, phytochemical studies, biological studies, traditional uses.

1. Introduction

Diospyros is a large genus of trees or shrubs, belonging to family Ebenaceae, which are widely distributed in both the hemispheres. About 41 species are indigenous to India, mostly in evergreen forest of Deccan, Assam and Bengal; a few have been reported in North India [2]. Its bark is bitter, astringent and febrifuge. The unripe fruit is a more powerful astringent [3].

In Indian system of traditional medicines like Ayurveda and Unani, various *Diospyros* species are used medicinally to cure fever, diabetes,

snake bite, diarrhoea, biliousness, ulcer etc[4]. Considering the voluminous work on this genus, present review has been focused only on 9 potent species, which are used in folklore medicine of Jharkhand, with regard to their phytochemical, biological evaluations and traditional uses.

Phytochemical studies

Phytochemically about 100 (out of 475) species of *Diospyros* are well explored among which the potent ones like *D. ebenum*, *D. kaki*,

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D. maritima, *D. melanoxylon*, *D. montana*, *D. peregrina* have been studied extensively.

Research on this genus began with the work of Iwata (1922), who isolated d-manitol in a crystalline form from *D. kaki* fruit [5].

Phytoconstituents of *Diospyros* ranges from hydrocarbons, long chain fatty acids to steroids, terpenoids, naphthoquinones, and naphthalene based aromatics and auronones.

Following Chemical constituents have been reported from different parts of *Diospyros* species [6]:

Fruit:	carotenoids, tannins, sugars, lipids, hydrocarbon, aromatics, flavonoids, terpenoids.
Seed:	sugars, hydrocarbons, lipids, terpenoids.
Leaf:	tannins, flavonoids, terpenoids, steroids.
Bark:	lipids, aromatics, terpenoids, steroids, naphthoquinones.
Root:	sugars, aromatics, flavonoids, naphthoquinones.
Heartwood:	terpenoids, steroids, naphthoquinones.

Table 1 presents the Chemical compounds; isolated so far from selected *Diospyros* species and the structures of pharmacologically active entities are also being presented in Figure 1.

Biological activities

Diospyros species are known for their medicinal uses since olden time. Almost all

the parts of these plants have been used as medicine e.g., the leaves are good for lumbago, fruits are carminative, astringent, cure biliousness and vata in ayurveda, seeds are sedative where as bark is bitter, astringent and febrifuge [6].

In modern medicine, various metabolites of *Diospyros* species like ursolic acid showed potent inhibitory activity against HIV-I protease and β -amyrin, betulin and diospyrin exhibit moderate to potent cytotoxic activity on different carcinoma models [6, 7].

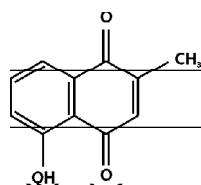
Traditional and folklore medicinal uses of potent *Diospyros* species and *in vivo/vitro* biological screening have been tabulated in table 2.

2. Discussion

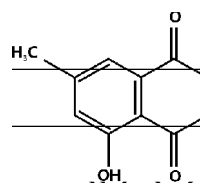
While preparing this review article, authors came across all the phytochemical and biological works, done so far on different species of *Diospyros*. Guided by the fact that only about 100 species have been thoroughly explored, it was found worthwhile to select a potent and virgin plant for further exploration. This is how *D. paniculata* was selected to work upon. Its evaluation would be forwarded to the journal in near future.

3. Acknowledgement

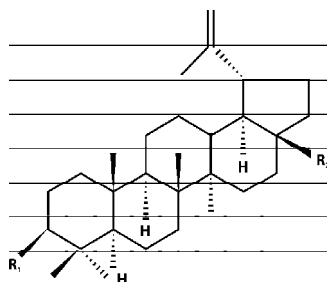
Authors are thankful to the Vice-Chancellor, Birla Institute of Technology, Mesra, Ranchi, for providing infrastructural and other facilities to carry out research. Second author (S.K. Bansal) is grateful to UGC for Junior Research Fellowship.



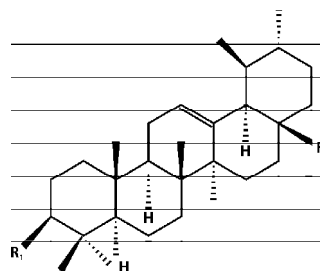
Plumbagin



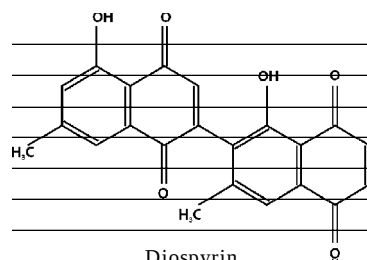
7-Methyljuglone



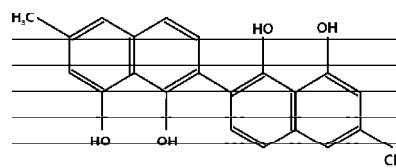
Lupeol $R_1: \beta\text{-OH}; R_2: \text{CH}_3$
 Betulin $R_1: \beta\text{-OH}; R_2: \text{CH}_2\text{OH}$
 Betulinic acid $R_1: \beta\text{-OH}; R_2: \text{COOH}$



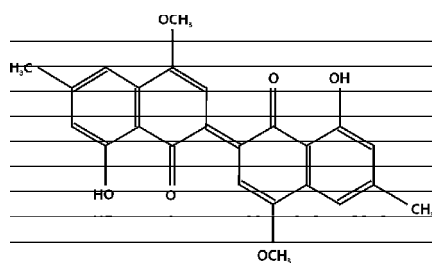
α -Amyrin $R_1: \beta\text{-OH}; R_2: \text{CH}_3$
 Ursolic acid $R_1: \beta\text{-OH}; R_2: \text{COOH}$
 Ursolic acid acetate $R_1: \beta\text{-OCOCH}_3; R_2: \text{COOH}$



Diospyrin



Diospyrol



Disindigo A

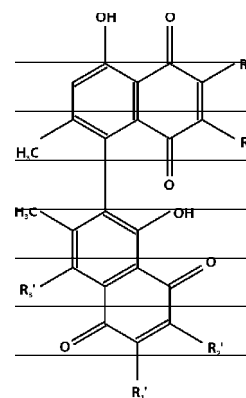
Isodiospyrin $R_1=R_2=R_1'=R_2'=R_3'=H$

Table 1: List of compounds isolated from *Diospyros* species

S.No.	Species	Chemicals Isolated	Ref.
1.	<i>D. chloroxylon</i>	2-methyl-3, 6-dihydroxy-4, 5-dimethoxynaphthalene, Betulin, Betulinic acid, β - Sitosterol, 7-methyljuglone, Diospyrin, Isodiospyrin, Xylorpyrin.	8
2.	<i>D. ebenum</i>	Lupeol, Betulin, Betulinic acid, Ursolic acid, α -amyrin, Bauerenol, β -sitosterol, Stigmasterol, Ebenone Plumbagin, Hexacosanol, 6-hydroxy-4, 5, -dimethoxy-2-naphthaldehyde, 4, 5, 6-trimethoxy-2-naphthalene, 6-hydroxy-4, 5 -dimethoxy-2-naphthoic acid.	9, 10, 11
3.	<i>D. exculcata</i>	Lupeol, Betulin, Betulinic acid.	12
4.	<i>D. kaki</i>	Kakispyrol, Diphenolase, β -amyrin, Uvaol, Ursolic acid, Lupeol Betulin, Betulinic acid, Phenolic metabolite (β -glucopyranoside), Xyloglucan, Oleanolic acid, Taraxerol, β -sitosterol, Campesterol, Plumbagin, β -sitosterolglycoside, 7-methyljuglone, Shinanolone, 3-methoxy-7-methyljuglone, Vitexin, Neodiospyrin, Isodiospyrin, 8-hydroxyisodiospyrin, Mamegakinone Maritinone, Hetroglycan DL-3Bb, Pectic polysaccharide DL-2A, 2'-o-rhamnosyl vitexin, Pheophorbide-A-methylester.	1, 13, 14, 15, 16, 17
5.	<i>D. maritima</i>	6-(1-ethoxy ethyl) plumbagin, etyledene-3, 3'-biplumbagin, Diospyrolidone, Diospylidiethyl malate, Lupeol, Betulin, Betulinic acid, 3-(E)-coumaroylbetulin-28-ylethylsuccinate, Plumbagin, 3-bromoplumbagin Droserone, isoshinanolone, Euptinone, Maritinone, Scopoletin, Chitraneone, Zeylanone.	18, 19, 20
6.	<i>D. melanoxylon</i>	Aurone, Lupeol, Betulin, Betulinic acid, Ursolic acid, α & β -amyrin, Uvavol, Bauerenol, Oleanolic acid, Hentri-acotanol, β -sitosterol, 7-methyljuglone, Dimelquinone, Dihydroxytriterpenic acid, Methoxyderivative of -1, 4-Naphthquinone, Disinidigo A&B, Pentacyclicquinone Biramentaceone, Dimethoxyderivative of 1-naphthol Hentriancontane, 8-hydroxy-octadec-10(Z)-enoic acid Malvalic acid, Bicylicsesquiterpene, Sterculic acid.	21, 22, 23, 24, 25, 26
7.	<i>D. montana</i>	Kaempferol diglucoside, Quercetin, Gallic acid Lupeol, Betulin, Betulinic acid, Allobetulin, Oxybetulin Ursolic acid, Ursolic stearate & palmitate, α -amyrenone Epiuvaol, α -amyrin, Oleanolic acid, β -Sitosterol, Stigmasterol, 7-Methyljuglone, Chromenone acid, Yerrinquinone, Diospyrin, β' -Dihydodiospyrin 8-Hydroxydiospyrin, Cyclodiospyrin, 2'&3'-Chloro-diospyrin, Biramentactone, Isodiospyrin, Mamegakinone.	27, 28, 29, 30, 31
8.	<i>D. peregrina</i>	Peregrinol, Lupeol, Betulinic acid, Betulin, β -Amyrin Marsformosanone, β -Sitosterol, Oleanolic acid Oleanolic acid glycoside, β -Sitosterol glucoside Hexacosanetriacontanol, Nonadecan-7-ol-2-one.	32, 33, 34, 35
9.	<i>D. paniculata</i>	Naphthoquinones.	36

Table 2. Pharmacological screening and Traditional uses

Sl.No.	Species	Traditional uses ^{2,3,6,7}	Extract for screening	Pharmacological activity	Ref
1.	<i>D. chloroxylon</i>	-	50%Ethanol[PER]	Antiviral	1
2.	<i>D. ebenum</i>	Astringent, attenuant & lithontriptic	-	-	-
3.	<i>D. exculpata</i>	As hemostat for cut & wound, Dysentery [bark], biliousness [wood] Ulcer, disease of blood, urinary losses [fruit], scorpion bite [root]	50%Ethanol[PER] Unsaaponified matter [seed]	Showed activity on cardiovascular system Produced fall in blood pressure and increase in respiration.also showed anorexia, CNA depressant and anti-bacterial activities	37
4.	<i>D. kaki</i>	Cough, hiccough, dysponea, antihypertensive	Methanol extract [PER] Flavonoids[Leaves] Acetone fraction [fruit peel] Purified naphthoquinones[stem bark]	Scavenging activity against DPPH (1,1-diphenyl-2-picrylhydrazyl) radicals with an IC(50) value of 0.11mg/ml (1)-Reduce Hydrogen Peroxide induced NG108 -15 cells Potent cytotoxic activity against human oral squamous cellcarcinoma cells (HSC-2) & human submandibular gland tumor (HSG) cells with IC(50) value from 20 to 59microgm/ml	38 39 40 18
5.	<i>D. maritima</i>	-	Amyrin, ursolic acid [leaves]	Exhibit activity against bacteria, fungi, guppy fish & human tumor cells	41
6.	<i>D. melanoxylon</i>	Diuretic, carminative, laxative [bark], urinary discharge, inflammation of spleen [flower], antidiabetic	Unsaaponified matter [seed] 90% Ethanol [bark] Pet ether, benzene, Chloroform [leaves]	Potent antifeedent activity aagainst Spilosoma oblique Spodoptera litura	1 42 43
7.	<i>D. montana</i>	For deliriumin high fever [bark], crack in sole of feet [fruit], abortifacient [root], tuberculosis [gum]	50% Ethanol [bark] Ethyl acetate Extract	Inhibited the growth of Ehrlich ascites carcinoma in mice Antibacterial and effective against mostof the organisms tested extracts were especially active against Bacillus subtilis and Corynebacterium pyrogenes	44 45
8.	<i>D. peregrina</i>	Good for dysentery & intermittent fever [bark], lumbago & blindness [flower], treatment of snake bite [laef], dysentery & diarrhea [seed]	-	Showed activity on human epidermoid carcinoma of nasopharynx in tissue culture and diuretic activity Significantly prevented rats from stress, gastric ulcers and hepatotoxicity. To be reported.	-
9.	<i>D. paniculata</i>	Rheumatism & ulcer [bark]	-		

PER: Part excluding root, Ref: Reference

References

1. Mallavadhani UV, Panda AK, Rao YR. (1998) *Phytochemistry*. 49(4):901-951.
2. Shastri BN. (1952) *The Wealth of India; A Dictionary of Raw Material & Industrial Research*, CSIR:New Delhi; 76-87.
3. Kirtikar KR, Basu BD. (1993) *Indian Medicinal Plants*. 3;1498-1509.
4. Nadkarni KM. (1976) *Indian Materia Medica*. 452-454.
5. Iwata M. (1929) *Bulletin of The Institute of Physical & Chemical Research*. 8:220-222. (1929) *Chemical Abstract*. 23:3520.
6. Yan X-Z, *et al.* (1989) *Phytochemistry*. 28:1541.
7. Topo KK. (1997) *Botanica*. 47:99-101 (1999) *Medicinal & Aromatic Plants abstract*. 27:2793.
8. Shidhu GS, Prasad KK. (1971) *Indian Journal of Chemistry*. 9:767-769.
9. Brown AG, Thomson RH. (1965) *Journal of chemical society*. 4292-4295.
10. Gupta RK, Mahadevan V. (1967) *Indian Journal of Pharmacology*. 29:289.
11. Gupta RK, Mahadevan V. (1968) *Indian Journal of Pharmacology*. 30:93.
12. Bhakuni DS, Satish S, Shukla YN, Tandon JS. (1971) *Phytochemistry*. 10:2829.
13. Chen G, Xu SX, Wang HZ, Zhang RQ. (2005) *Journal of Asian Natural Product Research*. 7(3):265-268.
14. Duan J, Zheng Y, Dong Q, Fang J. (2005) *Phytochemistry*. 65(5):609-615.
15. Duan J, Wang X, Dong Q, Fang J, Li X. (2003) *Carbohydrate Research*. 338(12):1291-1297.
16. Tashichiro N, Naokata M. (1960) *Yakugaku Zasshi*. 80:1298. (1961) *Chemical Abstract*. 55:3006a.
17. Matsuura S, Iinuma M. (1985) *Phytochemistry*. 24(3):626-628.
18. Gu JQ, *et al.* (2004) *Journal of Natural Product*. 67:1156-1161.
19. Higa M, Noha N, Yokaro H, Ogihara K, Yogi S. (2002) *Chemical & Pharmaceutical Bulletin*. 50(5):590-593.
20. Kuo YH, Chang CI. (2000) *Chemical & Pharmaceutical Bulletin*. 48 (8):1211-1214.
21. Sankaram AVB, Sidhu GS. (1971) *Phytochemistry*. 10(2):458-459.
22. Mallavadhani UV, Mahapatra A. (2005) *Natural Product Research*. 19(1):91-97.
23. Mallavadhani UV, Panda AK, Rao YR. (2001) *Pharmaceutical Biology*. 39(1):20-24.
24. Sankaram AVB, Sidhu GS. (1964) *Indian Journal of Chemistry*. 2:467-468.
25. Row LR, Rao CS, Ramaiah TS. (1969) *Indian Journal of Chemistry*. 7:204-206.
26. Sidhu GS, Sankaram AVB, Ali SM. (1973) *Indian Journal of Chemistry*. 11:507-508.
27. Desai HK, *et al.* (1970) *Indian Journal of Chemistry*. 8:852.
28. Likhitwitayawuid K, Dej-adisai S, Jongbunprasert V, Krungkrai J. (1999) *Planta Medica*. 65(8):754-756.
29. Pardhasaradhi M, Rao BN. (1990) *Phytochemistry*. 29(7):2355-2356.
30. Dutta PK, Dutta NL, Chakravarti RN. (1972) *Phytochemistry*. 11 (3):1180-1181.
31. Pardhasaradhi M, Krishnakumari L. (1979) *Phytochemistry*. 18 (4):684-685.
32. Chauhan JS, Kumari G. (1980) *Phytochemistry*. 19:2637-2638.
33. Chauhan JS, Saraswat M, Kumari G. (1982) *Indian Journal of Chemistry*. 21B:169-170.
34. Bhaumik T, Dey AK, Das PC, Mukhopadhyay AK, Chatterjee A. (1981) *Indian Journal of Chemistry*. 20B:664-666.

35. Chauhan JS, Kumari G. (1978) *Journal of Indian Chemical Society*. LV:1068-1070.
36. Mothilal KK, Inbaraj JJ, Chignell CF, Gandhidasan R, Murugesan A. (2004) *Journal of Photochemistry and Photobiology A: Chemistry*. 163(1-2): 141-148.
37. Bhakuni DS, Dhar ML, Dhar MM, Dhawan BN, Gupta B, Srimal RC. (1971) *Indian Journal of Experimental Biology*. 9:91.
38. Han J, Kang S, Choue R, Kim H, Leem K, Chung S, Kim C, Chung J. (2002) *Fitoterapia*. 73(7-8):710-712.
39. Bei W, Peng W, Ma Y, Xu A. (2005) *Life Science*. 76(17):1975-1988.
40. Kawase M, *et al.* (2003) *Phytotherapy Research*. 17(5):495-500.
41. Mallavadhani UV, Mahapatra A, Jamiel K, Reddy PS. (2004) *Biological & Pharmaceutical Bulletin*. 27(10):1576-1579.
42. Hazra B. (1981) *Journal of Indian Chemical Society*. LVIII:627-628.
43. Gautam MP, Purohit RM. (1973) *Indian Journal of Pharmacology*. 55.
44. Dhawan BN, Dubey MP, Mehrotra BN, Rastogi RP, Tandon JS. (1980) *Indian Journal of Experimental Biology*. 18:594.
45. Mondal SK, Chakraborty G, Gupta M, Mazumdar UK. (2005) *European Bulletin of Drug Research*. 13(1):25-30.